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ERRATA: page 129, line 18—for "*B. australis*" *(B. minor)*, read *B. leucantha;*
page 275, line 32—for pl. 34, read pl. 33.

TABLE OF CONTENTS

Annals
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Vol. 27 FEBRUARY, 1940 No. 1

CONTRIBUTIONS TO THE STUDY OF THE TRYPETHELIACEAE[1]

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INTRODUCTION

An interesting anomaly exists between the prevailing ideas as to the relationships of the species of pyrenocarpous lichens with similar species of pyrenomycetous fungi. Although few lichenologists have studied related fungi to any extent, most of them are firmly convinced that the Pyrenocarpeae are monophyletic in origin and that the so-called "lichen symbiosis" has been an association of considerable age that has resulted in significant evolutionary modifications within the group. The majority of mycologists, on the other hand, although as unacquainted with the details of lichen morphology as are the lichenologists with those of the fungi, are as firmly convinced that the same lichens are predominantly the result of the parasitism of various algae by different species of fungi and correspondingly that the group is not a phylogenetically distinct unit.

[1] A revision of a portion of a thesis submitted in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

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A preliminary survey of the families of pyrenocarpous lichens indicated that a study of the Trypetheliaceae should help to clarify the issue outlined above as well as increase our knowledge of the detailed morphology of lichens. This family is almost universally recognized by lichen systematists and they have differentiated it from other families chiefly in that "the perithecia are borne embedded in a stroma." The members of the family are often compared with the stromoid pyrenomycetes where similar structures are said to exist, and the greatest argument among lichenologists for the retention of the Trypetheliaceae as a family has been the major role that the stroma plays in the classification of the group considered analogous to it in the fungi. This latter fact suggested that one logical approach to the study of the relation of lichens to the fungi would be to examine the manner of development of the Trypetheliaceae and to compare this with that of the stromoid members of the Pyrenomycetes. Such an investigation, which has not hitherto been attempted, is reported in this paper. The results obtained do not fulfill all the predictions of those who have failed to base their observations upon developmental studies, and contributions are recorded to the detailed development of members of the Trypetheliaceae, their microscopic morphology in relation to their taxonomic treatment, and their probable evolutionary development.

Historical Review

The Trypetheliaceae is a relatively ancient lichen family, its demarcation from other groups being suggested by Eschweiler as early as 1824. Tuckerman (1872), Müller-Argau (1885), Zahlbruckner ('03–'07, '26), Smith ('21), Malme ('24), Fink ('35), and Keissler ('37) are systematists whose similar treatment indicates its almost universal acceptance. In its earlier stages the family included genera now assigned to other families, as *Arthonia, Glyphis, Chiodecton,* and *Astrothelium.* Müller-Argau, in 1885, delimited it to its generally accepted present form, embracing the genera *Melanotheca, Trypethelium, Tomasellia, Laurera,* and *Bottaria.* Since that time the

Trypetheliaceae have been considered as differentiated from other lichens by the following combination of characters: asci borne enclosed in a flask-shaped fruiting body (perithecium); perithecia united in a "stroma," each perithecium erect, with its own apical pore; thallus crustose, containing *Trentepohlia.* Only two lichenologists, Wainio (1890) and Watson ('29), have distributed such lichens among other genera or families.

A glance at the other families of the Pyrenocarpeae immediately shows that the chief characteristic of the Trypetheliaceae is the aggregation of separate perithecia into a so-called stroma. It is an interesting fact that the microscopic structure of this fundamental character of the family has never been accurately described. This is all the more striking when one carefully considers the following statement which was attached by Wainio (1890, footnote p. xxiii) to a discussion of the stromatic appearance of *Glyphis, Chiodecton,* and *Trypethelium:* "Pour les distinguer des *stromes* des Champignons, nous nommons *pseudostromes* les excipula adhérents, parce que ces organes, aussi bien par leur structure que par leur mode de développement, présentent des différences importantes." Wainio did not describe in detail the major differences that he insinuates are visible between the stromata of fungi and the structures present in the lichens cited. It is evident from the discussion in the text, however, that his concept of pseudostromata was somewhat loosely formulated or else was based upon macroscopic resemblances for he considered that not only species at present assigned to the Trypetheliaceae but that *Glyphis* and *Pertusaria,* among others, possessed them. The term is perpetuated in the literature in connection with several families of lichens (Trypetheliaceae, Astrotheliaceae, Mycoporaceae, Thelotremaceae) by Miss Smith ('21), but she merely accepted Wainio's statements as authority for doing so and did not describe the morphological details of the structure she designated in such a manner.

In discussing the Trypetheliaceae in the first edition of Engler-Prantl's 'Die natürlichen Pflanzenfamilien,' Zahlbruckner ('03, p. 69) made the following statements:

Wainio anerkennt das Stroma oder "Pseudostroma," wie er es bezeichnet, nicht als generisches Merkmal und betrachtet demgemäss die Gattungen der *Trypetheliaceae* als Untergattungen der analogen Genera der *Pyrenulaceae*. Zweifellos sind intermediäre Formen zwischen den gennanten beiden Familien vorhanden, und sie sind in ähnlicher Weise durch Übergänge verbunden wie die *Lecanoraceae* mit den *Lecideaceae*. Bei dem durch den polyphyletischen Ursprung bedingten Parallelismus der Flechtengattungen und bei dem Umstand, dass die Entwickelungsgeschichte der Stromen noch nicht festgestellt ist, scheint er derzeit angezeigter zu sein, die stromabildenen Flechtengenera als eigene Familie zu behandeln.

The same remarks were repeated without alteration in his treatment of the family in the second edition of the same work (Zahlbruckner, '26, pp. 81-82), and in addition the following significant sentence was added at the end: "Diesen Vorgang befolgen auch die Mykologen."

The most recent treatment of the family is that of Keissler ('37), who stated in this connection (p. 422):

Das Characteristische für die vorliegende Familie ist die Ausbildung eines Stromas. Dieses Merkmal spielt bekanntlich in der Mykologie bei den Pyrenomyceten für die Abgrenzung der Gruppen eine grosse Rolle. Es scheint daher wohl angezeigt, jene Gattungen der Flechten, welche sich durch ein solches Stroma auszeichnen, zu vereinigen und als eigene Familie abzutrennen. Anderer meinung ist Vainio, der nur von einem Pseudostroma spricht, dessen Vorhandensein er nicht einmal als generisches Merkmal wertet, sondern die Gattungen der Trypetheliaceen als Subgenera der analogen Gattungen bei den Pyrenulaceen betrachtet. Dementsprechend fasst er zum Beilspiel *Melanotheca* als Subgenus von *Pyrenula* auf. Es lässt sich ja nicht leugnen, dass intermediäre Formen zwischen beiden Familien vorkommen. Es scheint aber doch, solange man über die Entwicklung des Stromas bei den Flechten noch nichts Genaueres weiss, angezeigter, dem Beispiele der Mykologen in bezug auf die Wertung des Stromas zu folgen und die Trypetheliaceen als eigene Familie aufzufassen.

The existing lack of knowledge with reference to the detailed development of the Trypetheliaceae has resulted in the present paper. It is evident that special emphasis should be placed on the hitherto unknown morphology of the so-called stroma.

Materials and Methods

The author has had at his disposal during the course of the investigation numerous collections of pyrenocarpous lichens and some material killed and fixed in the field in Costa Rica by

Dr. C. W. Dodge during the summer of 1936. This has been supplemented by personal collections made near Lake Pontchartrain, Louisiana, in the spring of 1937, and in several states bordering the Gulf of Mexico (particularly Mississippi and Florida[2]) during December, 1938, and January, 1939.

Material killed and fixed in the field was subsequently embedded in paraffin (through the butyl-alcohol dehydration series recommended by Zirkle, '30) or in low-viscosity nitrocellulose (Koneff and Lyons, '37); microtome sections were cut; the resulting sections were stained and mounted in balsam. Sections 7–10 μ in thickness usually proved most useful for observation, and Heidenhain's iron-alum haemotoxylin with a counterstain of phloxine, the best staining combination. The slides resulting form the basis of the morphological observations described below.

Morphology and Development

The thallus of the Trypetheliaceae is very simple. It can be divided into three layers which may be designated as: (1) cortex, (2) gonidial layer, and (3) medulla—following the terminology applied in other groups of lichens (pl. 4, fig. 4). The cortex of most members of the family is very poorly developed, consisting merely of those strands of hyphae intermingled with the bark cells that are located above the algal zone. Some lichenologists might object to calling the structure a cortex, but it is homologous with that structure and for practical purposes must be considered a primitive one. In some members of the family an amorphous crust is formed over the tissue which covers the algal zone. The width of the tissue here designated as cortical varies with the species, and it is convenient to have a term for it that will be useful for taxonomic reference. The gonidial layer is usually fairly thin, somewhat poorly developed, and at times even seems unconnected with the fruiting body of the lichen. The medulla con-

[2] The author wishes to acknowledge assistance offered in the field by Dr. T. W. Brasfield and Mr. Severin Rapp, at Perkinston, Mississippi, and Sanford, Florida, respectively, during this trip.

sists of threads of hyphae intermingled with the bark cells that are located on the inside of the gonidial layer.

In this section the life history of *Melanotheca aggregata* will be described. For other organisms only such points will be noted as are so similar to or so divergent from the processes in *M. aggregata* as to deserve especial comment. Microscopic measurements peculiar to the species are not often given, except that the thickness of the cortex and gonidial layer is usually recorded. The latter structures are "lichen characters" formed by the association of the fungus and the alga. The degree of their development seems as indicative of the age of the association as the morphology of the "stroma," to which the greatest attention is naturally directed.

MELANOTHECA

Melanotheca aggregata (Fée) Müll. Arg.—

It is convenient to begin the description of the development of this species with the germination of the ascospore. This spore swells slightly and a germ-tube is usually sent out from one or both of the terminal cells; the central cells, however, frequently sprout also. Germination has been induced in various nutrient solutions and on bark. Growth is not vigorous with any of these but is relatively more so on bark where the germ-tubes penetrate the surface and form a mycelial network between the cells. The network has reached a considerable size with algae absent.

Filaments of *Trentepohlia* are able to penetrate the bark of many trees and they may live as far as eight to ten cell layers below the surface. It makes little difference whether the alga or the fungus inhabits a particular area first. After they come in contact a distinct vegetative thallus is formed through their combined growth.

The thallus of *Melanotheca aggregata* is completely embedded in the periderm. The fungal component consists of very slender, densely interwoven, hyaline hyphae which show few septa. The youngest stages in the formation of the perithecium consist merely of small spherical clumps of hyphae located on either side of the gonidial layer some distance below the surface of the bark (pl. 2, fig. 1). The primordia may become as large as 12 μ in diameter before visible differentiation takes place.

Darkening of the bark above the perithecial primordium usually accompanies its earliest stages. The darkened area grows wider and deeper throughout the subsequent growth of the perithecium and pseudostroma as will be noted below.

The outer hyphae of the spherical mass assume a definite polarity, growing toward the point which later becomes the apex of the perithecium, and the mass becomes more or less ovoid. The bark cells become more carbonaceous during this process, and it seems fairly evident that the fungal hyphae are the primary influences altering these cells. The ascogonia are now delimited, several being produced in each perithecium (pl. 2, fig. 2). Each ascogonium is composed of a spiral or coiled series of uninucleate cells.

The tissue surrounding the ascogonia continues to alter the bark cells, and these changes, combined with the pressure formed by the ever-increasing mass of hyphae, give rise to the perithecial cavity. Expansion continues until the tip of the mass reaches the exterior of the bark and an ostiole is formed. Trichogynes sent out from the ascogonia grow upward and project in tufts through the ostiole (pl. 2, fig. 3). In all cases favorable for examination they appear to be composed of uninucleate cells. Though they usually extend barely beyond the surface they have been recorded as reaching a distance of 30 μ above the bark.

It should be emphasized that the perithecial cavity has been delimited before great differentiation of the ascogonia has taken place and that its actual formation is due directly to the altering of the bark cells and the pressure exerted on these cells by vegetative hyphae. It should also be noted that the ostiole is formed by the action of these same hyphae before the formation of the trichogynes (and if fusion of spermatia and trichogynes occurs, before any ascogenous hyphae have been formed).

Spermagonia (pycnidia) become evident at this time. They are exceptionally small in the material examined, being about 10–30 μ in diameter. Each spermagonium (pycnidium) contains numerous minute spermatia (pycnidiospores). Although these structures appear regularly enough to suggest that they are a component part of the lichen it is also possible that they might represent a parasitic or saprophytic imperfect fungus.

No cytological evidence for the fusion of spermatia with the trichogynes has been observed. The trichogynes disappear rapidly and the ascogonia enlarge, becoming multinucleate. Several of the ascogonia give rise to ascogenous hyphae, and at least four to eight (sometimes more) can be readily identified within each perithecium. Branches given off by the ascogonia result in the formation of a concave layer at the base of the perithecium (pl. 2, fig. 4). At the same time the perithecium and the perithecial cavity increase in size, primarily through the influence of the hyphae of the envelope upon the surrounding bark cells. Many of these cells lose their normal appearance, shrink, and become hard and carbonaceous. Others are probably digested as the perithecial envelope and its contents expand. Some, particularly those in the uppermost two or three cell layers, are probably sloughed off.

It is common for several perithecia to arise in the same vicinity and to develop simultaneously. Each perithecium, however, originates deep within the substrate and develops independently below the surface of the bark (pl. 2, fig. 7). At the stage described to this point a stroma has not been formed and there is no indication that one will be. Each perithecium is bounded by a definite carbonaceous wall, although the bark cells above it have also become dark and carbonaceous and frequently extend a short distance from the cavity. The bark cells are in close relation with and are often completely surrounded by vegetative hyphae of the fungal component of the lichen. The so-called stroma then originates by the expansion of this carbonaceous tissue so as to include the walls of several adjacent perithecia (pl. 2, fig. 5). Individuals of this species produce perithecia in such great abundance that practically all eventually become embedded in this tissue by virtue of their proximity to each other. The "stroma" which develops in this organism is obviously composed primarily of bark cells and differs materially from stromata as ordinarily conceived in the fungi, which consist only of fungous tissue.

Since the structure developed by this species is quite different from the stromata of the fungi, and particularly from that typical of the stromatic Sphaeriales, it is necessary to consider a question of terminology. How should the stroma-like pustule produced by *Melanotheca aggregata* be designated? The designation *stroma* cannot be applied, but the term *pseudostroma* (previously used by Wainio (1890) for the covering of the aggregate fructifications of certain genera, as *Graphis, Pertusaria, Trypethelium,* etc., which are similar externally but which have different microscopic morphology) might be used in this connection. The term *pseudostroma* would then come to have a specific meaning for the first time and would be defined as an aggregate of perithecia in a pustule simulating the true stroma of the fungi, the pustule being composed primarily of bark cells altered by fungal hyphae.

When *Melanotheca aggregata* has developed to the stage described one finds extensive pseudostromata composed of numerous perithecia (pl. 2, fig. 6). Each perithecium is a flask-shaped structure with a carbonaceous wall (composed of vegetative hyphae in connection with bark cells) and a loosely arranged mass of very slender ascogenous hyphae at the base. Numerous branches are sent out from this basal region (the paraphyses). They are themselves unbranched and they completely fill the perithecial cavity before any differing elements are noted. The hyphae are too small to distinguish whether or not septa might be present, but it is evident that they are multinucleate throughout the course of their existence.

After the paraphyses have filled the perithecial cavity the first ascus primordium can be noted. It may be distributed at random among the paraphyses and it usually originates near the center of the cavity. One cell near the tip of a hypha simply becomes much larger and is seen with a definitive nucleus.

The hypha from which this has arisen is similar to those which gave rise to the paraphyses—very slender, with no visible septa, and with several nuclei. Actual union of the nuclei has not been observed at this point but conditions approaching crozier formation are apparent, and all evidence points to the fact that a nuclear fusion must take place here. The young ascus enlarges rapidly, its nucleus increases relatively in size, and the cytoplasm becomes quite vacuolate.

As the number of asci increase a more or less definite hymenium is formed, and the hyphae at the base of the perithecial cavity become more compact. The hyphae are so small and the concentration of protoplasm is so great that the heavy stain that is taken obscures many details. As contrasted with the nuclei of the ascogenous hyphae, however, the definitive nucleus of the ascus is plainly visible.

Compared to asci in other members of the Trypetheliaceae those of *Melanotheca aggregata* are rather small, and the details of nuclear division are not exceptionally clear. In spite of this it is certain that the fusion nucleus undergoes three successive divisions resulting in the formation of eight free nuclei. Astral rays have not been seen but cleavage planes are fairly evident. Eight uninucleate spores are delimited from the epiplasm of the ascus and the process is evidently similar to that described by many workers for other Ascomycetes. By two subsequent mitoses, accompanied by cell-wall formation, a 3-septate spore, 12–18 × 5–7 μ, is produced. The spore is brown at maturity.

Melanotheca cruenta (Mont.) Müll. Arg.—

This species has a thin thallus, a cortex 16–55 μ, a gonidial layer 10–45 μ, and a medulla varying in thickness. In most cases the medulla extends a considerable distance among the cells of the bark in which the plant grows—often to the extent of 12–16 cell layers. In some of the layers, and particularly in the uppermost, alteration of the bark cells from their normal condition is easily observed.

Ascogonia may be produced either above or below the gonidial layer. They are first seen as hyphal coils and they develop in the same manner as those of *Melanotheca aggregata* described above. The carbonaceous wall of the perithecium becomes embedded in pseudostromatic tissue; it is composed primarily of vegetative hyphae but encloses a large number of altered bark cells. Such cells are not confined to the perithecial wall but extend in all directions, forming pseudostromata. Ascogenous hyphae arise in the lower portions of each perithecium and give rise to asci and paraphyses. The young ascus is uninucleate. Three successive nuclear divisions follow and eight spores are delimited. After the formation of the ascospore membrane the nucleus of each spore divides to form a 3-septate spore 20–35 μ in length.

The pseudostroma of this species may appear in varying shades of red, forming a striking contrast with that of *Melanotheca aggregata* which is quite black. The perithecia sometimes stand well exposed on the surface of the bark. At other times they are borne entirely submerged with only an ostiole projecting which is so minute that it can scarcely be seen. Young pseudostromata are sometimes covered with cortex and a gonidial layer but these structures have usually been shed in older material. Sometimes the pseudostromata are continuous and confluent; on a different type of bark, however, pustules readily form. The elevation of the pseudostroma seems to depend upon the nature of its substrate. Although the pseudostromata of *M. aggregata* show great polarity of aggregation, those of *M. cruenta* exhibit great variations, both in this regard and in other characteristics, resembling the variability of other groups of stromoid plants.

Melanotheca arthonioides (Eschw.) Müll. Arg.—

The cortex of this species is 5–45 μ thick and contains few distinguishable fungal hyphae. The gonidial layer is borne in the bark and varies from 5–35 μ in thickness. The medulla extends several cell layers in depth. The substrate is considerably modified by the activity of the fungal component of the lichen. Counts on the number and disposition of the cells of the bark disclose the probability that a number have been removed during the formation of the perithecial cavity. The carbonaceous wall of the perithecium is denser than in any species previously discussed, but in favorable sections it can be ascertained that the structure is composed largely of bark cells (pl. 4, fig. 6).

The perithecial initials and young perithecia undergo individual development, but the gradual expansion of the blackened zone of the bark cells unites adjacent ones into typical pseudostromata. Single perithecia can sometimes be found but they do not often occur. The cortex and gonidial layer rarely seem in intimate connection with any carbonized bark cells. Usually the contour of the bark is not appreciably modified by the pseudostromata, and in the specimens examined the perithecia were completely immersed in the substrate. The ascogenous hyphae, paraphyses, and the nuclear history of the ascus are similar to those of other species of the genus.

Melanotheca concatervans (Nyl.) Zahlbr.—

Macroscopically the thallus of this species appears rather thin, almost as though algae were lacking. Microscopic examination reveals, however, that the cortex is 15–25 μ in thickness; the gonidial layer 15–30 μ; the medulla extending some distance farther. The perithecial initial is located deep within the bark (often below the gonidial layer); in its earliest stages it consists of a few coils of deeply staining hyphae in a spherical mass. Trichogynes have been observed; they are delimited slightly before the ascogenous hyphae appear. The early stages of the perithecial cavity are developed through the influence of the vegetative hyphae surrounding the perithecial initial, but the paraphyses sent out from the young ascogenous hyphae are responsible for its subsequent enlargement. At maturity the perithecia are embedded rather deeply in the bark, and the fungal hyphae exert visible effects on most of the upper cell layers. As each perithecium develops, the zone of carbonized bark cells spreads toward all sides and results in typical pseudostromata. The details of development are similar to those of the three other species of *Melanotheca* discussed above.

TRYPETHELIUM

Trypethelium tropicum (Ach.) Müll. Arg.—

Interesting characteristics of the gonidial layer are shown by the material of this species. The algae develop very deep in the bark of the tree upon which the lichen is growing and may be present whether any fungal hyphae can be distinguished or not. As the fungus penetrates into the periderm the outer bark layers are sloughed off until the cortex consists of only one or two layers of bark cells surrounded by fungal hyphae and the gonidial layer lies very near the surface. The cortex is then 5–20 μ, the gonidial layer 10–30 μ in thickness. The ascogonia have been found when the thallus is in this condition. The perithecial initials are either intermingled with algal cells or are located just above the gonidial layer surrounded by cortical tissue. Trichogynes are delimited and the entire primordium is similar to the same structure in species of *Melanotheca.*

After the young perithecium is formed, however, further development differs materially from any species of *Melanotheca.* Additional fungal hyphae are built up on the exterior of the ascogonial coils and a relatively large hyphal mass is produced. The mass is brownish in young stages but soon becomes carbonaceous and increases in size during the growth and maturation of the ascogenous hyphae and asci. The structure formed is homologous with the perithecial walls of species of *Melanotheca* as the latter structures are interpreted in this paper. The perithecial walls are thus formed separately and above that portion of the bark in which the cortex and gonidial layer are located (pl. 3, fig. 3). The nearness of some of the perithecia to others results in a great many of them becoming united, but the polarity inducing this is not nearly so great as in *Melanotheca.* It would seem that little polarity exists in this species, since almost as many perithecia occur alone as in groups.

All lichenologists have not assigned the species discussed to the genus *Trypethelium* although most modern authorities have done so, justifying such disposal upon macroscopic observation, for the masses of "united" perithecia are somewhat comparable in external appearance to the pseudostroma of *Melanotheca* (pl. 1, figs. 2 and 6). Microscopic examination discloses the fact that *Trypethelium tropicum* differs as fundamentally in its morphology from *Melanotheca aggregata* as the pseudostroma of *M. aggregata* differs from the "stroma" conceived in the minds of lichenologists as characteristic of the Trypetheliaceae. The "stroma" of *Trypethelium tropicum* is not composed of coalesced vegetative tissue unconnected with the perithecia, nor of altered bark cells, but of coalesced perithecial walls, homologous to the perithecial wall embedded in the pseudostroma of species of *Melanotheca.*

Trypethelium annulare (Fée) Mont.—

The perithecial initials of *T. annulare* are located farther below the surface of the bark than in any species of the genus examined. The gonidial layer, 10–35 μ in thickness, is often located eight to ten cell layers down and the ascogonia are borne below this layer. After the trichogynes disappear the ascogonia enlarge into ascogenous hyphae. Many of the bark cells around the young perithecium are rearranged and somewhat altered by fungal hyphae, though they never become dark and carbonaceous, and the expenditure of considerable force is a factor in the enlargement of the perithecial cavity. The perithecium is usually solitary, and its development is unconnected with that of any other. A carbonaceous perithecial wall may be conspicuous although it is often incomplete. The perithecium is embedded in cells of the bark. Such cells are almost normal in appearance and the structure formed, though similar in construction to species of *Melanotheca,* differs greatly in appearance (pl. 3, fig. 2). The extent of aggregation also differs from that genus for here many perithecia are solitary. It is interesting to note, however, that when two or more perithecia do occur in close proximity the cortical and gonidial layers are then considerably raised and hyphal threads extend among several loosened bark cells from one perithecium to the other. This does not often occur, and where possible the cortex sags to its natural level before rising above the neighboring perithecium.

Although this species has usually been considered a member of *Trypethelium* there is really less reason for its placement there on the basis of our present system of classification than for *T. tropicum,* described above. The organism is somewhat similar to *T. tropicum* in its earlier stages of development. However, a great difference exists in that the perithecial initial of *T. tropicum* is found near the surface of the bark and the perithecial wall stands free at maturity, whereas in *T. annulare* the initials are located very deep in the bark with the result that the perithecia are also deeply buried. The fact that the perithecia are produced below the surface of the substrate is probably the factor that has allowed the classification of this species in the genus, for lichenologists looking at a specimen, even under magnification, might think the perithecia embedded in a common stroma rather than in the bark (pl. 1, fig. 1). The bark cells are arranged around the perithecia in a manner similar to the pseudostroma of *Melanotheca,* but there is no carbonized alteration of these cells and the cortex and gonidial layers extend conspicuously throughout the structure. The "stroma" of this species is thus to be interpreted as vegetative lichen thallus and the perithecia are to be considered as merely immersed in the bark. The close proximity of occasional perithecia, however, shows a tendency that perhaps reaches a higher development in the species next to be discussed.

Trypethelium pallescens Fée—

As in *T. annulare,* the perithecial initials are formed unusually deep among the cell layers of the bark. They are formed below the gonidial layer, which is 11–25 μ thick, and covered by a cortical layer 15–45 μ in thickness. Perithecia are developed singly but considerably greater polarity of aggregation is evident than in any species of the genus discussed to this time. As the ascogonia develop and the perithecia expand, they raise, but do not rupture, the upper layers of the bark, and the bark cells below the fourth or fifth layers become loosely arranged. The perithecia develop a carbonaceous wall formed entirely of fungal hyphae. The top layers of bark cells are separated completely along the area of polarity, and the cells just below these layers are forced apart so that they stand loosely arranged in a network of fungal hyphae (pl. 3, fig. 1). The entire body of the perithecium is located below the surface of the bark, which usually contains both cortical and gonidial tissues, but which remains unbroken itself.

The "stroma" of this species then consists of a raised pustule with cortical and gonidial layers on the upper surface, followed by a perithecial layer interspersed with a loose network of fungal hyphae between somewhat altered bark cells. This structure is quite different from anything previously described in this paper, and the author suggests that the term "substroma" be used to refer to it. The term will be defined as an aggregate of perithecia in a pustule, the pustule being composed as much or more of fungal tissue than of bark cells, with whatever bark cells are present being loosely and somewhat irregularly arranged. This structure is interpreted as derived from species similar to *T. annulare* where at times transition filaments were noted between perithecia which occasionally occurred in close proximity.

Trypethelium eluteriae Spreng.—

In this species the cortex is 24–60 μ, the gonidial layer 35–70 μ in thickness. The perithecial initials are formed below the gonidial layer and the polarity of their aggregation is even more pronounced than in *T. pallescens;* consequently the initials are clustered in groups. As the clusters develop the mass formed is so great that many of the bark cells above the primordia are sloughed off. Others become embedded in excess fungal hyphae in a manner similar to the bark cells in the substroma of *T. pallescens.* In this case, however, the perithecia are so close together and so near the surface of the bark that few bark cells can be enclosed (pl. 4, fig. 9).

Here, for the first time, we find a sort of "stromatic" structure which must be somewhat similar to that on which the lichenologist's concept of the Trypetheliaceae has been based.

At maturity a pustule composed primarily of interwoven hyphae is developed, within which perithecia are enclosed (pl. 1, fig. 4). The pustule stands fairly free on the surface of the bark and few bark cells are embedded in it (pl. 3, fig. 4). The author considers this an advanced substroma in contrast to the primitive substroma described for *T. pallescens.* His reasons for not calling it a true stromatic form will be given in the discussion. It is fairly easy to imagine a series of steps in the evolution of such a substroma, starting with the condition found in *T. annulare,* passing through *T. pallescens,* and ending in *T. eluteriae.* In this series the development of perithecia has been gradually transferred from below the bark cells to within a fungal matrix, the transition being due primarily to a gradual increase in the polarity of aggregation of perithecial initials.

TOMASELLIA

Tomasellia aciculifera (Nyl.) Müll. Arg.—

Cortical and gonidial layers of this species are very poorly developed. Filaments of *Trentepohlia* do not form definite algal layers but occur sparsely in isolated clumps. The perithecial initials arise three or four cell layers below the surface of the bark. Each perithecium begins development separately, but many of them become joined at a later stage and typical pseudostromata are then formed. Only five to ten perithecia are embedded in each pustule, but otherwise this species is similar to *Melanotheca* in "stromatic" morphology. The wall of the perithecium is incomplete and the ascogenous hyphae appear to arise directly upon bark cells. If the species of *Pyrenula,* represented in pl. 4, fig. 5, were pseudostromatic, a structure somewhat similar to that of this species would be observed.

LAURERA

Laurera madreporiformis (Eschw.) Riddle—

The gonidia of this species are borne in groups a great distance below the surface of the bark. Often a layer 5–45 μ in thickness is formed, but the algae usually reproduce vigorously in clusters and relatively large assimilative areas are produced which push through the surface of the bark. In this process the top layers of bark cells are broken and the remnants sloughed off, leaving only fungal hyphae which form an amorphous crust representing cortical tissue.

Perithecial initials of this species are embedded in the bark above the gonidial layer and consist of several ascogonial coils. Trichogynes have not been seen. The initials are borne in fairly well-defined groups and typical substromata, similar to those of *Trypethelium eluteriae,* are finally formed (pl. 1, fig. 3). Bark cells fill the lower half of the substroma and a few are also embedded in the perithecial walls (pl. 4, fig. 1).

Laurera sanguinaria Malme—

The development of this species is similar to that of *L. madreporiformis* except that the perithecial initials are usually borne below the gonidial layer. The latter is only 10–25 μ thick, and is not quite so extensive as in the preceding species. The substromata, however, are more widespread and are composed predominantly of fungal tissue (especially in the lower half of the structure). Conspicuous bark cells, arranged in their natural layers, however, are found above the perithecial walls (pl. 4, fig. 3). A typical substroma, similar to those of *Trypethelium eluteriae* and *Laurera madreporiformis,* is formed.

BOTTARIA

Bottaria cruentata Müll. Arg.—

The cortex and gonidial layers of this species are relatively well developed, being 20–40 μ and 15–20 μ thick, respectively. The material referred to this species is interesting because it shows the most striking case of alteration of bark tissue that I have yet seen. The perithecial initials are borne extremely deep in the bark and the entire altered portion of the pustule may extend as far as 45 cell layers below the surface. The structure developed is similar to the pseudostroma of *Melanotheca* and although the earliest stages in its development have not been found it was probably formed in a similar manner.

Bottaria must be considered a relatively rare genus, since

Zahlbruckner ('22, '31) listed only seven species. Evidence indicates that the material studied here might be a member of the Astrotheliaceae rather than the genus to which it has been assigned. The specimens, though, are identical with the material described by Müller-Argau (1885) for that species, and they are considered here as the only authentic material available for our concept of the genus. Other species have at times been incorporated in *Bottaria,* as *Anthracothecium ochraceo-flavum* and *A. pyrenuloides.* These species are illustrated in pl. 4, figs. 7 and 8, but at times aggregations of perithecia are found whose macroscopic appearance would simulate the condition found in *Trypethelium annulare.*

Cytology

Since cytological similarities are indicative of probable relationships it seems desirable that the cytological phenomena in the asci of these lichens be compared with those described for analogous fungi. No similar study has been made on any member of the Trypetheliaceae; the Moreau's ('32) observations upon *Dermatocarpon* constitute our only knowledge of such processes among the Pyrenocarpeae.

Division stages are rarely encountered in sections of members of the Trypetheliaceae made from material killed at random intervals. The author was fortunate, however, in securing material of *Trypethelium annulare* which was more favorable for study and which has yielded the observations recorded below. A critical analysis of chromosome numbers and morphology, with a discussion of the mechanism of spore delimitation, is reserved for what is hoped may be a more comprehensive treatment at a subsequent time. The author is primarily interested in showing how closely the processes approach those known for the fungi.

Asci and paraphyses arise from a layer of ascogenous hyphae located at the base of the perithecial cavity. The layer is so dense and the elements are so small that it is difficult to trace their course in serial sections. The outgrowths from the ascogenous hyphae all appear multinucleate, and in most cases it is impossible to detect any differences in these nuclei. Occasionally, however, the tips of the shorter ascogenous hyphae appear somewhat recurved and the second nucleus is slightly larger than the others. It is such a short transition from this condition to the young ascus that the author is inclined to interpret the penultimate nucleus as a fusion nucleus and the recurved hypha as a crozier. Many transitions occur, not so easy to interpret, but a uninucleate ascus always results whose nucleus, contrasted to those of the ascogenous hyphae, is very distinct. The resulting definitive nucleus does not at first differ in constituency from any of the nuclei originally present, but it is slightly larger. The nucleus undergoes an increase in size before it divides and the ascus shows a corresponding change. While the nucleus enlarges it becomes less dense and a chromatic reticulum and dark-staining nucleolus show clearly. Usually chromatin threads are attached to the nucleolus. Spireme threads are organized. The nuclear membrane disappears shortly after this stage and subsequent development remains intranuclear throughout the division. After the disappearance of the membrane small chromatic fibers attached to the nucleolus radiate into the nuclear area. The nucleolus disappears and the spindle develops in the same area in late prophase. The spindle is located in the center of the ascus and is much longer than in either the second or third division. Chromatin globules are apparent at intervals on the spindle fibers. Astral rays are rarely seen.

Two nuclei reorganize completely from the first division. No cell wall is formed. The nuclei are much smaller than the definitive nucleus. The nucleolus, though smaller, is just as conspicuous. Numerous chromatic granules are present in the nuclear sap. Only a slight interval exists between the first and second divisions and the two nuclei divide simultaneously. The spindle is rather short; astral rays are not seen.

Four nuclei, similar in size and appearance to those resulting from the first division, reorganize from the second division. Some time seems to elapse between the second and third divisions, but the nuclei do not increase in size; they simulate resting nuclei. A conspicuous chromatic reticulum is present in the nuclear sap. The four nuclei divide simultaneously.

The spores are delimited immediately after the third division. Astral rays have not been correlated with this process. Definite cleavage planes seem evident as soon as the ascospore initials become distinct, and the final delimitation from the epiplasm of the ascus is due to their rapid development.

By virtue of the parallel arrangement of the spindles of the third division the young ascospores occupy an oblique position in the ascus. Growth of the ascus and ascospore is at first very rapid but slows down considerably as the more mature stages are reached. The uninucleate spore initial undergoes mitosis, accompanied by the septation of the spore. The spore and the ascus increase considerably during this division and the bicellular spore is quite vacuolate. The membrane that surrounds the spore has increased in thickness and is now a well-defined spore-wall. A second mitotic division occurs after which septa are again formed. During the last division both the ascus and the spores have increased greatly in size; the latter have secreted thicker walls. Eight three-septate spores are always produced in each ascus.

Lichen Acids

A view frequently expressed is that the lichen acid is a product peculiar to the lichen thallus and one that has been built up by the continual association of fungus and alga over a long period of time. Smith stated ('21) that their occurrence is of particular significance because of the fact that they have been found only in lichens and that they have been found in the majority of lichens examined.

Tests for the presence of these substances are based upon color reactions induced by certain chemicals. Such practice was first suggested by Nylander (1866, 1867) who recommended calcium hypochlorite and potassium hydroxide for that purpose. Both of these have been universally used since that time. In addition Asahina ('34) has recently proposed the use of paraphenylenediamine, and this reagent is now being widely used.

To provide data which might have some validity in indicating the relative abundance of lichen acids among the families considered in this paper the reaction of several pyrenocarpous lichens with certain chemical reagents is given in table I. Attention will be called to this data in the discussion below.

TABLE I

REACTIONS OF THE THALLI OF SOME PYRENOCARPOUS LICHENS WITH CHEMICAL REAGENTS

Species	Calcium hypochlorite*	Potassium hydroxide	p-phenylene-diamine
Pyrenula nitida	–†	–	–
Pyrenula laevigata	–	+	–
Pyrenula Coryli	–	–	–
Porina chlorotica	–	+	–
Porina mastoidea	–	+	–
Pseudopyrenula Papula	–	–	–
Clathroporina amygdalina	–	+	–
Arthopyrenia punctiformis	–	–	–
Arthopyrenia rhyponta	–	–	–
Anthracothecium ochraceoflavum	–	+	+
Anthracothecium pyrenuloides	+	+	–
Melanotheca aggregata	–	+	–
Melanotheca cruenta	–	+	+
Melanotheca arthonioides	–	–	–
Melanotheca concatervans	–	–	–
Trypethelium eluteriae	–	+	–
Trypethelium ochroleucum	–	+	–
Trypethelium tropicum	–	–	–
Trypethelium pallescens	–	+	–
Trypethelium virens	–	+	–
Trypethelium annulare	+	+	–
Tomasellia aciculifera	–	+	–
Bottaria cruentata	–	+	+
Laurera madreporiformis	–	+	–
Laurera ambigua	–	–	–
Laurera sanguinaria	–	+	+

* Calcium hypochlorite = saturated aqueous solution; potassium hydroxide = 7% aqueous solution; p-phenylenediamine = 0.1 g. in 5 cc. 95% alcohol.

† + = visible color change; – = no reaction.

Spore Germination

The difficulty of growing lichens in artificial culture is one of the reasons often advanced to support the belief that they are so distinct physiologically as to be monophyletic in origin. As far as the author has been able to ascertain no attempts have been made to culture members of the Trypetheliaceae.

Spore-germination tests on several members of the family were made in a wide range of nutrient solutions and on various agars, following the method reported by Wehmeyer ('23). All cultures were kept in a well-lighted room at 20–25° C. Little difficulty was experienced in germinating spores within three months of the date of collection of the material although the percentage of germination was never high. Spores of material dried for more than three months failed to germinate.

Trypethelium and Melanotheca: Spores of *Trypethelium pallescens, T. ochroleucum, T. annulare, T. eluteriae, T. tropicum, Melanotheca aggregata,* and *M. cruenta* have been successfully germinated and (with the exception of *T. ochroleucum)* mycelium resulting has been grown in culture. In *Melanotheca aggregata* considerable growth on bark has taken place. These species possess phragmospores. The terminal cells are invariably the first to germinate, and this often takes place within forty-eight hours. Germination of the central cells is not uncommon, although this usually does not occur until at least twenty-four hours later. Young germ-tubes are non-septate; septation does not occur for at least one week.

Laurera: Spores of *Laurera madreporiformis* and *L. megasperma* have been successfully germinated. Each merispore may give rise to a germ-tube. A rather large number of germ-tubes per spore may occur but three or four is the usual number seen. When fresh material is used germination may begin within forty-eight hours. The germ-tubes remain non-septate for one or two weeks, after which time septa are formed and lateral branches may develop.

Transference of germinating spores of either group to agar plates yields a rather slow-growing mycelium. Muriform spores rarely progressed beyond the germ-tube stage. Neither asexual spores nor perithecia have been produced in cultural studies. Furthermore, the mycelium, whether allowed to remain on the original medium or transferred to new substrata, failed to live more than six months.

The cultural work undertaken on members of the Trypetheliaceae can be summarized as follows: (1) ascospores have been successfully germinated in three genera and ten species; (2) the spores, if taken from fresh material, show a low percentage of germination but produce mycelium under a varying number of conditions; (3) phragmospores usually germinate from the terminal cells only, but germination of the central cells is not uncommon; (4) each merispore of a muriform spore is a potential germ-cell; (5) mycelial growth on agar cultures is exceedingly slow.

Substrate Relations

Lichenologists who have paid particular attention to the attachment of bark-inhabiting members of the higher lichens (foliose and fruticose forms) have agreed that if the rhizoids penetrate below the surface of the bark they do not extend far into the periderm (Schwendener, 1860, 1863, 1868; Lotsy, 1890). Bornet (1873) described the penetration of the fungus and alga of crustose forms into the periderm but did not mention their action on the substrate. According to Frank (1877), lichen hyphae and species of *Trentepohlia* dissolve the cellulose of the periderm cells and utilize nutritive material obtained from this action. Lindau (1895) vigorously opposed Frank's conclusions, stating that the organisms could neither penetrate the periderm cells nor dissolve the cellulose available. Fink ('13) gave a general discussion of the relation of lichens to their substrata and made the following remarks in that connection (p. 148):

It is certain that hypophloedal lichens which live in the periderm for a year or more outside the relation with an algal host must take nourishment from the periderm, though they do not dissolve sufficient material from the periderm walls to be detected by microscopic examination. So we must believe that these plants secure nourishment from the periderm without entering the cells or producing appreciable diminution in walls or other effects that can be detected without chemical analysis.

Bioret ('22) examined the thalline structure of bark-inhabiting Graphidaceae without reporting alteration of the bark cells by members of the group.

It is very difficult to say what the relation of the Trypetheliaceae to their substrata might be. Each species should be considered as a specific case. Proof that food material is actually obtained from the bark would be best if based upon chemical analyses of the bark cells before and after growth of the lichen, but this is almost beyond technical possibilities. Overwhelming evidence points to the fact that the lichens are not parasitic on the trees, although the author has often heard Dr. C. W. Dodge point out that pyrenocarpous lichens on trees that had just been cut would soon discharge their spores. I am able to confirm these observations and to state further that I have collected good fruiting material of this family only upon living trees. Perhaps the moisture ordinarily present in the bark is a necessary factor for vegetative growth.

Whether or not some of the plants acquire a portion of their food saprophytically, however, is another question. Admittedly one hesitates to make such an assertion—for a statement would be difficult to prove from purely anatomical considerations. Attention might be called to the fact that the bark cells composing the pseudostroma of species of *Melanotheca* are altered by the fungus. The alteration does not seem to be purely physical, but a definite carbonization, a chemical alteration, also occurs. This same condition has been observed in *Tomasellia* and *Bottaria.* In other genera evidence is not so striking. Although the bark cells in the substromata of *Trypethelium pallescens,* for example, have been separated and certainly look as though something had happened to them, they are no darker or more altered than those of adjacent bark.

If the plants should prove selective in substrate among trees having the same characteristic bark anatomy the fact might suggest preference for a certain type of food. Plants collected in Mississippi and Louisiana have been studied in this regard. Only those species collected ten or more times, backed by herbarium specimens of both lichen and substrate, are reported here. Of the ten species of the Pyrenulaceae and Trypetheliaceae which fulfill these requirements, eight have been collected on a single genus. Two other species have been collected on three genera but variations in the anatomical characteristics of the pseudostromata, cortex, and gonidial layer suggest that two or even three species might be involved in each case. More data covering a larger area must be accumulated, but it is interesting to note that preliminary study in a relatively limited locality indicates considerable lichen-substrate specificity.

The author is inclined to agree with Fink's ('13) generalization for certain hypophloedal lichens, as far as the Pyrenulaceae and Trypetheliaceae are concerned, i.e., that some of these organisms must acquire a portion of their nourishment from their substrata.

Notes on the Pyrenulaceae

The development of members of the Trypetheliaceae is very similar to that reported by Baur ('01) for *Pyrenula nitida.* Since this similarity is so great as to postulate close relationship the morphology of species classified in the Pyrenulaceae has been studied. In this section the author's notes on the development of *Pyrenula nitida* will be compared with Baur's description. The microscopic morphology of some other species of the family will be compared so that some concept of the degree of development of certain characters (particularly the gonidial layer and the extent of aggregation of the perithecia) may be obtained.

Pyrenula nitida (Schrad.) Ach.—

According to Baur ('01), the perithecial initials are first seen as hyphal knots located at about the same height as or slightly below the gonidial layer. In the material studied by the author they were found three and four cell layers below any algae present. Baur observed that early in development, even before the differentiation of the ascogonia, polarity becomes evident and the hyphal knot grows toward the exterior, the ends of the hyphae boring through the bark and reaching the surface. He compared these hyphae with the first paraphyses of *Pertusaria, Physcia,* etc., and suggested that it was their function to clear the way toward the exterior. In material studied by Baur the perithecium increased in size and resulted in a stage in which the form and almost the size of the mature fructification were reached before ascogonia were delimited. My material confirms these statements except that the ascogonia were produced in the early stages of perithecial expansion. After ascogonia, trichogynes are formed which grow toward the exterior and project beyond the surface of the bark. As was emphasized for members of the Trypetheliaceae, the perithecial cavity originates through the action of vegetative hyphae and trichogynes emerge through an ostiole before any ascogenous hyphae arise. The perithecial wall is not often composed of disintegrated substrate but the base of this wall is coalesced with dark, carbonaceous bark cells. A perithecium is covered by or partly immersed in the substrate, depending upon its state of maturity. In youth the uppermost bark cells cover it; later it breaks halfway through. The perithecia are almost spherical, 300–900 μ in diameter, and sometimes are clustered, showing a tendency to aggregate in groups. The perithecial wall is complete. The development of this organism is so strikingly similar to members of the Trypetheliaceae as to be almost identical.

Other Species:—

In *Pyrenula Coryli* Mass. the gonidia are exceptionally sparse; I have found them very infrequently and only in the neighborhood of perithecia. The gonidial layer of *Pyrenula laevigata* Arn. is very variable; often, however, it consists of only a single cell embedded in a mass of hyphae. The thallus of *Arthopyrenia punctiformis* Mass. is composed primarily of a black layer or a black scale over the surface of the bark; gonidia are rarely found and in all cases observed consist of single cells. In the three species listed in this paragraph the perithecia never show any transitions toward a pseudostromatic or substromatic structure.

In *Anthracothecium ochraceoflavum* (Nyl.) Müll. Arg. and *A. pyrenuloides* (Mont.) Müll. Arg., on the other hand, well-developed gonidial layers are found. In *A. ochraceoflavum* the cortex is 15–65 μ and the algal layer 5–20 μ thick. *A. pyrenuloides* has a cortex 20–55 and a gonidial layer 10–20 μ thick. In both species the perithecial initials are borne below the surface of the bark, and the perithecia may arise near each other or be widely separated. These transitions make the generic determination of the species a matter of opinion, for it would seem from macroscopic appearance that the specimens examined could equally well be assigned to *Bottaria.*

Anatomical observations on the species mentioned, as well as on others whose descriptions are omitted, support the following suggestions: (1) some members of the Pyrenulaceae are very primitive lichens as far as the relation of the fungus to the alga is concerned; (2) there are tendencies to evolve aggregated perithecia and a well-developed gonidial layer in the family; (3) some species show a morphology similar to that of species assigned to the Trypetheliaceae.

Discussion

The morphology displayed by members of the Trypetheliaceae makes necessary the discussion of a descriptive term that has been used in connection with the group. This object of particular concern is the term *stroma* of which recent elucidations have been given by Orton ('24), Wehmeyer ('26), and Miller ('28a) for certain fungi. A *stroma* is ordinarily defined as a fungus body formed of coalesced hyphae that does not arise as the result of a sexual stimulus. Although admitting necessary broadness in defining this structure it hardly seems logical to accept a definition such as the above which would place all paraplectenchymous and pseudoparenchymous tissues in stromatic genera whether connected with fructifications or not.

Examples are: the cortices of many lichens, the rhizomorphs of Basidiomycetes, sclerotia, etc. Miller's paper ('28a), in which he implies that all Sphaeriales are partially stromatic, is based upon important theoretical considerations, but actually the best that he does to limit the term is to consider coalesced hyphae belonging to the haploid generation stromatic tissue.

The designation *stroma* has been applied to structures in many families and many genera, often without sufficient knowledge of the microscopic morphology of the structure involved and without a basis from developmental morphology. The term was first used in connection with the structures on or in which the perithecia of *Sphaeria* are borne (Persoon, 1796). Five years later Persoon (1801) employed the term only in connection with a certain group of his genus *Sphaeria,* the examples given now being assigned to *Cordyceps, Xylaria* and *Hypoxylon.*

Xylaria, Hypoxylon, and some of their relatives have been shown to have a similar type of development in which the tissue bearing perithecia is divided into two layers (Füisting, 1867; Lupo, '22; Miller, '28a, '28b; Brown, '13; Dawson, '00; Wehmeyer, '26). Conidia are usually produced from an outer layer; subsequently perithecial initials develop near the outer portion of the inner layer. Such correlated characters have given rise to the opinion that these genera must be members of natural groups, and these groups have been consistently called "the stromatic Sphaeriales" and "the stromatic Hypocreales." There would be some advantage on the basis of exact usage to limit the term *stroma* to those groups which possess the following combination of characters: (1) perithecia borne in a mass of interwoven vegetative tissue; (2) mass divided into two layers; (3) asexual spores produced by the outer layer; (4) perithecial initials developed from the outer portion of the inner layer. The structure could then be definitely delimited on the basis of a combination of fairly easily observed microscopic characters.

Although some of its relatives do, *Cordyceps* does not possess the correlated characters mentioned above (Varitchak, '31; Jenkins, '34). In *Cordyceps* the perithecia are borne in a mass of purely vegetative hyphae, and current usage perhaps demands that this structure also receive the appellation *stroma.* The separation of "stromatic" forms from their nearest intergrading relatives is a difficult problem. The term *stroma* has been applied to so many structures that only one with a conservative attitude and proper acquaintance with all forms involved should try to limit it, but one set of the near intergrades must be discussed because it occurs in the group studied here. The author feels that the term *stroma* was never meant to apply to structures which were not purely fungal in nature, as is the case in members of the Trypetheliaceae. Even though one might claim the presence of bark cells relative and contend that pustules *almost* devoid of bark cells are entitled to be called stromata, the question of their separation from structures with more bark cells (*Trypethelium pallescens,* for example) becomes a matter of great difficulty. Here there would be great advantage, particularly as far as any phylogenetic significance attached to the term is concerned, to have the structure based upon a combination of characters as was suggested above, rather than upon a single feature. If the meaning of the term is to be at all relative, however, current usage would seem to demand at least that a stroma be composed entirely of fungal tissue, rather than to admit that structures containing bark cells could come within the scope of the term. The latter alternative would leave open the possibility that such forms as *Melanotheca aggregata* (where the "stroma" is composed primarily of altered bark cells) could be called stromatic. The developments of the pseudostroma of *Melanotheca* and of the stroma of *Hypoxylon* are so different that the application of the same term to the structures in which their perithecia are borne seems absurd.

For the reasons given I contend that a true stroma has not yet been found in the Trypetheliaceae. Following such reasoning I have felt it necessary to define two other terms on the basis of microscopic morphology for the more accurate description of members of that family—and perhaps of other organisms that will be found to simulate the formation of a stroma on macroscopic appearances. These are: *pseudostroma*—an aggregate of perithecia in a pustule, the pustule being composed primarily of bark cells altered by the fungus; and *substroma*—an aggregate of perithecia in a pustule, the pustule being composed of as much or more of vegetative hyphae than of bark cells. That there are transitions between non-stromatic, pseudostromatic, substromatic, and possibly stromatic forms is of course inevitable, but the recognition of the tendencies of evolution within various groups makes their distinction important.

The occurrence of various types of "non-stromata" and of intermediate transitions between these and substromata within generic groups (as the four types of development described in *Trypethelium)* indicates that we must regard the taxonomy of the Pyrenulaceae and Trypetheliaceae as in an unsettled state. Opinions on the limitations of the genera involved are withheld pending a taxonomic revision of the group.

Almost all investigators throughout the history of lichenology have recognized the aggregation of perithecia into a "stroma" as a matter for family distinction (see p. 2). This has resulted in placing *Melanotheca, Trypethelium, Tomasellia, Laurera,* and *Bottaria* in a single family, the Trypetheliaceae. Exceptions to this practice have been proposed by Wainio (1890), who considered the above genera as subgenera of the corresponding genera of the Pyrenulaceae, and by Watson ('29), who distributed the same genera among two different families, the Arthopyreniaceae and the Pyrenulaceae, depending upon the shape of the spore partitions and the nature of the paraphyses. Zahlbruckner ('26) and Keissler ('37) considered the Trypetheliaceae a natural family. Their reasons for such treatment give a forceful conception of the status of the knowledge of the morphology of its members previous to the publication of this paper. They merely imply that since the character of the "stroma" plays such an important part in the division of lower groups in the Pyrenomycetes it should likewise be permissible to do the same thing among lichens—at least as long as nothing certain is known about the development of the lichen "stroma."

In this paper the morphology of this so-called stroma has been described for several species at present classified in the Trypetheliaceae and some of the uncertainty with regard to its origin and development has been removed. Of the twelve species which have been most carefully studied only three have been shown to possess the morphology considered characteristic of the Trypetheliaceae. Four species of *Melanotheca,* and one each of *Tomasellia* and *Bottaria* are pseudostromatic. Three species of *Trypethelium* have not evolved well-developed substromata. Only *Trypethelium eluteriae, Laurera madreporiformis,* and *Laurera sanguinaria* possess the latter structures. Future investigation will add more species to each group, but the recognition of these divergent types of "stromatic" morphology and of the transitions between them is one of the chief contributions of this paper. In several species perithecia are borne in a definite plectenchymous tissue but all intermediate types and transitions from merely immersed to pseudo- or substromoid and from solitary to aggregated perithecia have been found, not only within the family, but also within some of the recognized genera. Other points are also pertinent here: (1) The spore characters are extremely divergent. The present treatment of these genera postulates the aggregation of perithecia into a pustule as of more phylogenetic value than the difference between a dark, elongate spore with lentiform partitions *(Melanotheca)* and a hyaline, muriform spore with cuboid partitions *(Laurera).* Developmental studies upon the organisms involved have disclosed the variation in pseudo- and substromata and have shown that such is not the case. (2) The absence of one-celled spores and the prevalence of dark spores indicate that the Trypetheliaceae as at present conceived includes genera that are very advanced from the standpoint of the fungal component. Altogether this evidence is sufficient to show that the Trypetheliaceae as delimited by Zahlbruckner, Smith, Keissler, and others does not bring together closely related forms and that further search should be made to find a proper place in which the various genera might be disposed in a more natural system.

In searching for a place to dispose of these genera one would naturally consider the fungi, particularly the sphaeriaceous forms. It has already been pointed out that they cannot be placed with the group where they have often been associated on theoretical grounds, the "stromatic Sphaeriales," because: (1) The large, septate spores of the lichen genera are aberrant in series with the small non- or one-septate spores of the fungal groups. (2) Correlated characters such as the production of conidia from a well-defined ectostroma and the origin of perithecial initials in the entostroma do not occur in the Trypetheliaceae. (3) Bark cells occur in the pustule containing perithecia. A true stroma, therefore, is not produced; pseudostromata and substromata only occur.

There is no doubt but that the structure of the perithecium of these lichens simulates the same structure in the Pyrenomycetes, and the asci of the two groups are almost identical. The asci enclose eight spores delimited from the protoplasm of the ascus after three successive divisions of a definitive nucleus. The ascus of the Pyrenocarpineae is so similar to the ascus in the Pyrenomycetineae that the common origin and consequently the monophyletic divergence of their members must be assumed. Granted that the members of the Trypetheliaceae (and most other lichens) should be considered members of the Ascomycetes rather than as a class coordinate in rank with them, the problem becomes that of deciding just how divisions should be drawn in that group.

An overwhelming mass of evidence indicates the close relationship of pseudo- and substromatic species with plants classified in the Pyrenulaceae. This could even be assumed from theoretical considerations, for according to Zahlbruckner's ('26) classification, the group, if treated as lichens, must be attached to this family simply because no pseudostromoid or substromoid lichens have been described with *Palmella* or *Protococcus* gonidia. Factual evidence is presented through the similarity of the manner of development of the Trypetheliaceae with that of *Pyrenula nitida* (Baur, '01). This similarity is evident in the ascogonia, trichogynes, perithecia, etc., and suggests that the two families be united. Since numerous transitions can be found between the "stromatic" and "non-stromatic" lichens, particularly with reference to the degree of aggregation of the perithecia, this disposal would obliterate the present confusion caused by using this character as a basis for family distinction. Furthermore, the spore forms, though differing as greatly within the family as before, can now be tied up with a phylogenetic scheme, the progression taking place both with reference to the degree of pseudo- and substromatic development and to the increasing septation of the spore. The lines of evolution can also be kept distinct with reference to the shape of the spore cells and the color of the spores.

For the above reasons the author prefers to regard the pseudostromoid and substromoid genera of the pyrenocarpous lichens as advances from simpler lichens usually classified in the Pyrenulaceae and to consider the genera of the Trypetheliaceae more logically placed as terminal members of the Pyrenulaceae. Thus, *Trypethelium* is regarded as having been derived from *Pseudopyrenula, Melanotheca* from *Pyrenula, Tomasellia* from *Arthopyrenia,* etc. Such an arrangement postulates that evolution in the group has proceeded from forms with simple spores, undifferentiated thalli (in the sense that neither a definite cortex nor a well-defined gonidial layer is evident), and single perithecia to more advanced forms with septate-elongate or muriform spores, well-developed cortices and gonidial layers, and a tendency toward the aggregation of the perithecia.

One is greatly impressed by the fact that some of the species examined, e.g., particularly *Pyrenula Coryli* and possibly *Arthopyrenia punctiformis,* lie on the very border-line between the fungi and the lichens. In many places no algae can be found in their thalli. In other species where algae are not often found the gonidial layer may sometimes be relatively well developed. I have found several cases where perithecia occurred 2 mm. to 2 cm. distant from the vegetative portion of a thallus. These transitions indicate a variability in the relationship of the fungus with the alga and suggest the possibility that in some cases the fungus might be able to live without the alga, utilizing the cells of the bark directly for nutritive purposes.

In all species the thallus arises from a germinating spore, and in the beginning it must act as a saprophytic fungus growing upon wood. This process has been followed experimentally with *Melanotheca aggregata*. The algal colonies are enclosed and the thallus is formed only at a later date. Thus it seems that the pyrenocarpous lichens mentioned must spend a portion of their life as purely saprophytic fungi; the other is spent in combination with an alga.

Lichenologists have made much of the mode of nutrition of the lichen and refer to its strict symbiotism as a claim for phylogenetic distinctness. In addition to the points noted above it seems fairly evident that in some species of the Trypetheliaceae the fungal component can utilize tissue of the substrate after combination with the alga. Attention has been called to the fact that the bark cells are altered in a great many species. Particularly striking examples may be found in the pseudostromata of species of *Melanotheca, Tomasellia,* and *Bottaria,* where chemical changes occur and the resulting structures consist primarily of carbonized bark cells.

These observations, with certain facts to be discussed below, have given rise to the opinion that the Pyrenulaceae is a relatively recent development in the phylogeny of lichens. Apparently those species on the border-line between the fungi and the lichens do not require algae for their development, and hence they must be able to obtain some food saprophytically from their substrate; an undoubted fungal or primitive character as far as lichens are concerned. Whether some of the substromatic species obtain food from the bark is very difficult to ascertain, but some of them do still retain the ability to alter the bark cells. Although the utilization of food produced by the alga is somewhat more advanced than the state displayed by saprophytic fungi, the advance is hardly to be considered as great as in those species where the bark is unaltered by the fungus.

Soredia, which are distinctive marks of vegetative evolution in other groups of the lichens, have not been found in the Pyrenocarpeae. Their absence would postulate that the entire tribe had formed the symbiotic relationship with the algae in relatively recent time. Other significant facts pointing toward this same conclusion are: (1) there are few gelatinous (blue-green) forms in the same group; (2) very few foliose and fruticose genera have been described in the group; (3) the number of pseudostromatic and substromatic forms is small when the group is contrasted with the fungi.

Wehmeyer's ('26) ideas with regard to the evolution of a stroma can be followed in the Pyrenulaceae. This gives additional support to the conception advanced above:

> The stroma has arisen in the Sphaeriales from simple Pyrenomycetes in which perithecia were immersed in the host or substratum tissue. . . . The first evidence of a primitive stroma appears as a blackening of the surface of the substratum. . . . The next step is the proliferation of the mycelium within the substratum. (See p. 580 for exact statements.)

Species similar to *Pyrenula Coryli* represent the stage in which the perithecia are immersed in the substrate; species similar to *Melanotheca aggregata,* the stage in which the surface of the substrate is blackened; species similar to *Trypethelium eluteriae,* the stage in which the mycelium has proliferated into a substroma. Differentiation into ecto- and entostroma, however, has not yet taken place and this group has, therefore, not evolved as highly as correlated groups of the fungi.

Certain conflicting evidence can also be explained on the assumption of recent symbiotic union in this group: i.e., the fact that the genera concerned present some rather advanced characters with regard to the fungal component (spore septation, size, and color) but some very primitive ones from the standpoint of their thalline characters (development of a cortex, presence of foliose and fruticose forms, absence of gelatinous forms, etc.). The origin of the symbiosis of Pyrenulaceae would be sought among rather advanced fungal genera.

Lichenologists have pointed out the characteristic disposal of the lichen acids as an aid in establishing the great antiquity of the lichen thallus. It seems that members of the Pyrenocarpineae are not nearly so rich in lichen acids as are some of the other lichen groups. In 1907, Zopf did not record a single lichen acid of known chemical composition from the Pyrenulaceae, and to the best of the author's knowledge none has been isolated since that time. Perhaps this scarcity of knowledge is correlated with their less frequent occurrence. The application of chemical reagents indicates that they do occur, but they seem more abundant in advanced groups (see table 1). Few of the "border-line" species gave reactions with either calcium hypochlorite, potassium hydroxide, or paraphenylenediamine—forms with well-developed gonidial layers being more abundant among those that did do so. If such crude tests as have been made are indicative of the presence of lichen acids (and they usually detect a great many of them) this fact seems of some significance. One cannot hold all lichen thalli to be ancient in origin simply because some species possess lichen acids, nor does it follow that all species without them are primitive. But if the presence of lichen acids be an advanced character in this group the data at hand support the suggestion that the "border-line" lichens are primitive and that other forms are more advanced. Although the author would agree with other lichenologists that the variety and specificity of the lichen acids, coupled with the many changes in the vegetative thallus of such groups as the Cladoniaceae, Parmeliaceae, Usneaceae, etc., certainly attest to the great antiquity of those families, the evidence found in the Pyrenulaceae favors the hypothesis of the recent association of the fungus with the alga.

One fact which does not favor such an assumption is the lack of known asexual spore forms in the Pyrenulaceae. Of course, these have not been determined for a great many Ascomycetes, but since the spores and resulting mycelium of advanced members of the family can be cultured it seems as though the primitive members of the family should have asexual spores. They were not produced in six months of culture but varying conditions might modify the results obtained.

Miller ('28a) published an important paper from the standpoint of theoretical mycology in which he distinguished the Dothideales and the Sphaeriales as follows: Sphaeriales, characterized by a diploid perithecial wall, lack of pseudoparenchyma in the perithecial centrum, true paraphyses and periphyses, concave hymenial layer, and ostiole schizogenous; Dothideales, with no diploid perithecial wall, pseudoparenchyma in the perithecial centrum, no paraphyses and periphyses, concave to flat to convex hymenial layer, and ostiole lysigenous. The paper is also of interest because of the discussion of such terms as stroma, ostiole, perithecial wall, paraphyses, etc. Since the author is suggesting that for the present the Pyrenulaceae be considered members of the Sphaeriales, attention must be called to the fact that some of the characters listed cannot be easily ascertained for the Pyrenulaceae.

The specimens examined in this study usually gave rise to the ostiole before the formation of the ascogenous hyphae, and trichogynes projected through the opening so formed. It is more likely that this opening persists until maturity than that it is closed after the trichogynes disappear, making necessary the formation of another ostiole at maturity. Some evidence also exists that bark cells are digested by certain species during the formation of the ostiole. In this connection it is interesting to note that de Bary (1884, p. 207) stated that the ostiole is predominantly schizogenous in species of *Sordaria, Melanospora, Claviceps, Epichloë* and *Eutype,* but lysigenous in *Diatrype, Verrucaria, Endocarpon, Pyrenula,* and *Massaria* (Füisting, 1868). Dodge ('37) reported lysigenous ostiole formation in a species of *Leptosphaeria.*

The presence, absence, or nature of the paraphyses has been used taxonomically in the Pyrenulaceae to a considerable extent. In this family branched or unbranched paraphyses grow out from the ascogenous hyphae into the perithecial cavity. The small size of the component elements makes it difficult to ascertain whether the structures are diploid or multinucleate, for septa cannot be distinguished. If a diploid membrane exists independently of the paraphyses surrounding the asci it is completely fused with bark cells, carbonized haploid hyphae, or is very difficult to see. Periphyses have been hard to demonstrate. Paraphyses are usually present in young, and absent in old material, so that their presence or absence is not essentially a good taxonomic character. It seems significant that after the maturation of the spores the paraphyses (like the membranes of the asci) usually disappear.

Summary

(1). Previous to the publication of this paper no developmental study of any lichen assigned to the Trypetheliaceae had been made.

(2). Details of development are recorded for species assigned to the five older genera considered in that family. No material of *Trypetheliopsis*, a recently described monotypic genus from Japan (Asahina, '37), has been available for examination.

(3). The development of *Melanotheca aggregata* is described from the germination to the maturation of the ascospore. In culture the spore gives rise to mycelium that may live some time without the presence of an alga. In nature, however, the fungal component contacts an alga early in its growth and a lichen thallus is formed. Ascogonia provided with trichogynes are produced and spermagonium-like structures have been found. No evidence for the fusion of spermatia with trichogynes could be seen. The perithecial primordium consists of several ascogonia surrounded by a sheath of vegetative hyphae. The gametophytic tissue is active in cutting out the perithecial cavity and in the formation of the ostiole. The ascogenous hyphae give rise to branches, some of which ultimately produce asci. The cytological phenomena involved in the production of ascospores are essentially the same as those described for other Ascomycetes. The so-called stroma of *M. aggregata* is composed primarily of bark cells, evidently altered by the fungal hyphae of the lichen. The blackened area

is first evident with the origin of the ascogonia and gradually expands so as to embrace several perithecia that develop in the same vicinity. The term *pseudostroma* is suggested for structures of this kind.

(4). All species of *Melanotheca* investigated are members of a fairly natural group. Their development is similar to that of *M. aggregata,* and the formation of a pseudostroma seems a character of the genus.

(5). Species assigned to *Trypethelium* are more variable and four types have been differentiated: (1) *T. tropicum* in which the perithecia become superficial and the aggregated perithecia are united merely by coalesced perithecial walls; (2) *T. annulare* in which the perithecia are borne below the surface of the bark without stromoid structures; (3) *T. pallescens* in which primitive substromata are formed; (4) *T. eluteriae* which forms highly developed substromata.

(6). Species of *Bottaria* and *Tomasellia* investigated possessed pseudostromata; those of *Laurera* possessed substromata.

(7). The Trypetheliaceae cannot be considered a natural group because of transitions between similar forms with and forms without pseudo- and substromata.

(8). The genera that have been placed in the Trypetheliaceae fit much better as terminal members of various series in the Pyrenulaceae.

(9). Some of the lichens with pseudo- and substromata have evolved from lower groups of lichens. They are not merely analogous pseudo- or substromatic Sphaeriales parasitic on species of algae.

(10). The Pyrenulaceae are Ascomycetes and should be considered as such; at the present state of our knowledge they should be classified in the Sphaeriales as a family equal in rank with the Sphaeriaceae and as derived from them.

(11). Cultural records are given for species of *Melanotheca, Trypethelium,* and *Laurera.*

(12). Data are presented with reference to the relative abundance of lichen acids in the Pyrenulaceae. These data correlate closely with the suggestions made in this paper with respect to the relationships within the group.

(13). The author is inclined to believe that some of the species studied acquire a portion of their nutrient material saprophytically from their substrata.

(14). The data presented favor the supposition that the first symbiosis in the Pyrenulaceae occurred in relatively recent time with rather advanced fungal components and that the fungi and the lichens (as far as the family is concerned) have evolved concomitantly since that time.

Acknowledgment

The author is indebted to Dr. Carroll W. Dodge for many helpful suggestions, for a portion of the material upon which this study is based, and for the privilege of consulting his private herbarium and library.

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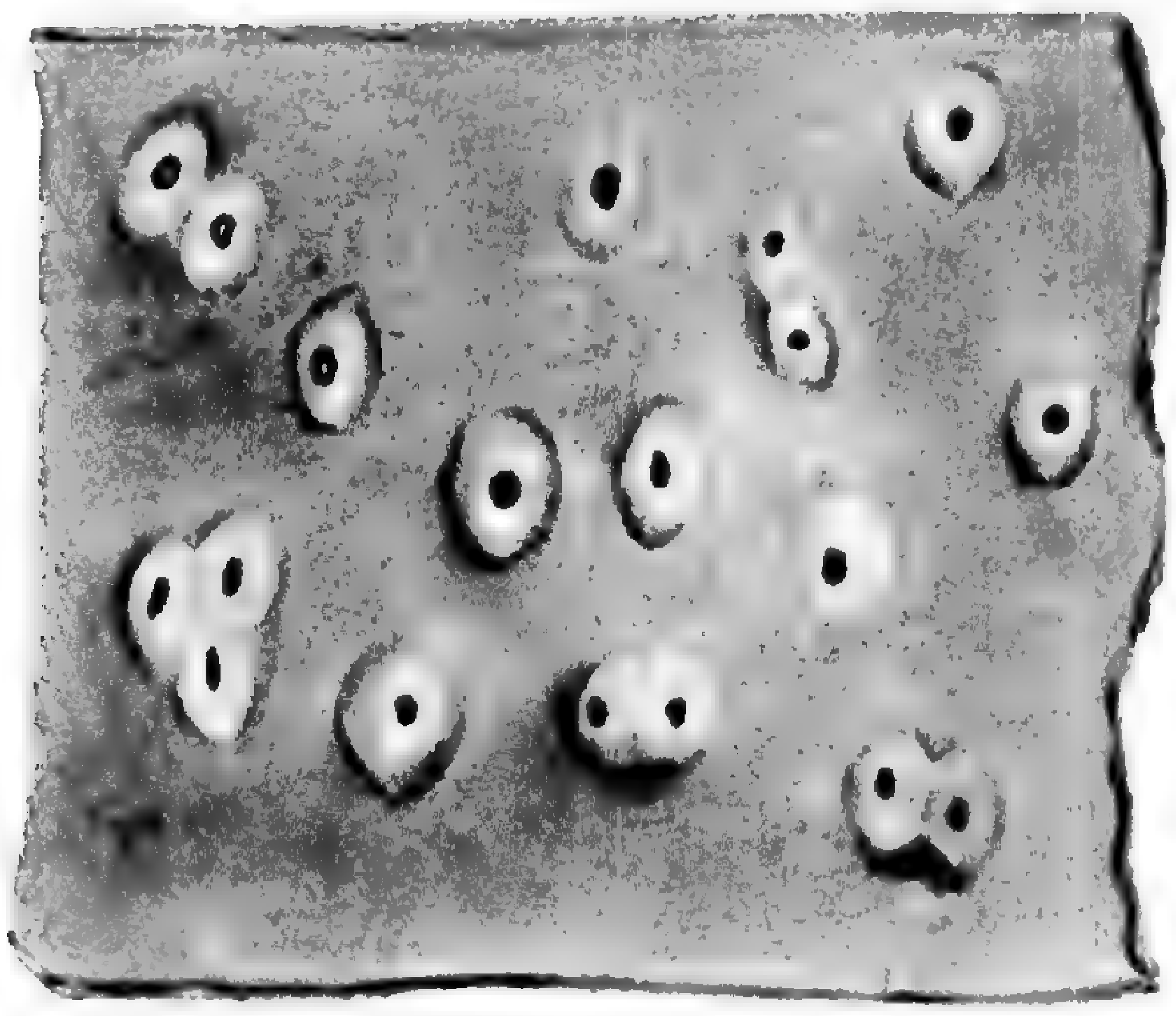
Explanation of Plate

PLATE 1

Habit sketches, illustrating the macroscopic appearance of several pyrenocarpous lichens. These sketches should be compared with photomicrographs of identical or related species which will be found in the other plates. In some cases this plate shows variation in the degree of aggregation of perithecia; in others it suggests how structures differing greatly in microscopic morphology seem similar macroscopically. Miss Elizabeth Heuser assisted in its preparation. (× approx. 12 diameters.)

Fig. 1. *Trypethelium annulare.*
Fig. 2. *Melanotheca aggregata.*
Fig. 3. *Laurera madreporiformis.*
Fig. 4. *Trypethelium eluteriae.*
Fig. 5. *Pyrenula mamillana* (Ach.) Trevis.
Fig. 6. *Trypethelium tropicum.*



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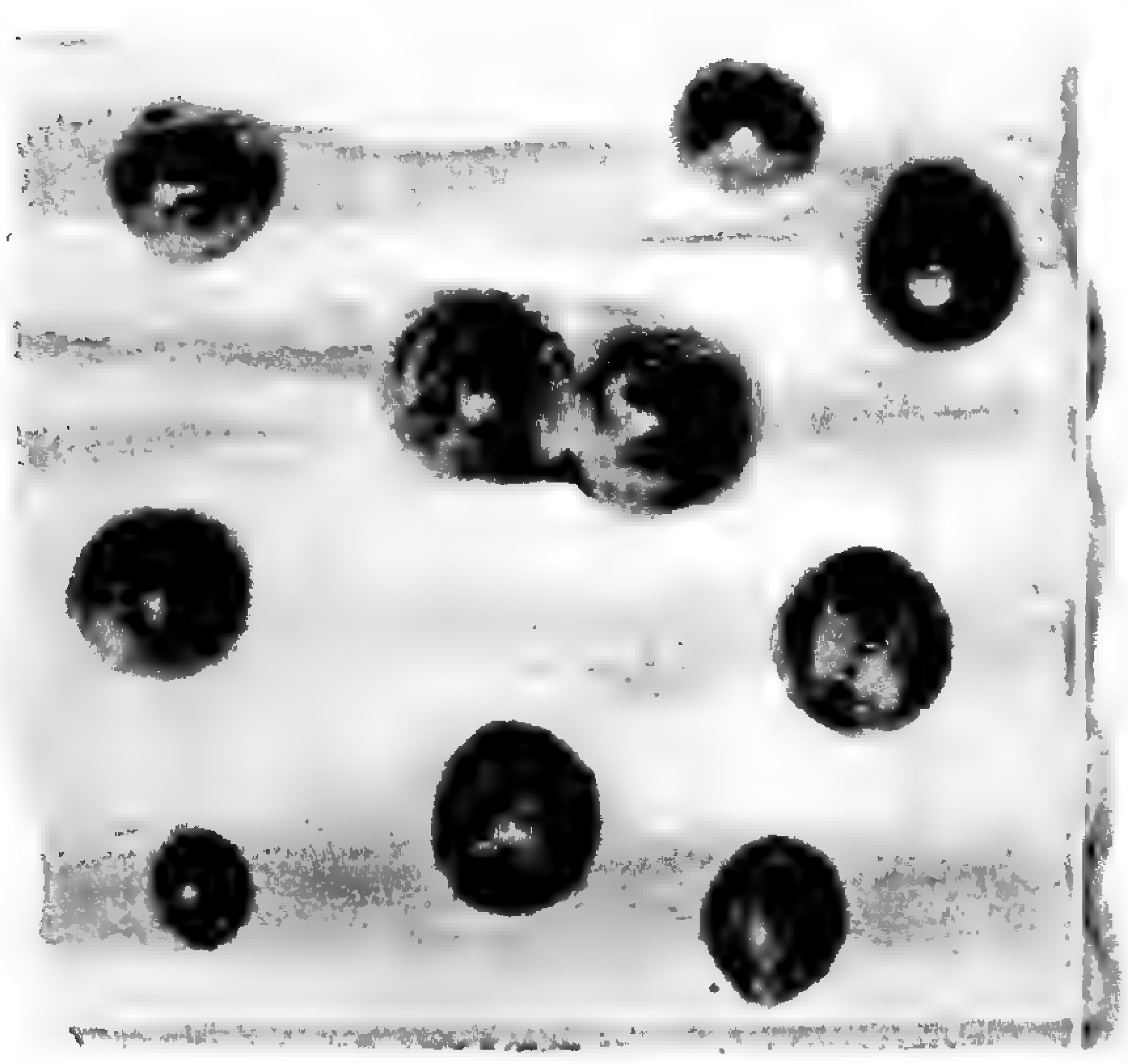

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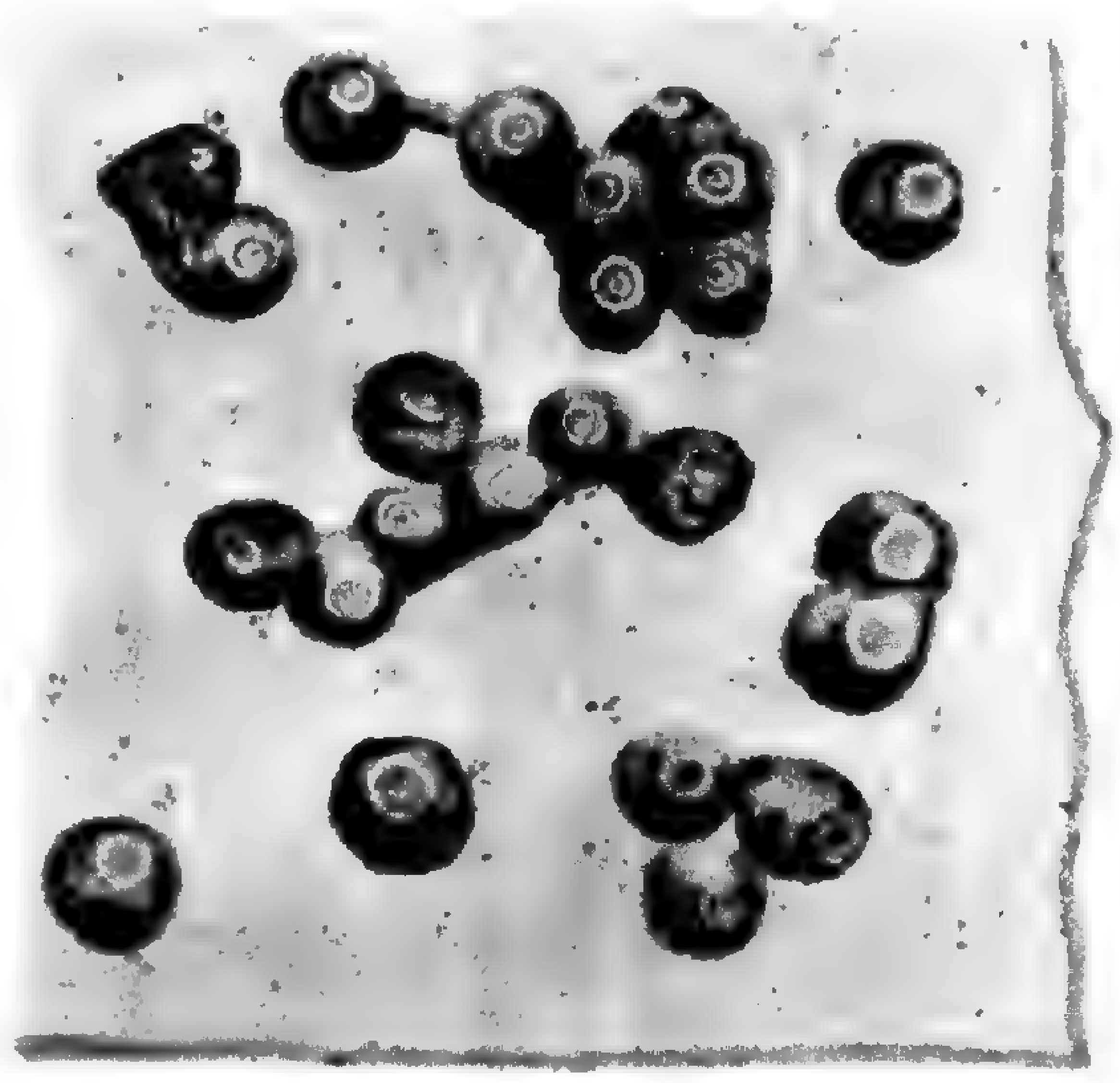

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JOHNSON -- TRYPETHELIACEAE

Explanation of Plate

PLATE 2

Photomicrographs illustrating stages in the development of *Melanotheca aggregata.* (Magnifications approximately as follows: figs. 5 and 6, × 60; fig. 4, × 110; figs. 1 and 7, × 200; figs. 2 and 3, × 500.)

Fig. 1. Two perithecial initials. They are formed a few cell layers below the surface of the bark.

Fig. 2. Young perithecial initial, showing ascogonia.

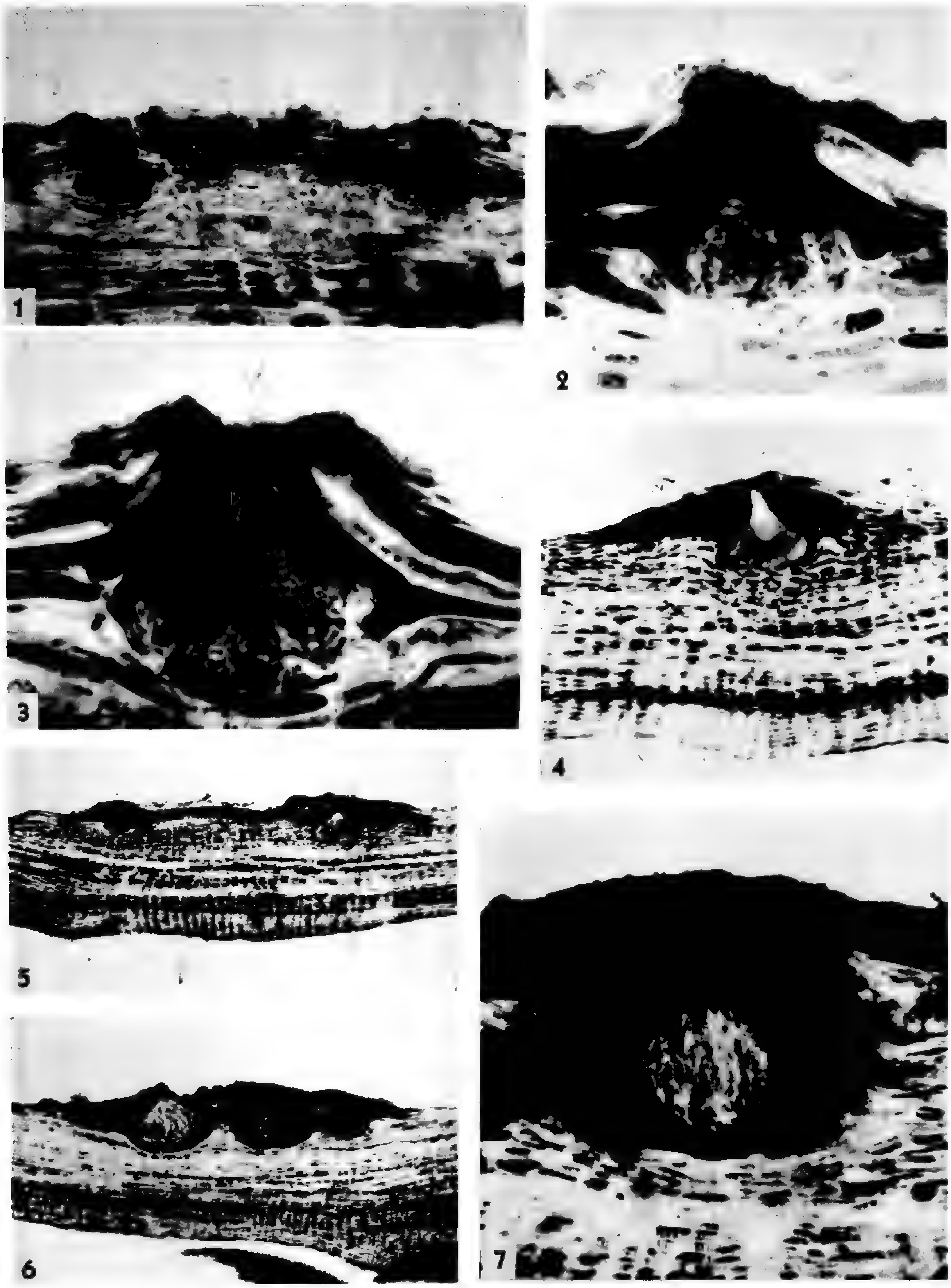
Fig. 3. Perithecial initial, showing ascogonia and trichogynes.

Fig. 4. Perithecium with a layer of ascogenous hyphae at its base. The "blackened area" which will form the pseudostroma is fairly well developed. This area is quite dense, but its cellular nature is suggested in the lower right-hand portion.

Fig. 5. Early stage in pseudostromatic development. The surface of the bark has become blackened, and this zone encloses several perithecia that have developed in the same vicinity.

Fig. 6. Mature pseudostroma and perithecia.

Fig. 7. Lateral section of a mature perithecium, showing its relation to the pseudostroma and to unaltered bark cells.



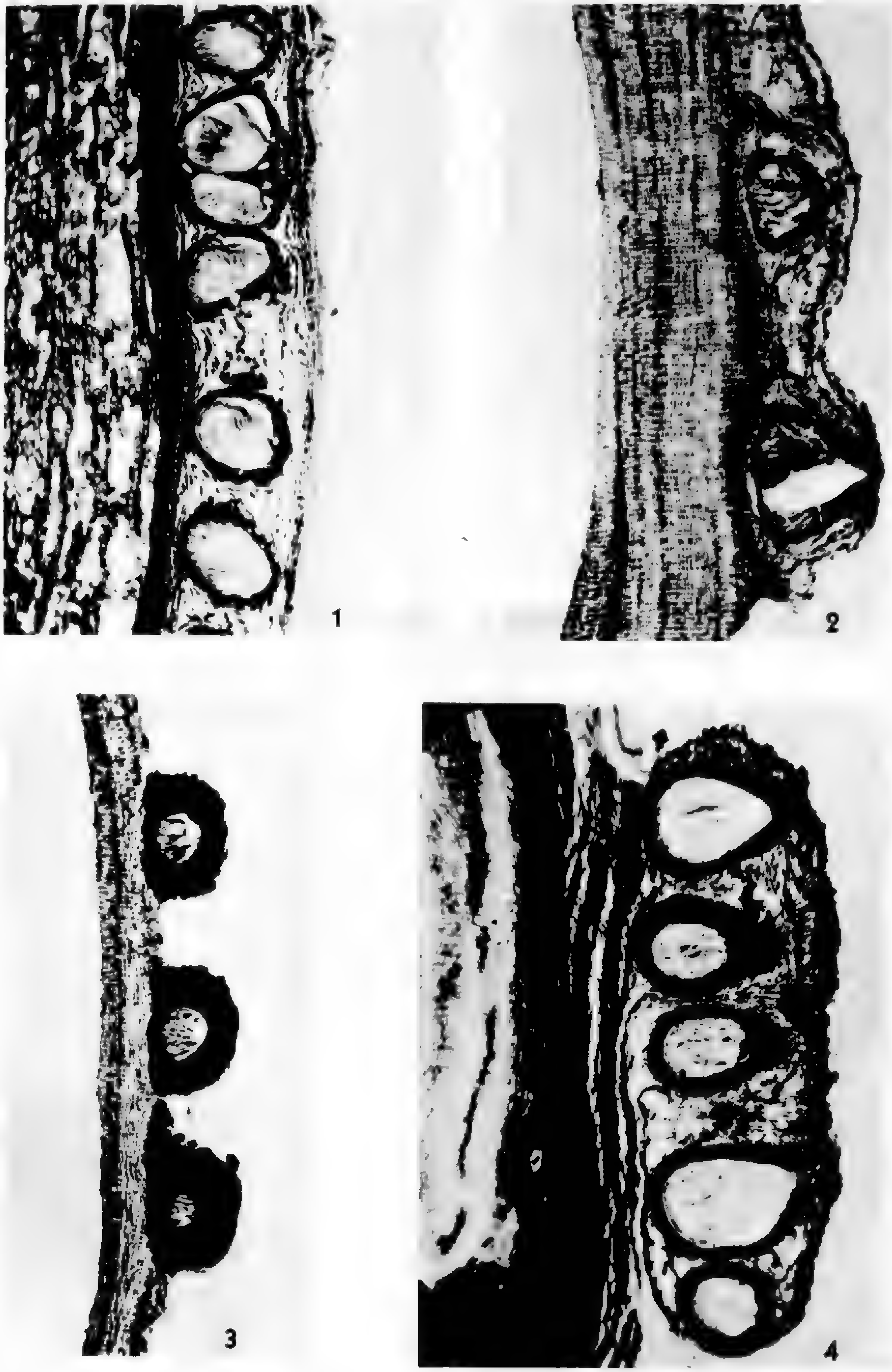
JOHNSON — TRYPETHELIACEAE

Explanation of Plate

PLATE 3

Photomicrographs illustrating the varying microscopic morphology among species that have usually been assigned to the genus *Trypethelium* (× approx. 200 diameters).

Fig. 1. *Trypethelium pallescens.*
Fig. 2. *Trypethelium annulare.*
Fig. 3. *Trypethelium tropicum.*
Fig. 4. *Trypethelium eluteriae.*



JOHNSON — TRYPETHELIACEAE

Explanation of Plate

PLATE 4

Photomicrographs of the vegetative and reproductive structures of various pyrenocarpous lichens (× approx. 200 diameters).

Fig. 1. *Laurera madreporiformis.* A large number of bark cells are present in the lower portion of the substroma.

Fig. 2. *Laurera chapadensis* Malme. Bark cells surround the perithecial wall.

Fig. 3. *Laurera sanguinaria.* Note the layer of bark cells above the central perithecium.

Fig. 4. Thallus of *Trypethelium eluteriae.*

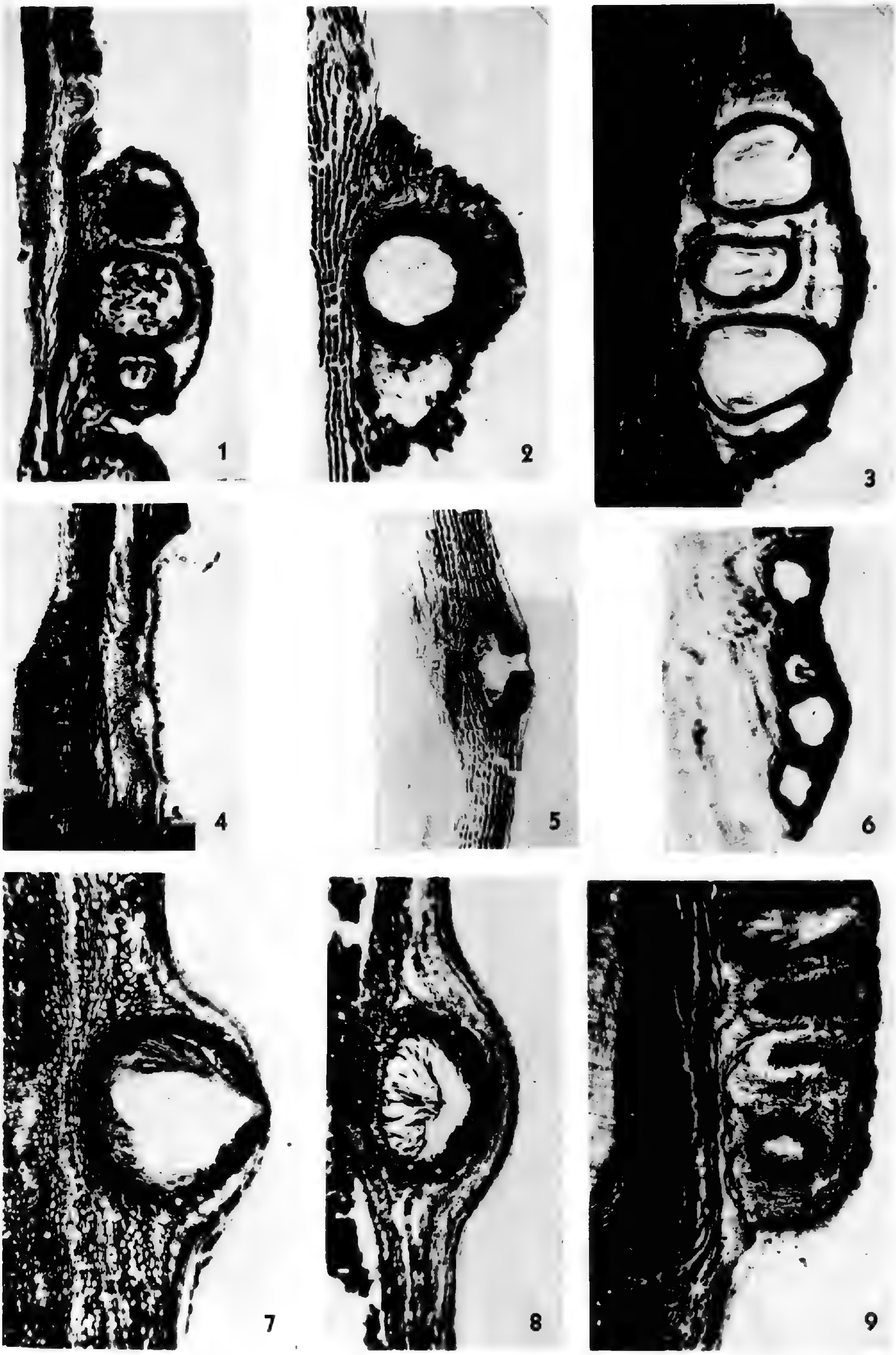
Fig. 5. A species that has been assigned to *Pyrenula.* Several bark cells near the perithecium have been considerably altered.

Fig. 6. Pseudostroma of *Melanotheca arthonioides.* Its cellular nature is evident opposite one of the lower perithecial cavities.

Fig. 7. *Anthracothecium ochraceoflavum.*

Fig. 8. *Anthracothecium pyrenuloides.*

Fig. 9. *Trypethelium eluteriae.* A number of bark cells are visible in the upper portion of the substroma.



JOHNSON — TRYPETHELIACEAE

ON THE STELAR ANATOMY OF THE PTERIDOSPERMS WITH PARTICULAR REFERENCE TO THE SECONDARY WOOD[1]

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Introduction

Probably no group of plants, fossil or living, has ever created as much combined interest for the botanist, geologist and layman as the rather heterogeneous assemblage of vegetative and reproductive "species" included within the Palaeozoic Pteridospermae. However, from the time of the publication of Palaeobotany's foundational 'Histoire' of Brongniart (1828) three-quarters of a century was to elapse before the combined efforts of Oliver, Williamson, and Scott gave positive evidence of the seed-bearing habit of the pteridosperms, although the great French palaeobotanists had in the previous decades gathered together highly suggestive evidence. An even longer time was to elapse before new concepts of morphology, based largely on an increased knowledge of these and other fossil forms, began to cast doubt on the concept of a filicinean ancestry of the seed plants.

The relatively abundant primary wood of these plants early attracted considerable attention, and in many cases its taxonomic value seems to have been emphasized at the expense of the secondary wood. No careful survey of the secondary wood has ever been undertaken, an omission which is perhaps partly explicable as a reactionary feeling towards the questionable taxonomic value of the secondary wood in certain other groups.

[1] An investigation carried out at Cambridge University, England, and in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

The description of many fossil coniferous and angiospermous woods whose affinities are doubtful has tended to discredit the taxonomic value of the secondary wood in general. Only within recent years has a thoroughly organized study of living angiosperm woods been commenced, and already it is proving of great significance.

It is the purpose of this paper to present the results of a study of the secondary wood of many of the plants included within the Pteridospermae and a comparative analysis of the nature and taxonomic significance of the primary and secondary xylem. It is not intended to present an exhaustive treatise on the stelar anatomy of these plants, much of which would only be repetition, but rather to bring to light those aspects of their structure which have been neglected for one reason or another.

Although Harris wrote in 1932 that, "It should be pointed out, however, that we do not know what constitutes a pteridosperm or what are the morphological limits of this class," it will be shown in the following pages that when the supposed seed plants of the Upper Palaeozoic, especially the secondary wood, are studied with reference to their stelar anatomy, three main types may be distinguished. One of them is exemplified by the very simple, mostly protostelic, Upper Devonian and Lower Carboniferous forms (Type I, p. 71); one includes plants of cordaitean-coniferous affinities (Type IV, p. 82); and the third is characteristic of the plants for which the class Pteridospermae was originally established (Types II, p. 72, and III, p. 77).

At the outset it should be stated that the view that the pteridosperms represent an intermediate group between the ferns and the cycads is no longer tenable. Rather we must look to a common psilophytalean-like ancestor with terminally borne sporangia, a solid protostele and primitive secondary wood for the origin of the ferns and pteridosperms (the secondary wood being usually lacking in the former). In support of this view the following points must be kept in mind:

(1) The evidence supplied by fructifications is overwhelmingly in support of the common origin of the ferns and pteridosperms from plants with terminally borne sporangia. This position has been retained by the latter, whereas in the ferns the sporangia have become dorsally located on the leaf-like structures termed sporophylls. There can no longer be any doubt that sporangia had their origin at or near the tips of branches or telomes[1] as evidenced by such plants as *Rhynia, Horneophyton* (Barghoorn & Darrah, '38), *Asteroxylon, Hedeia, Sporogenites, Psilophyton,* and *Taeniocrada.*[2]

(2) There is no evidence that the position of sporangia superficially on the dorsal surface of leaves (as in the majority of living ferns) is anything other than derived from a terminal position.

(3) It is only in Upper Carboniferous rocks that fructifications closely comparable with, and which may readily have led to, modern ferns become abundant. Among the better-known forms and their probable relationships are: *Oligocarpia* (Gleicheniaceae), *Seftenbergia* (Schizeaceae), *Ptychocarpus, Asterotheca,* and *Scolecopteris* (Marattiales).[3]

(4) Below the Upper Carboniferous these fern-like fructifications are much less abundant, but, beginning in the Lower Carboniferous rocks and extending up through Jurassic times, there runs quite a different line of microsporangiate fructifications. The fundamental similarity of their organization is such as to indicate with little doubt a great and continuous line of development. Some of the better-known members of this group are: *Telangium, Crossotheca, Aulacotheca, Whittleseya, Potoniea, Goldenbergia, Dolerotheca,* (Kidston, '23-'25, Halle, '33); *Pteruchus* and *Caytonanthus* (Thomas, '25, '33). The members of this line retained their sporangia in a

[1] With the exception of the Lycopod line represented by such members as *Baragwanathia* and *Protolepidodendron*. In the former the sporangia were borne on the stem close to the leaf axil whereas in the latter they were borne in much the same manner as in *Lepidodendron*.

[2] A few of the more pertinent publications relating to these genera are: Kräusel ('36), Kidston & Lang ('20–'21), Halle ('36), Dorf ('33), Bertrand ('13).

[3] See Kidston, '23–'25; Radforth, '38.

terminal position for the most part, although modified by fusion and aggregation of various types. The plants included under (1) above are undoubtedly representative of the complex from which both the fern and pteridosperm lines arose.

It must be emphasized that there is no evidence that the ferns were evolved prior to the pteridosperms. If either has priority the evidence points rather to the pteridosperms. This is by no means an original concept on the part of the present writer but its significance certainly has been overlooked by botanists in general. Robert Kidston, one of the greatest authorities on Carboniferous floras, presented a concise discussion of the matter in his 'Fossil Plants of the Carboniferous Rocks of Great Britain' (pt. 4, pp. 277-8). He considered in particular the value of the presence or absence of an annulus on a sporangium as a means of distinguishing between ferns and pteridosperms and pointed out that its absence, although generally considered indicative of the pteridosperms, must be used with reserve. Kidston's conclusion, that "They [the ferns and pteridosperms] appear as two distinct groups as far back as they can be traced, and from the earliest time seem to have constituted two parallel lines of development," has been more firmly substantiated since it was written.

It may also be pointed out that the cupule, although a morphologically problematical organ, seems to be a distinctive one of the pteridosperms, and it is now well known from the Lower Carboniferous. This will be discussed further in a later paper.

In view of the above evidence and our knowledge of the actual connection or association of the vegetative and reproductive parts of such plants as *Lyginopteris* and *Heterangium*[4] and the South African pteridosperms (Thomas, '33), Harris's statement that we do not know what constitutes a pteridosperm is not entirely valid. To be sure, we do not know what the exact limits of the group are but we do have a fair knowledge of the characteristic structures of the types for which it was created, such as the terminally clustered sporan-

[4]See Halle, '29, pp. 18-22, for a summary of known seed-bearing species of pteridosperms.

gia, the cupulate seeds, the fern-like foliage and the secondary wood (see pp. 72-82).

Before presenting the results of the study of the secondary wood the primary body will be considered in the light of Prof. Bower's "Size and Form" principles (Bower, '30). Certainly few greater contributions to morphology have been made in recent years than that author's explanation of the relationship between living parenchyma cells and the dead conductive elements of the primary body. It is safe to assert that had 'Size and Form in Plants' appeared twenty-five years earlier considerably less confidence would have been placed in the taxonomic value of the primary body as a means of delimiting species and genera in the Pteridospermae.

Variation in the Anatomy of the Primary Body

Anatomical variations have not gone entirely unnoticed. In 1917 Seward pointed out the fact that:

> "The external position of the protoxylem is a character to which too much weight may easily be attached; the difference in position between the protoxylem of *Rhetinangium* and *Heterangium* is in some examples of the latter genus hardly perceptible. Kubart (1914) speaks of the stele of his species *Heterangium Sturi* as being almost exarch. The inconsistency in the position of the protoxylem of the osmundaceous stems and in the primary bundles of *Eristophyton* and other Palaeozoic genera is worthy of consideration in this connexion."

In his discussion of "Old Wood and the New," Scott ('02a) wrote:

> "Lastly, we come to *Cordaites* itself, which is anatomically on the same level as recent Cycads; centripetal wood has wholly disappeared from the stem while it still forms the main constituent of the xylem in the bundles of the leaf."

There is, of course, no close relationship between the cycads, on the one hand, and *Cordaites* and related forms, on the other; if such existed in the past it must be traced to a common ancestor in pre-Carboniferous times. Since in practically all of the earliest vascular plants with secondary wood, the centripetal wood composing the metaxylem was abundant if not predominant, its presence in the more conservative parts of the later divergent groups would necessarily be expected. Like the seed habit, which had its origin independently in various groups such as the cordaites, pteridosperms, and lycopods, the centripetal or "Old Wood" occurs in widely divergent groups and must be used with caution as a taxonomic character. The same holds true for the position of the protoxylem as will be shown in the following pages.

The primary body of Lyginopteris oldhamia (Binney) Potonié

In view of the abundant remains of this plant in Upper Carboniferous times, its wide distribution, and the many authors through whose hands it has passed, a further consideration may seem superfluous. Although the great range in size and structural details of the stem particularly is generally known, the figures and descriptions are scattered through the literature and many of the more interesting features have never been adequately described. Furthermore, it is only when such figures are presented at the same magnification that a true picture of the variation is realized.

Figures 1 to 10 of plates 5 and 6 represent transverse sections (all shown at a magnification of × 7.5) which have been selected to show variation in size of the stem, the nature of the primary xylem, and the sclerotic "nests" and resin cells.[5]

The limits of publication necessitate the presentation of only the most outstanding features. It must be borne in mind, however, that one of the most significant points in the stelar variation of *Lyginopteris* lies in the fact that no sharp divisions can be drawn separating true forms or varieties. The variation is wide but the almost inseparable intergradations preclude any segregation.

a. Size variation.—The great variation in the size of the primary body of the stems may be seen by comparing figs. 1 and 2 of pl. 5. Although I have observed but few stems smaller than that shown in fig. 2 the larger one shown in fig. 1 is not

[5] These have been drawn from a study of some few hundreds of slides of this plant contained in the Scott, Williamson, Kidston, Manchester, University College (London), Binney (Cambridge), Cambridge Botany School, and Liége University Collections, in addition to numerous "nitrocellulose pull" preparations and blocks, supplied to the author by Messrs. W. Hemingway and J. R. Lomax.

the maximum that the stems may attain. Aside from its somewhat exceptional size, fig. 1 represents a more or less typical stem with respect to relative extent of primary and secondary bodies, abundance and distribution of primary xylem, and sclerotic "nests." It is quite similar to the type specimen (pl. 6, fig. 5) except that the primary body of the latter is relatively smaller.

b. Parenchyma-sclerenchyma relationship.—There is considerable divergence from the more or less spherical nests as seen in figs. 1 and 5. In addition to such groups there are usually scattered through the pith numerous individual cells (sclerotic or resinous) with dark contents. In some sections the sclerotic nests are absent and the individual secretory cells are more or less uniformly scattered throughout the pith (fig. 4). Particularly small stems (fig. 2) may be almost or entirely lacking in either. That fig. 2 represents a small but mature stem and not merely a young one is evidenced by the prolific secondary xylem.

The distribution and abundance of these pith elements may be highly variable. In figs. 1 and 4 they are quite uniformly distributed, whereas in fig. 8 they form a peripheral cylinder immediately within the secondary xylem, or they may be confined to the central region of the pith as in fig. 7 and to a lesser extent in fig. 10.

c. Primary xylem.—The primary wood, with its mostly centripetally developed elements, generally occurs as five or six rather widely separated eccentrically mesarch bundles in direct connection with the secondary wood. However, the occurrence of a continuous band of primary tracheids in small stems (fig. 3) or of a nearly continuous ring in larger stems (fig. 9) is not uncommon. Various intermediate forms between continuous rings and typically scattered bundles (figs. 1, 5) are to be found. In pl. 8, fig. 17, the primary xylem extends unbroken through approximately 180°, the remainder of the periphery being composed of isolated bundles.

The eccentrically mesarch bundles are well known and need no further description here, but a few of the more interesting divergences from the normal bundle (shown for comparison in pl. 10, fig. 32) may be briefly noted. Figure 35, a camera-lucida drawing of a bundle in the stem shown in fig. 17, shows abnormally high development of the centripetal elements. Figure 34 shows a very loosely aggregated "bundle" with no readily distinguishable protoxylem. The nature of the specimen whose primary bundle is shown in fig. 35 will be taken up below.

d. Extra-stelar meristematic activity.—The most remarkable stem referable to *Lyginopteris oldhamia* that has come to my attention and which, to my knowledge, has never been described is shown in pl. 7, figs. 11, 14, 15, 16; pl. 10, fig. 33. Its extraordinary feature lies in the presence of a complete medullary cylinder of secondary xylem.

The occurrence in *Lyginopteris* of internal (secondary) xylem in association with the primary bundles (fig. 12) and even irregularly scattered between them (fig. 13) is not uncommon, and as such may be of no phylogenetic significance; at least such was the opinion of Williamson and Scott (1896). But when this internal xylem forms a complete cylinder it most certainly merits careful consideration. The tracheidal cells of this internal secondary xylem are arranged for the most part in radial rows and are of about the same size as the earliest formed centrifugal secondary xylem tracheids; the degree of lignification is the same in both. The amount of associated "ray" or parenchyma cells may be seen to be somewhat greater in the former.

The nature of the tissue between these two bands of secondary xylem is shown in figs. 16 and 33, the latter being a camera-lucida drawing. It will be noticed that there is a striking resemblance to the "partialmark mit primartracheiden" of the Chemnitz Medullosas (Weber and Sterzel, 1896). No distinct primary bundles are present, the primary tracheids being scattered as individual cells or in small groups throughout the "partialmark." When in small groups they are usually in contact with the tracheids of the normal secondary xylem (fig. 33), but the groups consist of only a few cells and lack a distinct protoxylem.

The ontogenetic origin of such an internal cylinder of xylem is of considerable interest. If it had been laid down in the usual way for secondary wood, by a single row of meristematic cells, one would expect the parenchyma, either on its inner or outer face, to show some indication of crushing. It is, however, for the most part well preserved and there seems to have been no crushing.

Another type of meristematic activity which occasionally occurs in *Lyginopteris* stems may be noted. At *a* in pl. 8, fig. 19, a group of radially arranged cells appears which are almost in contact with the normal secondary xylem and tend to flare out somewhat at the opposite extremity. The cells of such groups are not always radially arranged but may be less regularly oriented as shown in fig. 13. They are unlignified and there is no indication of a true cambium. Whether or not the internal secondary xylem described above represents a later stage (after lignification) cannot be proven but presents an interesting possibility.

It is evident from Miss Esau's studies that the sharp distinction between primary and secondary vascular tissues on the basis of radial arrangement is invalid. She has shown that in *Nicotiana glauca* Graham and *N. tabacum* L. ('38) and in *Apium graveolens* L. ('36) the procambium may lay down radial rows of primary xylem. Of the latter species she states:

> "As the layer of dividing procambium cells narrows down to a few rows of cells, the meristem shows an increasing similarity to the cambium of herbaceous dicotyledons. Eventually cells appear with short radial diameters and become arranged, in longitudinal sections, in horizontal tiers. The longitudinal divisions are predominantly periclinal and the resulting cells retain a radial arrangement in the mature state." ['36.]

Since the ontogeny of primary and secondary vascular tissues is a continuous process (except where the primary xylem is entirely centripetal) one must follow Miss Esau's conception of procambium and cambium as two developmental stages rather than as two distinct meristems. In the light of our knowledge of such procambial activity in living plants it appears not impossible that this apparently secondary centripetal growth in *Lyginopteris* may be of like origin.

Williamson and Scott (1896) dismissed these anomalies as lacking significance and in his 'Studies' (1923) Scott writes:

> "The most frequent anomaly in *L. oldhamia* is the formation of a medullary cambium, usually arising first inside the primary xylem strands and producing wood and bast with inverted orientation. . . . in extreme instances the wood may become broken up into several distinct masses, each with its own ring of cambium, forming new secondary tissues all around it."

The conclusions of these authors might be accepted without reservation for instances where the internal xylem is associated only with leaf traces (pl. 7, fig. 12), but when it forms a complete ring the similarity to such woods as *Cycadoxylon robustum* or certain of the Permian Medullosas is too striking to ignore any possible phyletic implications.

Although the identification of the specimen may be called into question, there seems to be sufficient evidence in favor of its allocation to *L. oldhamia.* Most of the tissues external to the secondary xylem have been destroyed, although there is a fragment of the characteristic "Dictyoxylon" cortex present. The characteristic sclerotic nests and secretory cells are present in the pith (pl. 7, fig. 11), and the general structure of the centrifugal secondary xylem is typical. Furthermore, this internal secondary xylem occurs in association with leaf traces (fig. 12) and even irregularly scattered between them (fig. 13) in undoubted specimens of *L. oldhamia.*

e. Roots.—The relationship between the tracheids and parenchyma in the roots of *L. oldhamia* in general coincides with the physiological requirements of Bower's "Size and Form" principles. The smaller roots (pl. 8, fig. 22) usually have a solid primary body while in the larger (figs. 20, 21, 23) there is an admixture of parenchyma (these figures are all at a uniform magnification of × 23). The root shown in fig. 22 is about the maximum size that the primary body may attain and still remain purely tracheidal. All roots smaller than this that have come to my attention are likewise composed of tracheids only. When, in the larger roots (figs. 21, 23), the primary body contains an appreciable amount of parenchyma the xylem is broken up into rather regular groups with the protoxylem outermost; and when the tracheids largely disappear from the central region the roots may present a striking resemblance to the stems (figs. 9 and 20).

f. Foliage.—It has been pointed out in the preceding paragraphs that, although these plants have a wide range of variation in the primary body they form a continuous series. Such is not the case with the foliage "species" associated or in organic connection with the stem remains.[6] The frond species, on the contrary, are distinct and appear to present a significant example of the varying rate of evolution that different organs undergo.

Sphenopteris Hoeninghausi Brongniart is so well known and has been found so often in contact with the stems having a *dictyoxylic* cortex that it needs no further mention here. It is, however, not so well known that *Sphenopteris Baumleri* Andrae has been found in organic connection with stems exhibiting the dictyoxylic cortex. Although Gothan ('23), Kidston ('23–'25) and Stur (1885) have figured this it does not seem to have attracted the attention that it merits. While I was studying in Bruxelles, Dr. Stockmans showed me two fine specimens from the Westphalien of Belgium (Nos. 5933, 5930, Mus. d'Hist. Nat., Brux.) in which *S. Baumleri* was associated with the dictyoxylic stems. In the latter specimen (No. 5930) the similarity between the stem compressions associated with *S. Baumleri* and those to which *S. Hoeninghausi* is attached *(Lyginopteris)* extends beyond that exhibited by the hypodermal sclerenchyma, for numerous spines are to be observed quite like those found on the rachis of *S. Hoeninghausi.*

In addition to these two well-defined species of *Sphenopteris* actually in organic connection with the dictyoxylic *(Lygi-*

[6] Lacking the evidence of internal structure the only characters on which the supposed identity of *Lyginopteris oldhamia* stems is based are the anastomosing strands of hard cortical tissue and in some cases the presence of epidermal spines. Considering the wide distribution and abundance of *L. oldhamia* stem petrifactions it is likely that many of the stem and petiole compressions exhibiting a "Dictyoxylon," or perhaps better a *dictyoxylic* cortex, actually do belong to that species; nevertheless they cannot be proven as such. Paleobotanists have perhaps accepted this external evidence a bit too freely.

nopteris type) stem, others are found in association. A specimen of *S. taitiana* Kidston from the Vendéenne region in France has been figured by Mathieu ('37, II, pl. 7, fig. 6) in association with a fragment of a rachis (or stem?) showing cortical structure characteristic of *Lyginopteris.* Zeiller (1897) described a specimen of *Diplotmena distans* (Sternberg) Stur which, judging from the account, must have been attached to a stem of the dictyoxylic type:

> "Quant à l'axe principal, sa surface est divisée en compartiments fusiformes inégaux et irréguliers, de 4 à 6 millimètres de longueur, circonscrits par des stries longitudinales flexueuses entre-croisées, qui donnent lieu de penser que l'écorce était formée, au voisinage de sa surface externe, de bandes sinueuses résistantes, comprenant entre elles des mailles de tissu plus mou. C'est ce que a lieu dans les écorces du type connu sous le nom de *Dictyoxylon,* où des mailles parenchymateuses sont ainsi encadrées entre des bandes sinueuses de sclérenchyme, organization que Williamson a reconnue notamment chez son *Lyginodendron Oldhamium.*
>
> "Ainsi constitués, ces larges axes charbonneux ressemblent d'une facon frappante à ceux qu'on observe chez le *Sphenopteris Hoeninghausi* Brongt. . . ."

The petioles described under the name of *Lyginorachis* likewise present a range in anatomical variation similar to that in the gross external morphology of the fronds. In addition to the petioles of *Lyginopteris oldhamia* five other species of petiole *(Lyginorachis),* for the most part well defined, have been described, namely, *L. taitiana* Kidst. & Crookall, *L. papilio* Kidst. & Scott, *L. Waltoni* Calder, *L. Brownii* Calder, and *L.* sp. (Crookall, R., '31).

Summarizing briefly, it may be seen that the stem anatomy, although highly variable, forms a nearly continuous series, whereas the foliage and petioles, for the most part, represent well-defined species. *Sphenopteris Hoeninghausi* is somewhat of an exception to this in that it is difficult to distinguish from other very closely allied species. Seward in 1917 noted that:

> "It is not an easy task even for those most familiar with Carboniferous fronds to distinguish clearly between species agreeing generally with *Sphenopteris Hoeninghausi,* a species regarded by some authors as the type of a group of very similar and closely allied forms all of which were probably borne on stems referable to the genus *Lyginopteris.*"

The Calamopityeae

Of all the supposed pteridosperms preserved as petrified stem remains the assemblage included under the Calamopityeae presents the most difficult taxonomic problems, as is adequately attested by the frequent revisions of members retained within the group.

Calamopitys saturni Unger and *C. annularis* (Unger) Solms are the oldest known members of the Calamopityeae as instituted by Solms-Laubach in 1896, the former species being the genotype. A few years later Scott (1902) described two more species of *Calamopitys (C. fascicularis* Scott and *C. beinertiana* Scott) after having tentatively assigned them in a previous publication (1899) to *Araucarioxylon.* Zalessky ('11) in turn proposed the genus *Eristophyton* to include these latter two which differ very markedly from either *C. saturni* or *C. annularis* in the structure of the secondary wood and in the structure and arrangement of the primary bundles. Read ('37) has upheld Zalessky's genus and there can be little doubt that this decision is correct. It is, moreover, doubtful whether the very problematical *Calamopitys radiata* Scott, with its highly dilated rays, should remain in the genus. Lastly it may be noted that *Sphenoxylon eupunctata* (D. E. Thomas) Read, originally described as a *Calamopitys,* agrees neither in the nature of its primary or secondary wood with *C. saturni* or *C. annularis.* There can be little doubt that it is generically distinct and for that reason the name *Sphenoxylon* proposed by Read ('37, p. 91) is adopted here.

Judging from the wide divergence of characters in the members of the Calamopityeae, the family can hardly be considered a natural group, as it stands at present. Two points are particularly significant in the history of the group, namely, the early recognition of the similarity of *Calamopitys* (i.e., *C. saturni* and *C. annularis)* to *Lyginopteris,* and Scott's original description under *Araucarioxylon* of the species at present retained in the genus *Eristophyton.*

The close similarity, if not actual identity, of *Calamopitys americana* Scott & Jeffrey, *C. saturni* Unger, and *C. annularis*

(Unger) Solms is well known to those who have dealt with the group. The differences between *C. americana* and *C. annularis* are exceedingly slight, while *C. saturni* is supposed to be unlike these two in having distinctly separate centrally mesarch strands and a primary xylem consisting of a nearly confluent ring with eccentric protoxylem.

Through the kindness of Professor Gothan a considerable number of the type slides of *C. annularis* was obtained from Berlin.[7] They apparently were not seen by Scott at the time he wrote his "Notes on *Calamopitys* Unger" ('18), since the slides he observed are still in the Scott Collection under the numbers 3676-3681 inclusive.

In the American species, *C. americana,* the primary body is described by Scott and Jeffrey ('14) as follows: "So far the primary structure—pith surrounded by a ring of nearly confluent mesarch xylem strands—is quite similar to that described in the case of *Calamopitys annularis.* In the American species, however, there is strong evidence for the somewhat unexpected conclusion that the pith was a 'mixed' one, containing tracheids." Read ('37) has confirmed the existence of a mixed pith in this plant.

In 1918 Scott notes with regard to the possible presence of medullary tracheids in *C. annularis:* "I have carefully looked into this question. In transverse sections one can distinguish at a few places elements with thicker walls than the ordinary parenchyma, and resembling the tracheids of the xylem ring. But the preservation is not such as to make these indications at all convincing." Now the slides 97(40a) and 101(43I), not

[7] The slides from Berlin examined by the writer are as follows (the numbers and notations given as they appear on the slides): Radial sections: 97(40R) *Calamop. ann.* Berlin Landesanst; 101(44R) *C. annul.* Culm, Saalfeld, Berlin Landesanst; 49(6R) *Calamop. annular.*, Culm, Saalfeld, Berlin Landesanst; 101(44) *Stigmaria annularis,* Saalfeld, Berlin Landesanst; 49(6R) *Calamop. annularis,* Berlin Landesanst; 100(43I) *Stigmaria annul.* Saalfeld, Berlin Landesanst; 49(6R) *Cal. annul.* Berlin Landesanst; 101(44) *S. annul.* Culm, Saalfeld, Berlin Landesanst. Transverse sections: 97(40a) *Calam. ann.* Berlin Landesanst; 74(24) *Stigmaria annul.* Saalfeld, Richt., Berlin Landesanst; 98(41) *Stigmaria annularis,* Saalfeld, Richter, Berl. Landesanst; 100(43I) *Stig. annul.* Saalfeld Richter, Berlin Landesanst. Tangential sections: 49(tg) *Calamop. annul.* Culm, Saalfeld, Berlin Landesanst.

seen by Scott, are very well preserved, and I believe there can be no doubt that the pith is mixed, that is, with tracheids scattered through it. Judging from a careful comparison of the slides of *C. americana* and *C. annularis* in the Scott and Berlin collections there seems to be no valid reason for the existence of two species based on this material.

The differences between *C. annularis* (or *C. americana*) and *C. saturni* are primarily the presence of a discontinuous xylem ring in the primary body of the latter and the position of the protoxylem. The primary body is comparatively large in the first two species (7 mm. or more as compared with less than 2 mm. in *C. saturni*), but in view of the size difference in other species of pteridosperms as shown here and the host of plants considered by Bower ('30), that alone can bear little weight. In the Berlin slides 97(40a) and 100(43I) of *C. annularis* primary xylem does not form distinctly continuous rings (pl. 9, fig. 29); at least the variation from a continuous ring is of sufficient significance as regards the supposed distinction of these species.

Perhaps the most interesting slide of all those received from Prof. Gothan is No. 74(24), labeled *Calamopitys annularis*. It is quite likely that it was cut from the same specimen as the section described by Scott ('18, p. 214) which he tentatively assigned to *C. annularis*. Since it has a distinct bearing on the taxonomy of these three species and is better preserved than the slide described by Scott, a detailed description will be given.

The distinctive features in the slide at Scott's disposal may be briefly summarized as follows: primary body only 2.5 × 1.7 mm.; primary xylem forms a continuous band, while elsewhere there are only scattered tracheids between the primary strands; position of protoxylem not determined; rays of secondary wood narrow.

In my slide the nature of the primary body may be seen in pl. 8, fig. 18, pl. 9, fig. 30. The primary xylem resembles that in the Scott slide but is better preserved, the protoxylem elements being centrally mesarch in most of the bundles—a distinctive feature of *C. saturni.* It may be noted, however, that in the two bundles shown in fig. 18 the position of the protoxylem varies, that in the bundle at *a* being eccentric. On the other hand, the xylem forms a nearly continuous ring, that part of the primary body between the bundles proper being occupied by tracheids with a few admixed parenchyma cells. There are, however, scattered tracheids within this ring—a feature of *C. americana* and *C. annularis.*

In view of this admixture of characters, it is evident that the distinction between the three "species" is not sharp. A feature of their leaf-trace anatomy may be noted. In slide 3680 (apparently cut from the same block as Berlin slide 98(41)) Scott ('18) described two complete bundles in the cortex or leaf base: "Each is elongated, approximately in the radial plane, and has three internal protoxylem groups, the latter lying toward that side of the strand which faces its neighbor." In the Berlin slide, however, there are four instead of three protoxylem groups in one of the strands, and their position is eccentric towards the outside rather than on the side adjacent to the other strand. It appears then that as the traces pass out not only does the number of the protoxylem groups change but also their position. This is not surprising in view of the sudden change that may take place in the nature of the vascular supply of many living plants—any one who has taken the trouble to follow the course of the bundles in the basal portion of the petiole of such a plant as *Aesculus Hippocastanum* L. could not fail to be struck by the rapid change through a few millimeters. Such rapid ontogenetic changes give a hint of the caution that must be used in comparing supposedly different fossil species unless equal parts of homologous structures be available for comparison.

Although perhaps these three species of *Calamopitys* should not be merged until further material is obtained, in view of the variable nature of the primary body in this and other groups, combined with the modern concepts of "Size and Form," the specific distinctions are questionable. An investigator of the present day would certainly describe them as variant of a single species.

Eristophyton Beinertianum (Goeppert) Zalessky and *E. fasciculare* (Scott) Zalessky present certain points of interest which are appropriate to the present discussion. In both species the protoxylem of the leaf-trace bundles, although mesarch at the point of entrance, becomes endarch as it passes down the stem. A further instance of the variation that may be expected in size of the primary body is found in *E. Beinertianum.* First, it may be recalled that the diameter of the primary body of the British specimens varies from 13 to 15 mm., while it is 8 mm. in the Falkenberg specimen (Scott, '18). There are, moreover, four uncatalogued slides in the Scott Collection labeled "*Calamopitys,* Gin Head Vent, near Tantallon Castle, North Berwick." The primary xylem is poorly preserved but in all four the sclerotic "nests" characteristic of *E. Beinertianum* are prominent, and the general appearance of the secondary wood leaves little doubt as to their identity. The dimensions of the primary body and the total diameter (nothing outside of the secondary wood is preserved) of the stems in these four slides are given in table I.

TABLE I

EXPLANATION IN TEXT. ALL DIMENSIONS IN mm.

Slide No.	Primary body	Diameter over all
1	9 × 14	27 × 35
2	4	20
3	3.5	11
4	5	22 × 18

Endoxylon zonatum (Kidston) Scott was segregated from *Calamopitys* (Scott, '24a) primarily on the basis of its endarch primary xylem strands. An examination of the sections in the Kidston Collection has convinced me that this feature is not constant. In slide 803 Kidst. Coll., a strand may be noted that is more mesarch than endarch.

To emphasize further the necessity of caution in the taxonomic use of characters of the primary body a few examples of plants not included within the Pteridospermae may be mentioned.

Although the slides of *Mesopitys Tchihatcheffi* (Goeppert) Zalessky were not available for my examination, Seward's opinion ('17) is of interest: "I am not convinced that the primary xylem-strands are exclusively endarch; in most of the primary groups the protoxylem is clearly on the inner edge, but in a few cases there may be a small amount of centripetal xylem present."

Certainly one of the most remarkable cases of ontogenetic variation in the primary body is that of *Selaginella spinulosa.* Here, according to Gibson (1894), in the upper region of the erect stem seven protoxylem strands occur on the outside of the stele. Farther down these fuse to form three (still exarch), and in their course down the stem they gradually pass toward the center of the stele until, in the trailing axis, they fuse to form a single central protoxylem strand. Not only does the number of protoxylem groups change but there is a complete transition from centrally endarch in the trailing axis to exarch in the stem.

A fine example of the physiological relationship between primary tracheids and parenchyma is shown in the famous fossil hollow trees of Aran, *Lepidophloios Wunschianum* Carruthers. Although it had long been supposed that the steles of other plants had washed into the rotted hollow centers of the trunks, Walton ('35) showed that as the small solid primary xylem enlarged upward the degree of medullation correspondingly increased.

Anatomy of the Secondary Wood

As was pointed out in the introduction, a careful consideration of the characters afforded by the secondary xylem presents an outstanding gap in the literature, particularly in the light of current studies of dicotyledonous woods. This is well illustrated by the original description of *Megaloxylon* in which the secondary wood was described as practically identical with *Cycadoxylon (Lyginodendron) robustum.* The latter has also been compared closely with *Lyginopteris oldhamia* (Scott, '23). However, if the ray structure of these three be compared (pl. 13, figs. 39, 40; pl. 14, fig. 42) all three are found to be distinctive.

The secondary xylem in the pteridosperms has been studied in detail to determine what characters, if any, are sufficiently constant to be relied on.

Materials and Methods.—The author has been fortunate in having had access to the type slides of the majority of the pteridosperm woods discussed below, and in many cases the type specimens or additional blocks have been available. The specimens thus dealt with are:

Cycadoxylon robustum (Seward) Scott: portion of the type block from the British Museum (Natural History).

Cycadoxylon anomalum (Will.) Will. & Scott: portion of the type block from the Hunterian Museum, Glasgow University, Glasgow.

Megaloxylon Scotti Seward: portion of the type block from the Binney Collection, Sedgewick Museum, Cambridge.

Lyginopteris oldhamia (Binney) Potonié: numerous blocks supplied by W. Hemingway (Derby) and J. R. Lomax (Bolton); a block from the Binney Collection, Sedgewick Museum, Cambridge.

Medullosa anglica Scott: block supplied by J. R. Lomax.

Medullosa Noei Steidtmann: blocks in the Botany School, Cambridge; blocks supplied by Dr. James Schopf, Illinois State Geological Survey.

Medullosa stellata Cotta, *M. Solmsii* Schenk, *M. Leuckarti* Solms-Laubach: blocks deposited in the Botany School, Cambridge.

Heterangium sp.: block supplied by Prof. W. T. Gordon, King's College, London.

Where the preservation has been particularly good serial tangential sections have been prepared through the secondary wood, using the cellulose-pull technique; when the wood was not sufficiently well preserved to permit this technique ground sections were cut as close together as possible.

The anatomy of the secondary xylem was investigated first to determine whether or not the ray structure is constant throughout the radius and whether it could be correlated with other characters such as pitting and tracheidal morphology. Since the ray structure presents the most reliable taxonomic character of the secondary wood, the ray types into which most of the pteridosperm woods may be segregated will be described and illustrated. The blocks were in varying states of preservation and in one group the rays were extremely tall. For these reasons uniformly good photographs could not be obtained and drawings were prepared by means of a reflector attached to a vertical photomicrographic camera.

It is not possible to classify these woods on the basis of their ray structure according to the system employed for angiosperm wood by Kribs ('35). Until more extensive studies are made of other groups it seems best to set up an independent classification for the plants discussed here. Four rather distinct ray types are found within the group:

I. Rays varying from very low (3–4 cells) and uniseriate to tall (usually not over 2 mm.) and 3–4-seriate, the latter not regularly fusiform, heterogeneous. (Chief feature is the uniform gradation between low uniseriate and rather tall irregularly multiseriate). Pl. 12, fig. 37.................................. *Sphenoxylon, Tetrastichia, Palaeopitys, Aneurophyton.*

II. Rays of great height, up to and exceeding 2 cm.; sides generally parallel but occasionally irregularly dilated; low uniseriate or fusiform rays extremely rare; cell walls very thin, mostly unpitted; cells angular, heterogeneous, intercellular spaces small.
   A. Rays of first-formed secondary xylem usually narrow, becoming greatly dilated toward the outside. Pl. 14, fig. 42.................*Lyginopteris.*
   B. Similar to A but less variable in tangential dimensions, usually not more than 4–5 cells wide. Pl. 12, fig. 38; pl. 14, fig. 41..*Heterangium, Stenomyelon, Calamopitys, Rhetinangium, Sutcliffia, Megaloxylon, Medullosa* (in part)—*M. anglica, M. Noei, M. pusila, M. centrofilis, M. distelica, M. Leuckarti.*

III. Rays elongate-fusiform to nearly circular (that is, with tangential and vertical dimensions nearly equal), heterogeneous, uniseriate rays rare. Pl. 11, fig. 36; pl. 13, fig. 39... *Cycadoxylon, Colpoxylon, Ptychoxylon, Medullosa* (in part)—*M. Solmsi, M. gigas, M. stellata* (?)

IV. Rays mostly uniseriate, occasionally 2–4-seriate, low, generally not more than 7–10 cells high; heterogeneous; cell walls relatively thicker than in other groups. Pl. 15, figs. 43, 44... *Eristophyton, Bilignea, Protopitys, Cladoxylon, Endoxylon.*

TYPE I.

Type I is illustrated by a camera-lucida sketch (fig. 37) from slide 15T6 Petry Collection (Cornell U.). It is a partial reconstruction in the sense that it represents a composite view of a number of the best-preserved portions of the slide. Other slides were available and as the preservation of the stele of this plant is in general very good the drawing is an accurate generalized reproduction of the ray structure. The secondary woods of *Palaeopitys* and *Tetrastichia* are not as well preserved, particularly the former. However, a careful examination of the slides in the Kidston and Gordon Collections indicates that their ray structure is essentially the same as that of *Sphenoxylon.* Although slides of *Aneurophyton* have not been available for examination, the description given by Kräusel ('36) indicates a close similarity to the other members of this group. Because these early forms are of particular interest as possible forerunners of the Pteridospermae proper a brief summary of the structure of their primary body is included here:[8]

[8] Although the present treatise involves primarily the stelar anatomy of the pteridosperms, a discussion of the seed or megasporangiate fructifications should be appended in order to present a composite picture of these very early Gymnosperms or "Pro-Gymnosperms." The latter term, originally introduced by Saporta and Marion (1885) to include plants of sigillarian, calamarian, and cordaitean affinities, or the term Hemi-Gymnosperm, is probably more truly descriptive of the plants included under Type I than any other. On the basis of anatomy alone this may appear too speculative but when considered in the light of the fructifications discovered in recent years in these correspondingly early rocks such a belief seems justified. The morphology of the secondary enclosing structure, the cupule, of certain Lower Carboniferous seeds is indeed a pressing problem. Recently an extraordinary large cupule (6.2 cm. long) was discovered in the Lower Carboniferous oil shales of Scotland and will be described in a separate paper. This cupule, as well as *Calathiops Bernhardti* Benson, probably contained in life more than one seed, whereas the smaller forms, such as *Calymmatotheca Kidstoni* Calder (Calder, '38), contained only one seed as in the Upper Carboniferous ones.

In his discussion of the affinities of that extremely interesting plant *Tetrastichia bupatides,* Gordon ('38) has pointed out certain similarities with the petiole base of *Telangium affine,* and it may also be noted that the only foliage (other than that of Lycopods) found in association with the above-mentioned cupule is again *Telangium affine.* The evidence of association is highly suggestive.

Palaeopitys Milleri M'Nab (Kidston & Lang, '23). Solid protostele 1.5 mm. in diameter, protoxylem elements probably near secondary wood. Mid-Devonian.

Aneurophyton germanicum Kräusel & Weyland (Kräusel, '36). Solid protostele, approximately 1.5–3 mm. in diameter, triarch, the three protoxylem groups near the periphery. Mid-Devonian.

Tetrastichia bupatides Gordon (Gordon, '38). Solid 4- or 5-rayed protostele 1.5–2.5 mm. in diameter, with protoxylem centrally placed in the arms. Lower Carboniferous.

Sphenoxylon eupunctata (D. E. Thomas) Read (D. E. Thomas, '35). Primary body consisting of medullated central column 4 × 2 mm., with four radiating arms of primary xylem. Upper Devonian.

It is of interest to note that the primary body in three of these four genera is a solid protostele. In *Sphenoxylon,* with its somewhat larger primary body, it is not surprising to find it mixed. Bower has shown that in the Psilotales and Psilophytales the increasing size of a solid protostele is correlated either with medullation (as in *Psilotum)* or stellation (as in *Asteroxylon),* with the result that the xylem-parenchyma ratio remains more or less constant. The same holds true in a general way for these forms with secondary wood. The primary body of *Palaeopitys* is the smallest and is a solid cylindrical protostele. In the other three the primary body is larger and is either more or less stellate as in *Tetrastichia* and *Aneurophyton,* or mixed as in *Sphenoxylon.* It seems evident that the stellate protoxylem (actinostele) had its origin from the protostele at a very early date and that both types independently gave rise to secondary growth.

TYPE II

The woods grouped under Type II constitute a rather uniform assemblage, at least as far as the structure of the secondary wood is concerned. The segregation of *Lyginopteris* from the other members is based on a difference in degree—the greatly dilated rays as they pass outward seem to be more generally characteristic of this plant than those placed under the sub-type B.

The series of three drawings in pl. 14, fig. 42, represents portions (as the rays of *Lyginopteris* are exceedingly high, often exceeding 2 cm., it is not possible to show complete rays without making an unduly large plate) of a few rays of *Lyginopteris*. At *a* the rays are shown as they appear close to the pith, at *c* as they appear at the outer border of the secondary xylem, while at *b* they are shown midway between. The total radial distance from *a* to *c* was 2.7 mm. The rays do not often attain greater tangential dimensions than those shown in *c*, and it may be noted even here, in the lower left-hand corner of the figure, that the ray is being split at two different points.

The vertical fusion of rays as they pass toward the outside is not an uncommon feature. In fig. 42*c*, the ray at the right now extending the full length of the figure has resulted from the fusion of two separate vertically aligned rays in *a* and *b*.

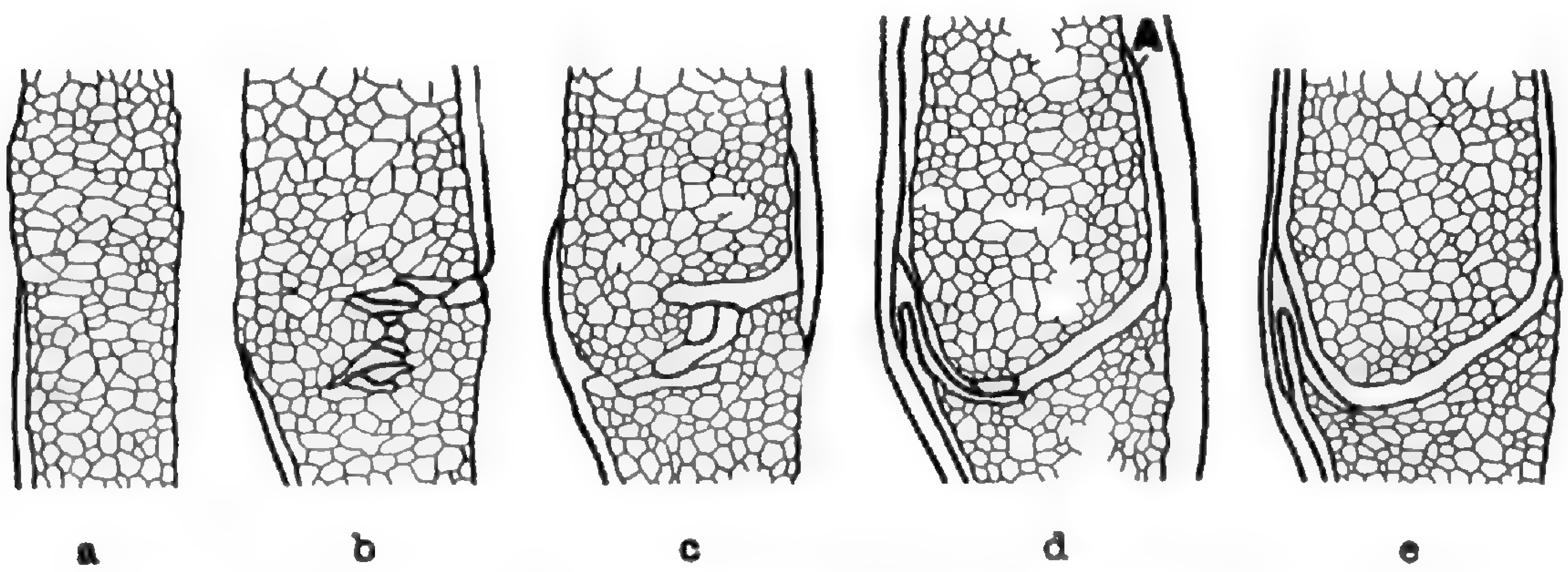
The question of the phylogenetic origin of the multiseriate ray is one that has long been disputed by anatomists, evidence having been brought forward by Jeffrey and his students in support of an origin from the aggregation of numerous uniseriate rays, and by Bailey and others in support of the widening of a uniseriate ray. In 1914 Bailey and Sinnott wrote:

> "Multiseriate rays of varying width are well developed in the majority of arborescent or shrubby dicotyledons and may be traced through the Tertiary to the Middle Cretaceous . . . The investigation of the structure and development of rays in the various families of the dicotyledons reveals much evidence that the multiseriate rays originated by the gradual widening of primitive uniseriate rays."

In view of the evidence presented by both Schools it seems quite likely that the multiseriate rays have had a dual origin. That they were formed ontogenetically in *Lyginopteris* by the dilation of uni- or biseriate rays is well shown in fig. 42 but the bearing that this may have on the origin of homologous structures in more recent seed plants is open to question.

Although the tracheid-ray ratio varies considerably in this plant these greatly dilated rays are general in occurrence and, although widest when in association with leaf traces, they are by no means confined to this region. In close proximity to the leaf traces the rays, as is usually the case, lose their characteristic shape.

Mechanics of ray division.—It has been possible in two of the pteridosperms to trace individual rays closely enough to determine the manner in which they divide. It was found that in *Cycadoxylon robustum* the actual mechanics of ray division follows essentially the same process as shown for *Cola togoensis* Engler & Kräuse by Miss Chattaway ('37). A single tracheid initial cuts diagonally across the ray, apparently in-



Text-fig. 1. Ray division in *Lyginopteris oldhamia.* Explanation in the text.

creasing in length by sliding growth. The unique anastomosing nature of the tracheids and rays in this wood will be taken up below.

In *Lyginopteris* the case is somewhat different, for the rays do not simply divide by the increasing length of a single tracheid initial. Blocks were selected in which the secondary wood was especially well preserved and a series of tangential sections was prepared by the cellulose-pull technique. Although transverse ground sections of *Lyginopteris* often present remarkably fine cellular details the delicate ray tissue is rarely sufficiently well preserved to produce a uniform series of tangential pulls. Of four especially well-preserved blocks treated in this way one proved to be somewhat superior to the rest (text-fig. 1). Of sixteen sections taken through a radial distance of 1 mm. those shown in the text-figure have been selected to show the mode of ray division. At *a* the ray may be observed prior to any indication of division; at *b* it has increased its tangential dimensions considerably and ten of the ray cells laid down by the cambial initials have become lignified, their walls being composed of bordered pits as in normal tracheids. Although some of these lignified cells are no larger than the ray-parenchyma cells certain others are distinctly elongated. In *c* the number of lignified cells is smaller but those remaining are considerably larger and the ray has been almost completely dissected.

This increase in size of the lignified ray cells, or "ray tracheids," is apparently due to increase in size of certain cambial initials with resultant crowding out of the others. This increase merges imperceptibly into typical sliding growth as the later-formed lignified cells assume a more distinctly tracheidal shape. If the cell indicated at *A*, text-fig. 1*d* be compared with the corresponding ones in *c* and *e* respectively this becomes apparent; in the latter figure the cell formed from the same initial had so elongated that the end could not conveniently be included in the figure. The resultant U-shaped tracheids are not of uncommon occurrence, and when in association with leaf traces they may assume much more bizarre forms.

Although the division of the rays is primarily due to increase in size and sliding growth of certain initials there remains the possibility of the occasional fusion of the initials themselves.

These lignified cells may occur isolated in the rays unassociated with any later divisions. That is, an initial may lay down a ray cell which becomes lignified while the succeeding cell will remain a normal ray-parenchyma cell. New rays may be formed either by this division of one into two more or less equal parts or by a fragmentation process whereby a small arc-shaped portion of the ray is segmented off followed by a gradual dilation of the newly formed rays as shown in fig. 42.

Williamson and Scott ('96) noted that in *Lyginopteris*, "Additional secondary rays appear *de novo* in the later formed layers, as secondary growth proceeds." . . . Their deduction was apparently based on transverse sections in which it is very difficult to ascertain positively the mode of origin of new rays. It is apparent that serial tangential sections present a much more positive means of determining ray origin, and while new rays may arise *de novo* the mode of secondary ray origin as described above is the only one that has been observed in the present investigation.

In subtype B the rays are for the most part very narrow, with nearly parallel sides, and of great height, being as high as 2 cm. or more in *Medullosa Noei* (fig. 41). In *Sutcliffia insignis* Scott (fig. 38) the rays are as high or higher. In slide 71 (0.73), University College Collection (London), three rays were measured having heights of 13.6, 17.6, and 14.0 mm., respectively; a fourth measured nearly 25.0 mm. These figures do not represent extremes but cracks or spots where the preservation is poor prevents the measurement of many rays throughout their entire height.

In *Calamopitys* the rays are very tall, quite uniform in their tangential dimensions, but somewhat broader than the other members of this subgroup (fig. 28).

Tangential sections through the xylem of the large outer steles ("snakerings") of *Medullosa Leuckarti* have been prepared by Mr. Hemingway.[9] Although the cellular details are not well preserved the general shape of the rays is clearly defined. They are very narrow, most of them probably not more than two cells wide and well over a centimeter high. They are indeed quite similar to the rays of the Medullosae of the *anglica* section (Schopf, '39), such as *M. anglica* and *M. Noei.* That this similarity should exist is not surprising for other than being somewhat larger, the general stelar anatomy of *M. Leuckarti* is not vastly different from *M. anglica.* The latter does of course lack the star-rings but this is perhaps not a point of great distinction since there is one present in *M. centrofilis* which Seward ('17) described as forming "a connect-

[9] Slides Nos. 1060, 1061, in the Botany School, Cambridge.

ing link with certain continental Medullosae." The structure of the rays tends to confirm Schopf's tentative inclusion of this species in his subgenus *Anglorota* (Schopf, '39).

Megaloxylon presents somewhat of an exception in that its ray structure is more or less intermediate between subtype IIB and Type III. The rays (fig. 40) do not reach the extreme height characteristic of II and smaller rays are more abundant. The larger rays tend to be fusiform although more elongate vertically and not as broad as the rays of Type III.

TYPE III

The members of Type III possess rays varying from elongate-fusiform to cylindrical. In general they are quite distinct from the high, narrow, parallel-sided rays of the preceding group. The pitting of the tracheids is likewise somewhat different as will be pointed out later. In view of the more or less transitional *Megaloxylon* I am inclined to believe that the members of this group may not be fundamentally different from those of Type II but rather represent an end line of development from the latter, typified in the extreme by the bizarre *Cycadoxylon anomalum.*

Cycadoxylon anomalum.—This remarkable wood has been mentioned a number of times in the literature since its original description by Williamson in 1878. However, inasmuch as certain details of its structure have never been adequately figured and certain questions have arisen with regards to possible identity with *Cycadoxylon robustum* (Seward, 1897) a reinvestigation was undertaken. Two fragments of the original block were located in the Hunterian Museum, Glasgow, one of which has been utilized for the study of the rays. A second and somewhat larger fragment is preserved in the Williamson Collection at the British Museum.

The fragment of secondary wood upon which the species is based was collected from the Lower Carboniferous of Arran. It is especially remarkable that such a highly specialized wood should be found in this low horizon, and some doubt has been cast by those familiar with the locality as to its actual derivation from these rocks.

Although originally described by Williamson under the name of *Lyginodendron anomalum* (Williamson, 1878) it became evident that there was no close affinity with *Lyginodendron (Lyginopteris),* and it was subsequently placed in Renault's genus *Cycadoxylon* by Williamson and Scott (1896). In his description of *Cycadoxylon robustum* Seward (1897) suggests a similarity between *C. anomalum* and that portion of *C. robustum* where the wood is disturbed by a leaf trace:

> "The resemblance between *Lyginodendron robustum* and *Lyginodendron anomalum* as regards the structure of the wood and the form of the medullary rays, which is specially striking in the wood of the former species where the normal form of the rays is modified by the bending of the tracheids to a leaf-trace bundle, points to the possibility of the two forms being closely allied to one another."

In order to check the constancy of the ray structure of *C. anomalum* a small block was studied first by means of serial tangential pulls through a radial distance of approximately 2 mm. When it was found that there was almost no change in the structure of the rays through this distance the block was ground more rapidly and photographs made directly from the etched surface by means of reflected light.[10] This was carried on through a radial distance of approximately 1.5 cm. where there was very little change in the ray structure. It is certain then that there is no close similarity between this constant tracheid-ray relationship and the very irregularly contorted rays in *C. robustum* where they are associated with the leaf traces. A careful comparison of the slides of both species in the Williamson, Scott, and Cambridge Botany School collections, combined with the constant ray structure of *C. anomalum* as shown above, leaves no doubt as to the specific distinction of the two. In fact, it is probable that the distinction is a generic one.

The pitting of the radial walls of the tracheids shows considerable variation from the closely compacted reticulate pitting figured by Williamson (1878). Although the crowded

[10] Very satisfactory photographs were obtained when the silicified block was roughly ground down with #150 carborundum, smoothed with #500, etched for five minutes in 25 per cent hydrofluoric acid, dried, and photographed with reflected light.

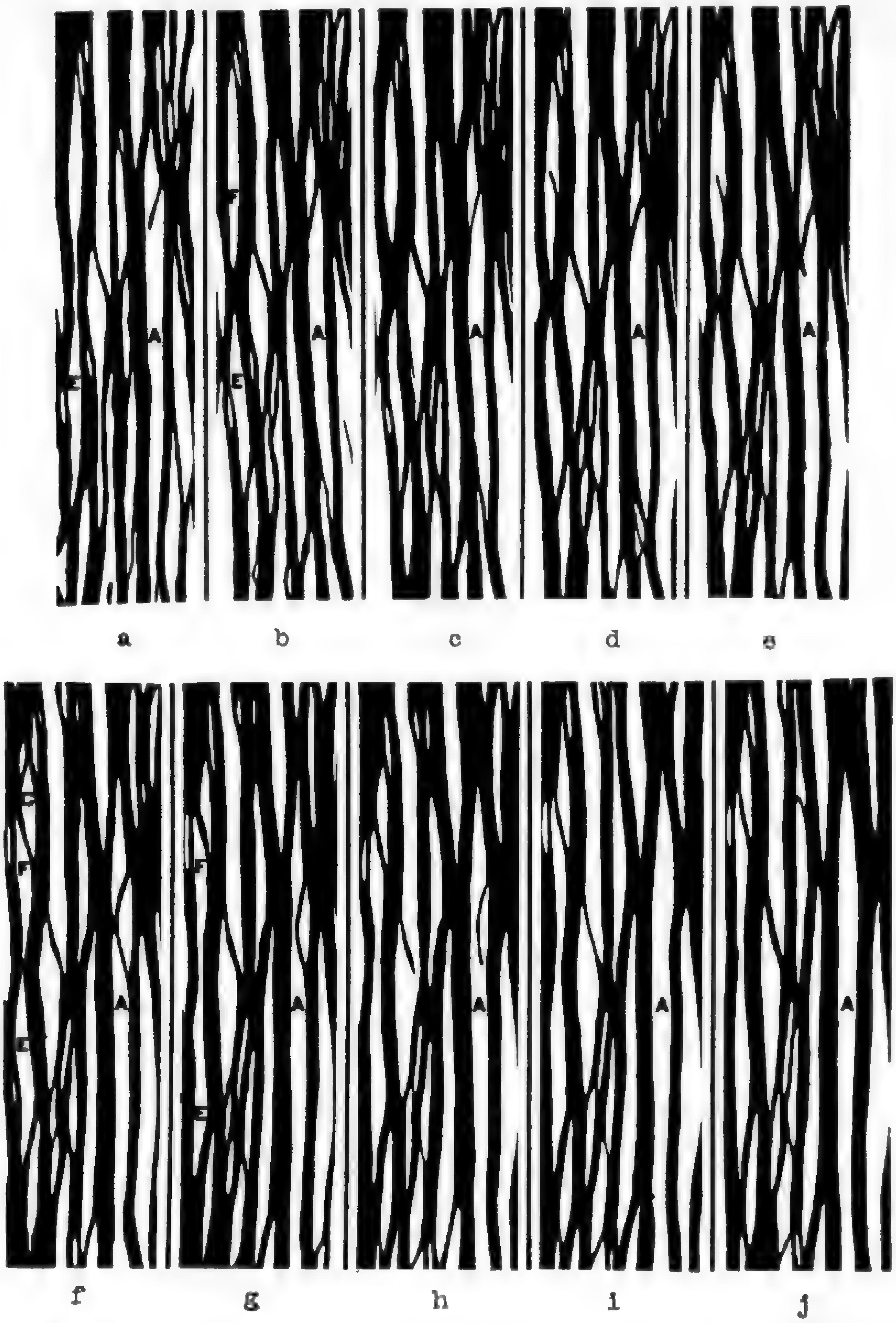
reticulate type (fig. 26) is common it is more often "loose" with the pits irregularly arranged (figs. 25, 27) and in some tracheids they are quite distantly scattered (fig. 24).

Cycadoxylon robustum.—This wood was treated in essentially the same manner as *Lyginopteris.* Although quite well preserved, sufficiently satisfactory preparations could not be obtained by the cellulose-pull technique. A preliminary series of the latter through about 1 mm. of the wood did indicate, however, that ground sections could be prepared sufficiently close together to show the significant features of the anatomy. Consequently, a series of 14 tangential sections extending through a radial distance of 2.5 cm. was prepared by Mr. Hemingway from fragment No. 3 of the original block (V4280 British Museum), the average distance between sections being slightly less than 2 mm.

A region was then selected which was representative and well preserved throughout the entire series. This has been reproduced (text-fig. 2) by means of tracings made with a photomicrographic projector. The drawings correspond to slides 1, 3, 5, 6, 7, 10, 11, 12, and 14, respectively.[11] Those sections (Nos. 2, 4, 8, 13) which show no appreciable change over the ones preceding them have been omitted from the series. Text-fig. 2*a* represents the section nearest (2 cm. from) the pith while *j* represents the outermost section. The tracheidal tissue is shown in black and the rays in white.

The most interesting feature of the wood lies in the fact that the new rays cut off from the older ones do not retain their individuality and increase uniformly in size as shown in *Cola togoensis* (Chattaway, '37); rather the rays and the tracheids form an anastomosing network. In order to understand this relationship an individual ray, A in text-fig. 2*a,* will be followed through the series of drawings. In *a* a small portion of the ray is being split off at the top and in *b* this is completed; in *e* a second ray segment is being cut off immediately below the first; in *f* this second division is complete, there being now three distinct rays; in the next figure, *g,* the first of the newly formed

[11] Preserved in the British Museum (Natural History), London.



Text-fig. 2. *Cycadoxylon robustum.* Series of ray tracings showing the anastomosing nature of the ray-tracheid tissue.

rays has again fused with the "parent" ray, in *h* the second segment follows and is completely fused in *i*, resulting in a single individual ray again.

While these changes have been progressing in the upper portion of the ray A it will be noticed that another division has taken place in *b*, a little above the lower extremity of that portion of the ray shown in the figure; in *d* two small rays are cut off, while in *c* all four have again fused.

As a second example the ray E in text-fig. 2*a* may be followed: this divides to form two equal rays (E and F) in *b*; F divides again (figs. *d* and *e*), producing the two rays F and C in *f*, while F and E fuse again in *g* and remain thus throughout the remainder of the series. Although the structure of any single ray may not remain constant for any great radial distance the general tracheid-ray relationship at any point throughout the secondary wood shows no appreciable variation.

Medullosa Solmsii.—There remains much to be known of the Permian Medullosas of Chemnitz, and it is more than likely that when further knowledge is forthcoming those plants included within the genus must be segregated into a number of different genera. In general, the rays of the Permian forms are lower and more fusiform than those of the English and American species.

The detailed anatomy of the remarkable *M. Solmsii* is but little known, and the structure of the rays has, to my knowledge, never been figured. Weber and Sterzel (1896) figured a tangential cut through the outer ring of meristeles in a specimen of the variety *typica* but it is not sufficiently clear to show the structural details.

Five tangential sections have been prepared from two different meristeles by Mr. Hemingway and two prepared from a third meristele by the author. These sections include both the "internal" and "external" portions of the secondary wood composing the meristeles.

This wood is frequently disturbed by the passage of leaf traces. In the vicinity of the traces the rays are, as is usually the case, broader, lower and less regular in shape. In that portion of the wood farthest from the traces the rays are quite tall but with a considerable admixture of lower uni- and biseriate rays (fig. 46). The rays do not approach the great height found in Type II, although there is no great dissimilarity between them and the rays of *Megaloxylon* which, as previously noted, is more or less intermediate between Types II and III.

Medullosa gigas B.R.—Slides of this species have not been available for study. However, judging from Renault's ('93–'96) description and figures the rays are similar to those of *Cycadoxylon robustum*, clearly justifying its inclusion within this group.

TYPE IV

Those plants included under Type IV have uniformly small rays, only a few cells high and mostly uniseriate, in striking contrast to either Types II or III. The rays of *Bilignea resinosa* (fig. 43) are typical for the group.

Endoxylon zonatum (fig. 44) presents a unique and very striking character in the oblique nature of the horizontal walls of the ray cells. This does not occur in all the rays, as may be seen in the figure, but the majority possess it.

It has been pointed out that the Calamopityeae includes genera which diverge very widely in certain of their characters. The variation in the structure of the secondary wood between certain members of the group is evident if either figs. 43 or 44 be compared with fig. 28 *(Calamopitys annularis)*. Scott described such wood as cordaitean and it seems likely that the natural affinities of the following members of the Calamopityeae lie closer to the cordaitean-coniferous complex than to the pteridosperms: *Eristophyton fasciculare, E. Beinertianum, Endoxylon zonatum, Bilignea resinosa, B. solida.*

The Tracheidal Morphology of the Pteridosperms

a. *Pitting types.*—The type of pits found in the tracheids of the secondary wood of certain of the pteridosperms is strikingly distinctive. The pits are irregular in size and shape (figs.

50, 51, 52), angular due to their crowded nature, and not arranged in any regular order. This type is characteristic of the following genera: *Heterangium, Lyginopteris, Rhetinangium, Stenomyelon, Calamopitys,* and *Medullosa (anglica* section). In addition to these, *Palaeopitys* and *Tetrastichia* may be assigned to this group, and also *Aneurophyton* judging from Kräusel and Weyland's description ('29): "die Wande der vierseitigen oder polygonalen Zellen sind in ihrer ganzen Ausdehnung mit netsformig angeordneten Tupfeln bedeckt." Although the pitting occasionally may be typically alternate (fig. 53) it is comparatively rare.

It should be noted, furthermore, that the pits of the metaxylem tracheids of these same woods are universally of this reticulate bordered type, differing from those of the secondary wood only in their often more irregular size and shape (fig. 49). Certain uncatalogued slides of *Stenomyelon tuedianum* Kidston in the Scott Collection show particularly well the rapid transition from scalariform tracheids in the protoxylem to reticulate in the metaxylem (figs. 45, 52, 53).

The great geological age of these plants, the generally primitive nature of the primary body, and this rapid transition, all indicate that this reticulate-bordered pitting is palingenetically the primitive type for the metaxylem and the secondary tracheids of this group; there is no indication in any of the genera from the simplest, such as *Palaeopitys* and *Tetrastichia,* to the more advanced members, such as *Lyginopteris,* that in the secondary wood this type of pitting was ever derived from an annular or scalariform type.

The close correlation of this reticulate-bordered pitting with the ray anatomy of the genera *Stenomyelon* to *Lyginopteris,* as shown in table II, is particularly significant. The range in structure of the primary body from a solid protostele through mixed protosteles to *Lyginopteris,* with a few scattered peripheral bundles, indicates clearly the comparative constancy of the secondary wood throughout the group.

The pits in the secondary wood of those members grouped under ray Types III and IV are either of the typical araucarian-cordaitean type (figs. 54, 56) or are more or less scattered, round or oval. *Protopitys,* with its usually crowded elongate bordered pits, presents a very distinctive type (fig. 48). Such pits occur occasionally in *Mesoxylon multirame* but are not nearly as striking as in *Protopitys.* The figure of *Bilignea resinosa* (fig. 55) is more or less typical for that genus and *Eristophyton.* In *Cycadoxylon robustum* and *Megaloxylon Scotti,* although the pits are closely crowded, the arrangement is more regular (tending to vertical rows) than in those woods with the typical reticulate-bordered type. In *Cycadoxylon anomalum* the pits may be closely crowded (fig. 26) but they are generally more loosely arranged (figs. 24, 25, 27).

TABLE II

EXPLANATION IN TEXT

	Nature of primary body	Ray type	Pitting of radial walls of secondary xylem
Tetrastichia	Solid protostele	I	Reticulate-bordered
Aneurophyton	Solid protostele	I	Reticulate-bordered
Palaeopitys	Solid protostele	I	Reticulate-bordered
Stenomyelon	Solid protostele with 3 narrow "rays" of parenchyma	II	Reticulate-bordered
Heterangium	Mixed protostele	II	Reticulate-bordered
Rhetinangium	Mixed protostele	II	Reticulate-bordered
Medullosa (*anglica* section)	Mixed protostele	II	Reticulate-bordered
Calamopitys	Mixed protostele but more highly medullated than the above three	II	Reticulate-bordered
Lyginopteris	Medullated with distinct scattered peripheral bundles	II	Reticulate-bordered

b. *Pitting in the tangential walls of the tracheids of the secondary wood.*—Judging from accounts in the literature one would conclude that tangential pitting in Paleozoic woods is of rare occurrence. A careful examination of many of the stems of Devonian and Carboniferous seed plants or supposed seed plants reveals a somewhat different story. Reasons will be presented below which seem to indicate that the tangential walls of the secondary wood of all primitive seed plants, or rather the stock from which seed plants arose, were pitted in the same manner as the radial walls.

In 1935 D. E. Thomas listed the following plants in which tangential pitting was known to occur: *Pitys antiqua, Palaeopitys Milleri, Callixylon triflieve, C. Newberryi, Volkelia refracta, Mesoxylon multirame, Bilignea resinosa, Sphenoxylon eupunctata.*

Considering first those plants enumerated under ray Type I it may be noted that *Tetrastichia bupatides, Palaeopitys Milleri,* and *Aneurophyton germanicum* have all been reported as having tangential pitting. I have been able to examine slides of the first two in the Kidston and Gordon Collections, and for the third, Kräusel and Weyland ('29) write: "Die Mehrzahl der Tracheiden gleicht aber auch hier deren des sekundären Holzes, d.h. die Wande der vierseitigen oder polygonalen Zellen sind in ihrer ganzen Ausdehnung mit netzförmig angeordneten Tüpfeln bedeckt, die in ein bis sechs Reihen stehen können." . . .

The tracheids of these three plants then are pitted alike on the tangential and radial walls. Although the tangential walls of *Sphenoxylon eupunctata* are abundantly pitted, the pits are, as Thomas points out, in many cells scattered and not crowded as in the radial walls. This tendency to lose the tangential pits correlates interestingly enough with the more advanced nature of the primary cylinder of *Sphenoxylon* with its highly medullated primary body.

In addition to the above, I have observed tangential pitting in the following: *Sutcliffia insignis,* slide 71(0.73) University College, London; *Medullosa anglica,* slide A.M.7 Binney Collection, Cambridge; *Heterangium tillaeoides,* slide 1621 Williamson Collection, British Museum (Natural History); *Heterangium (punctatum?),* Renault Collection, Natural History Museum, Paris; *Stenomyelon tuedianum,* uncatalogued slide in the Scott Collection, British Museum; *Heterangium* sp., slide 91 Gordon Collection, King's College, London, and numerous slides in my own collection.

The most striking occurrence of tangential pitting is found in the last-mentioned *Heterangium* from Burntisland. Prof. Gordon has kindly allowed me to examine his slides and has placed in my hands a block containing portions of two stems. The excellent preservation of the structure made possible the preparation of a fine series of cellulose pulls through the zone of secondary wood. The latter is quite narrow, being little more than 0.5 mm. wide, but the pitting is *uniform on the tangential walls throughout* as shown in fig. 31. These specimens of *Heterangium* are closely comparable with *H. Grievei.*

It is particularly significant that the most primitive woods possessing secondary xylem *(Tetrastichia, Palaeopitys,* and *Aneurophyton)* should be pitted alike on the tangential and radial walls, and that the somewhat more advanced forms *(Sphenoxylon* and *Heterangium)* show a tendency to lose the tangential pitting. The above-noted specimens of *Heterangium* from Burntisland possess uniform pitting on the tangential walls, while in *H. tillaeoides* and *H. punctatum* the pits are scattered. In more highly specialized forms still, such as *Medullosa* and *Sutcliffia,* this character becomes relatively rare.

c. *Tracheid measurements.*—The great length of the tracheids of such pteridosperms as *Lyginopteris oldhamia* and *Medullosa anglica* has been noted by previous workers. Actual measurements have never been made, however, due to the difficulty of obtaining tangential longitudinal sections showing the entire length of the tracheids and the impossibility of obtaining complete serial sections with the older technique. It is surprising to note how few good tangential sections of the relatively common pteridosperms are available in the great English collections, a lack which may be attributed to the emphasis placed on the primary body.

The tracheids were measured by means of complete series of tangential cellulose pulls taken through the secondary wood. Particularly well-preserved tracheids were chosen and traced centripetally and centrifugally through successive pulls in order to check the length accurately.

The tracheid lengths given for *L. oldhamia* are based on two blocks containing exceptionally well-preserved secondary wood. Although only approximately 25 tracheids were followed in their entirety, the results are representative since the variation in those measured was not great. The average length was found to be 5.8 mm., with a minimum and maximum of 5.1 and 6.7 mm., respectively.

The two species of *Medullosa, M. anglica* and *M. Noei,* have tracheids of remarkable length. The figures given in table III are based on only two complete measurements, the length being so great that it is difficult to find a complete cell. In the blocks from which the measurements of both species were obtained many tracheids were traced for well over 1.5 cm. with no termination, and it is almost certain that if figures could be based on more numerous complete cells the average length would be actually greater than that given.

In the following table figures for other gymnosperms are included for comparison, also for the dicotyledons taken from Bailey and Tupper ('18). These latter figures have been compounded from the numerous average measurements of the older wood (not the first annual ring) given for many genera and species included under the six groups.

TABLE III

TRACHEID LENGTHS (mm.)

	Average	Source of data
Lyginopteris oldhamia	5.8	Blocks supplied by J. R. Lomax and W. Hemingway
Medullosa Noei	24.0	Block in the Botany School Collections, Cambridge
M. anglica	17.5	Block supplied by J. R. Lomax
Cycadoxylon robustum	5.6	Block supplied by British Museum (Natural History)
Coniferae	3.6	Bailey & Tupper ('18), average of 35 gen. and 131 sp.
Cordaitales	5.	Bailey & Tupper ('18), average of 2 gen. and 2 sp.
Bennettitales	5.3	Bailey & Tupper ('18), average of 1 gen. and 2 sp.
Cycadales	6.8	Bailey & Tupper ('18), average of 1 gen. and 1 sp.
Ginkgoales	3.5	Bailey & Tupper ('18), average of 1 gen. and 1 sp.
Angiospermae-Dicotyledeae	1.2	Bailey & Tupper ('18), average of 262 gen. and 276 sp.

The great length of the tracheids in *Lyginopteris* and particularly in *Medullosa* is not surprising when one considers their transverse dimensions. In *M. Noei* and *M. anglica* these cells may reach a diameter of 0.25 mm. and, although some few are as small as 40 μ or less, the average diameter is greater than that of any other seed plant that has come to my attention. It is interesting to compare the tracheid diameter of a few representative members of the Carboniferous pteridosperms with the vessels of the earliest known (Lower Cretaceous) dicotyledons:

TABLE IV

TRACHEID AND VESSEL DIAMETERS OF CERTAIN PTERIDOSPERMS AND LOWER CRETACEOUS DICOTYLEDONS RESPECTIVELY

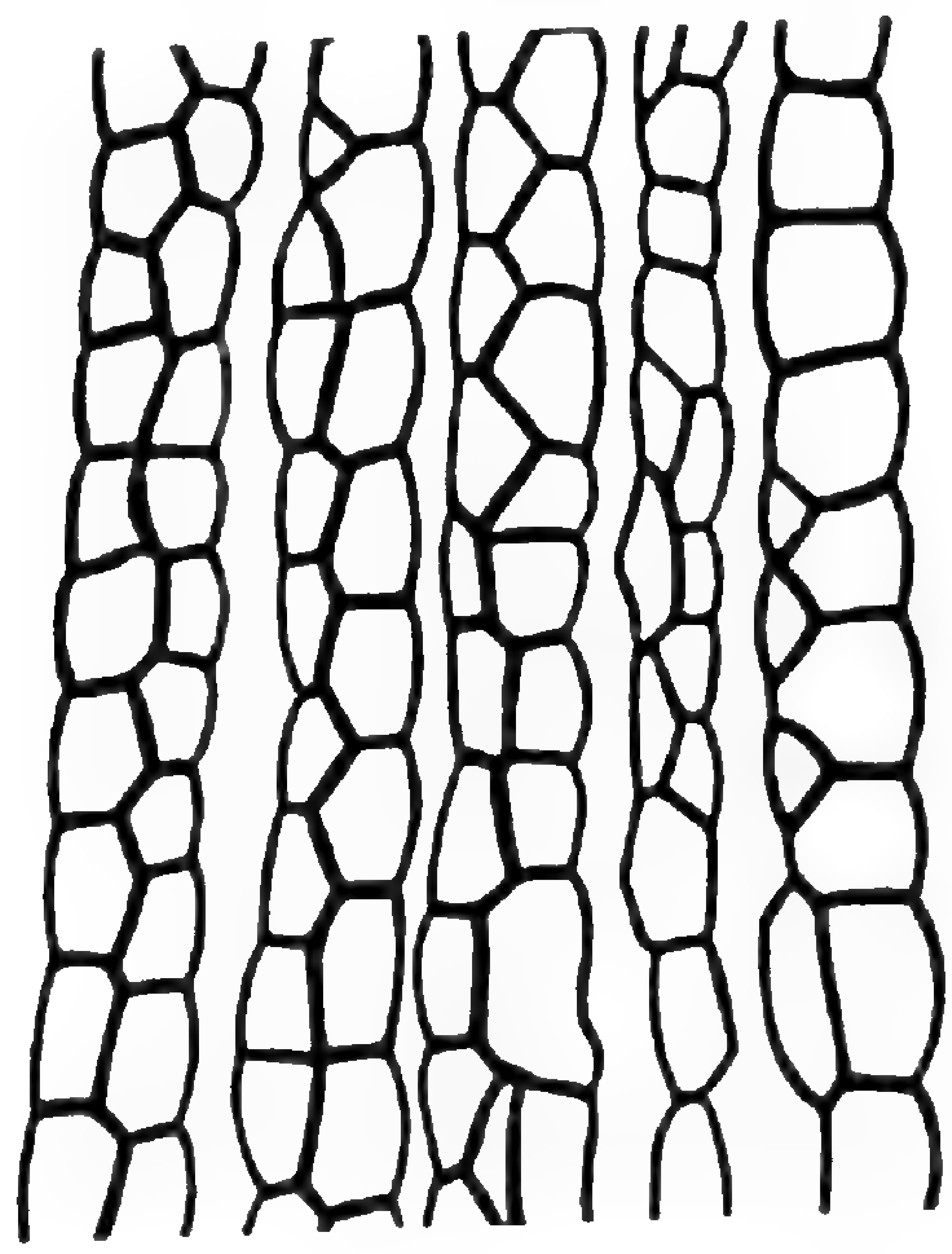
Species	Average diameter in μ*	
	Vessel	Tracheid
Lyginopteris oldhamia		72.
Medullosa anglica		128.
Rhetinangium Arberi		45. – 85.
Aptiana radiata Stopes	28. – 40.	
Woburnia porosa Stopes	280. – 370.	
Sabulia Scottii Stopes	25. – 60.	
Cantia arborescens Stopes	30. – 50.	
Hythia Elgari Stopes	50.– 70.	

*Although the author has been able to study the slides of the five Lower Cretaceous dicotyledonous woods *(Aptiana, Woburnia, Sabulia, Cantia,* and *Hythia)* the figures are taken directly from Stopes ('12). The measurements for *M. anglica* are from slide 922, Andrews Coll.; for *L. oldhamia,* an average of about 600 cells, from slides 180, 183, Binney Coll., and 1147, 251, Scott Coll.

It is significant that the earliest known dicotyledonous woods described by Stopes ('12, '15) are, with the exception of *Woburnia porosa,* woods with vessels of exceptionally narrow diameter. The tracheids of the above pteridosperms not only equal but in some cases greatly surpass in diameter the vessels of these early angiosperms. The distinction, then, between diameters of tracheids and vessels in the higher plants vanishes when these fossils are taken into consideration.

The angular, irregular shape of the tracheids is particularly noticeable in *Medullosa (anglica* section), *Lyginopteris,* and *Sutcliffia* (text-fig. 3). Tracheids of this shape are found in certain conifers and dicotyledons, and while perhaps of little significance their appearance is striking and has been commented upon by other paleobotanists.

It is significant that there is no trace to be found in the secondary wood of the pteridosperms of tracheids with scalariform pitting on their side or end walls such as has been described in certain families of angiosperms and considered to



Text-fig. 3. *Sutcliffia insignis.* Transverse section of secondary xylem (slide 5(040) Univ. College Coll., London). × 50.

be an indication of a primitive nature. In view of the carefully compiled evidence obtained from living plants by such wood anatomists as Frost ('30, '31) and Kribs ('35) and since we have as yet no proof that the pteridosperms are ancestral to the dicotyledons, it seems best for the present to withhold further phylogenetic considerations in this respect.

Lines of Development in the Pteridosperm Complex

The discovery in recent years of new psilophytalean and supposed seed-plant stem remains, combined with a more detailed knowledge of the secondary wood of these early plants, materially facilitates a clearer understanding of the natural relationships of this Devonian-Carboniferous complex.

Since *Rhynia* presents the simplest known type of stele it will serve as a starting point in the present discussion. It is evident that two stelar types may have developed from such a protostele. With increase in size the primary body became either medullated or convoluted in order, supposedly, to maintain a more or less constant tracheid-parenchyma ratio. The fossil record clearly indicates that the actinostele arose very early, and like the protostele, acquired secondary wood at a very early date.

In a consideration of what appear to be primitive stelar types in which secondary wood is present, the genera under ray Type I *(Palaeopitys, Aneurophyton, Tetrastichia,* and *Sphenoxylon)* may be included. It seems reasonable to consider Prof. Harris' very interesting *Schizopodium* as an intermediate form between this group and the simple stelar types of *Rhynia* and *Asteroxylon,* but until more is known of the ontogeny of the "secondary" xylem of *Schizopodium* final judgment must be withheld.

A stele of the *Heterangium* type is not far removed from the above-mentioned group, and from this point a number of lines may have originated. First, with nearly complete medullation as in *Lyginopteris* and the development of extra-xylary rings as shown to occur in that genus the origin of the bizarre medullosas lies close at hand. Secondly, the cycadophytes may quite conceivably be derived from the *Heterangium*[12] type through such a form as *Megaloxylon.* Other than size there is not a great deal of difference between the primary body of the two. The peculiar aggregation of the tracheids to form a leaf trace in *Megaloxylon* is apparently due to the somewhat lower tracheid-parenchyma ratio of the primary body. The secondary wood is in certain respects intermediate between *Heterangium* and the cycadean type.

If it is ever possible to trace dicotyledonous ancestry to the

[12] The writer is quite aware of the danger of employing a few specific plants in building supposed lines of evolution. Names, however, are unavoidable in such a discussion, and it must be borne in mind that they are used only as a matter of convenience to convey *types* of structure represented.

Carboniferous it seems to me that the members of ray Type II present the most plausible group as far as potential plasticity is concerned. It is tempting to consider such phyletic implications with well-known pteridosperms of the *Lyginopteris* type but supporting facts are still notably lacking. As far as the stelar anatomy is concerned there is no sound basis for assuming such a line of development. Further discussion of the angiosperms with reference to the Paleozoic plants considered here could be only in the nature of a review or speculation. The subject has been adequately treated, from the standpoint of reproductive structures, by Dr. H. H. Thomas in his more recent papers.

Summary

1. The distinguishing characteristics of the pteridosperms and their probable relationships to other groups are discussed generally.

2. The primary body of the stem and root of *Lyginopteris oldhamia* is considered in detail with reference to size variation, parenchyma-sclerenchyma relationship of the pith, and the nature of the primary xylem.

3. Medullary meristematic activity is discussed and a remarkable specimen described in which a complete medullary cylinder of supposedly secondary xylem is present.

4. It is pointed out that there are no gaps in the stelar variation of *L. oldhamia* sufficiently wide to permit segregation of varieties, whereas the foliage in organic connection or associated with the stems presents distinct specific segregation. This is explained partly on the basis of character phylogeny and partly on the physiological requirements of the primary body.

5. Evidence is summarized indicating the probable synonymy of *Calamopitys americana, C. saturni,* and *C. annularis.*

6. The primary body of certain other fossil and living plants is discussed in relation to ''Size and Form'' principles.

7. Four ray types are described for those plants generally included within the Pteridospermae.

8. The mechanics of ray division in *Cycadoxylon robustum* is shown to be essentially the same as Miss Chattaway described for *Cola togoensis*. In *Lyginopteris* the method is somewhat different and is described in detail.

9. *Cycadoxylon anomalum* is partially redescribed and is shown to possess a very constant ray structure and it is unquestionably distinct from *C. robustum*. The rays and tracheids are shown to anastomose.

10. Those woods included under Ray Types I and II, particularly the latter, possess a distinctive type of pitting, the pits being irregular in size and shape, closely crowded and irregularly (reticulately) arranged. The woods grouped under Ray Types III and IV possess either loosely arranged circular pits or the araucarian type.

11. It is pointed out that there is no evidence that the secondary tracheids of the pteridosperms ever possessed scalariform pitting. In the earliest known forms only well-developed bordered pitting is found.

12. It is shown that pitting in the tangential walls of the secondary tracheids is of much more common occurrence in these plants than is generally supposed. It is identical with the radial-wall pitting and occurs throughout the secondary wood in *Tetrastichia, Palaeopitys, Aneurophyton,* and certain specimens of *Heterangium,* and to a lesser extent in others.

13. The lengths of the secondary tracheids have been determined for *L. oldhamia* and *Medullosa Noei.*

14. As a whole it seems clear that the secondary wood offers more stable taxonomic characters than the primary wood, the latter being more readily affected by "Size and Form" factors.

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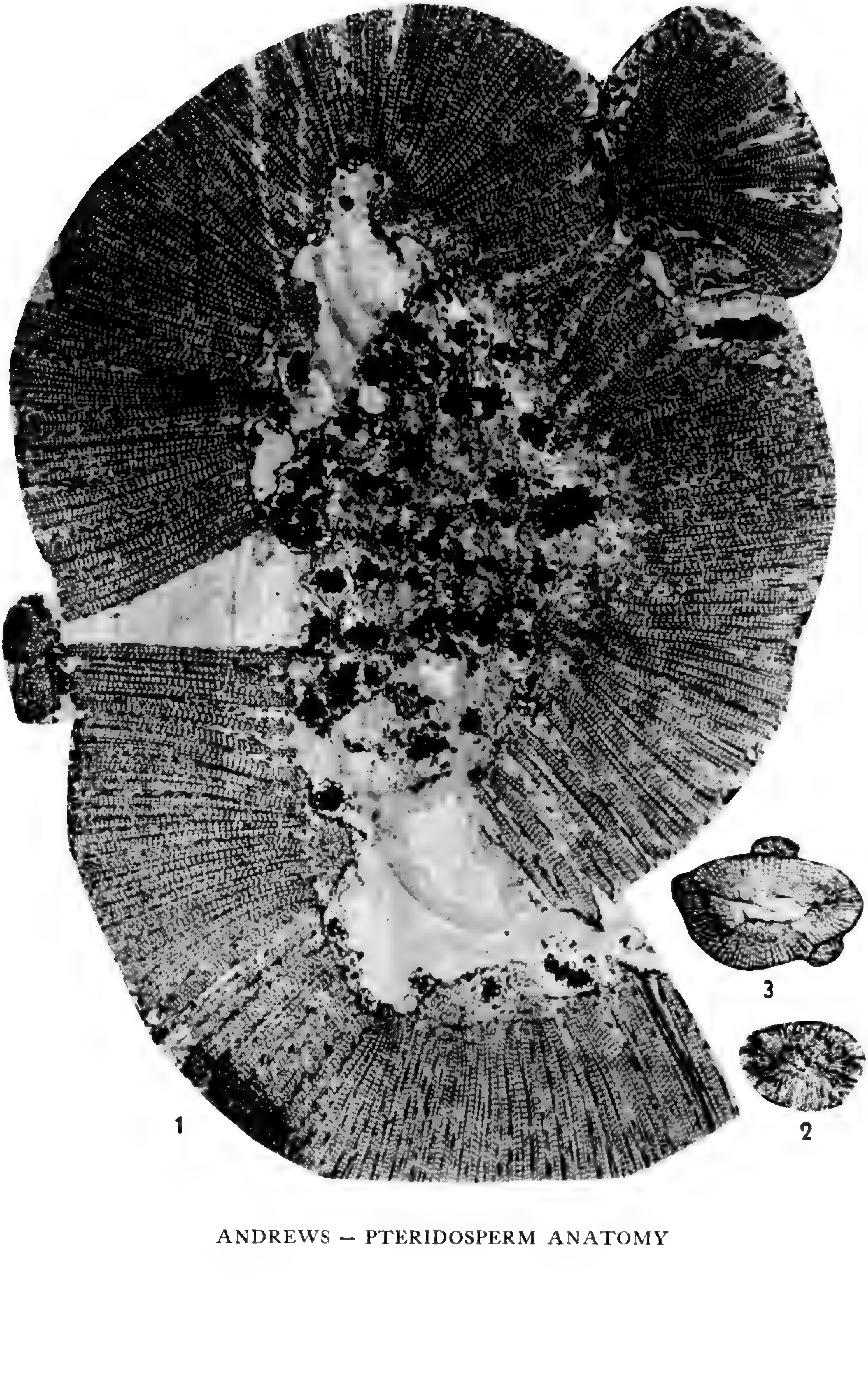
Explanation of Plate

PLATE 5

Lyginopteris oldhamia. Transverse sections of stems, all × 7.5.

Fig. 1. Andrews Coll. 1140.
Fig. 2. Manchester Coll. R838b.
Fig. 3. Williamson Coll. 1885HH.



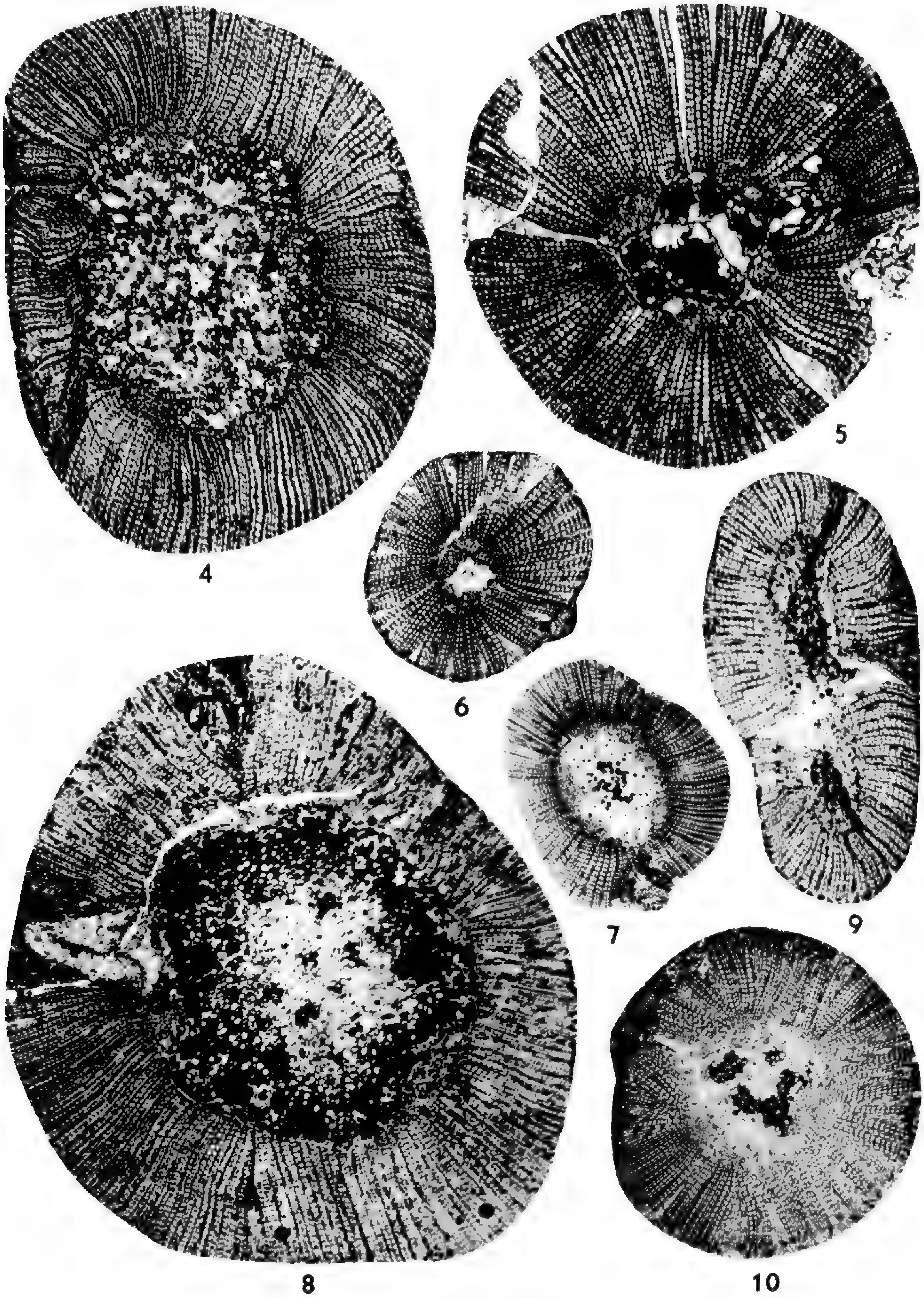
ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 6

Lyginopteris oldhamia. Transverse sections of stems, all × 7.5.

Fig. 4. Williamson Coll. 1116.
Fig. 5. Binney Coll. 180. From the type specimen.
Fig. 6. Andrews Coll. 611.
Fig. 7. Scott Coll. 637.
Fig. 8. Scott Coll. 251.
Fig. 9. Cash (Manchester) Coll. Q10.
Fig. 10. Williamson Coll. 1882.



ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 7

Lyginopteris oldhamia.

Fig. 11. Central portion of fig. 14 more highly magnified. × 9.

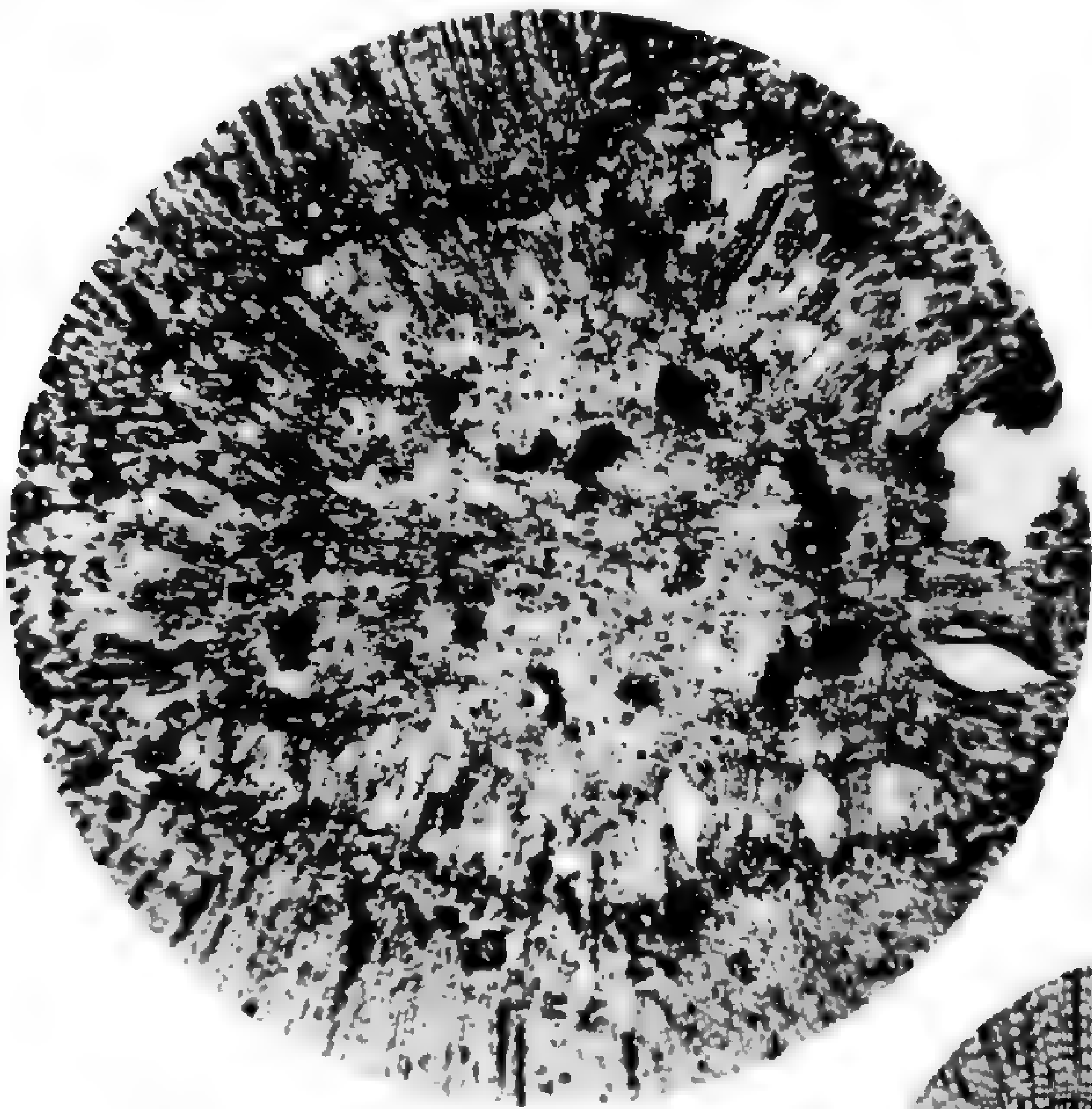
Fig. 12. Showing secondary centripetal xylem associated with a primary bundle. Manchester Coll. 1625. × 27.

Fig. 13. Anomalous meristematic activity. Manchester Coll. R1059. × 8.

Fig. 14. Stem with complete ring of "centripetal" secondary xylem. Manchester Coll. R1060. × 7.

Fig. 15. Same showing scattered nature of primary xylem adjacent to normal secondary xylem. × 26.

Fig. 16. Portion of fig. 14 shown at magnification of × 26.



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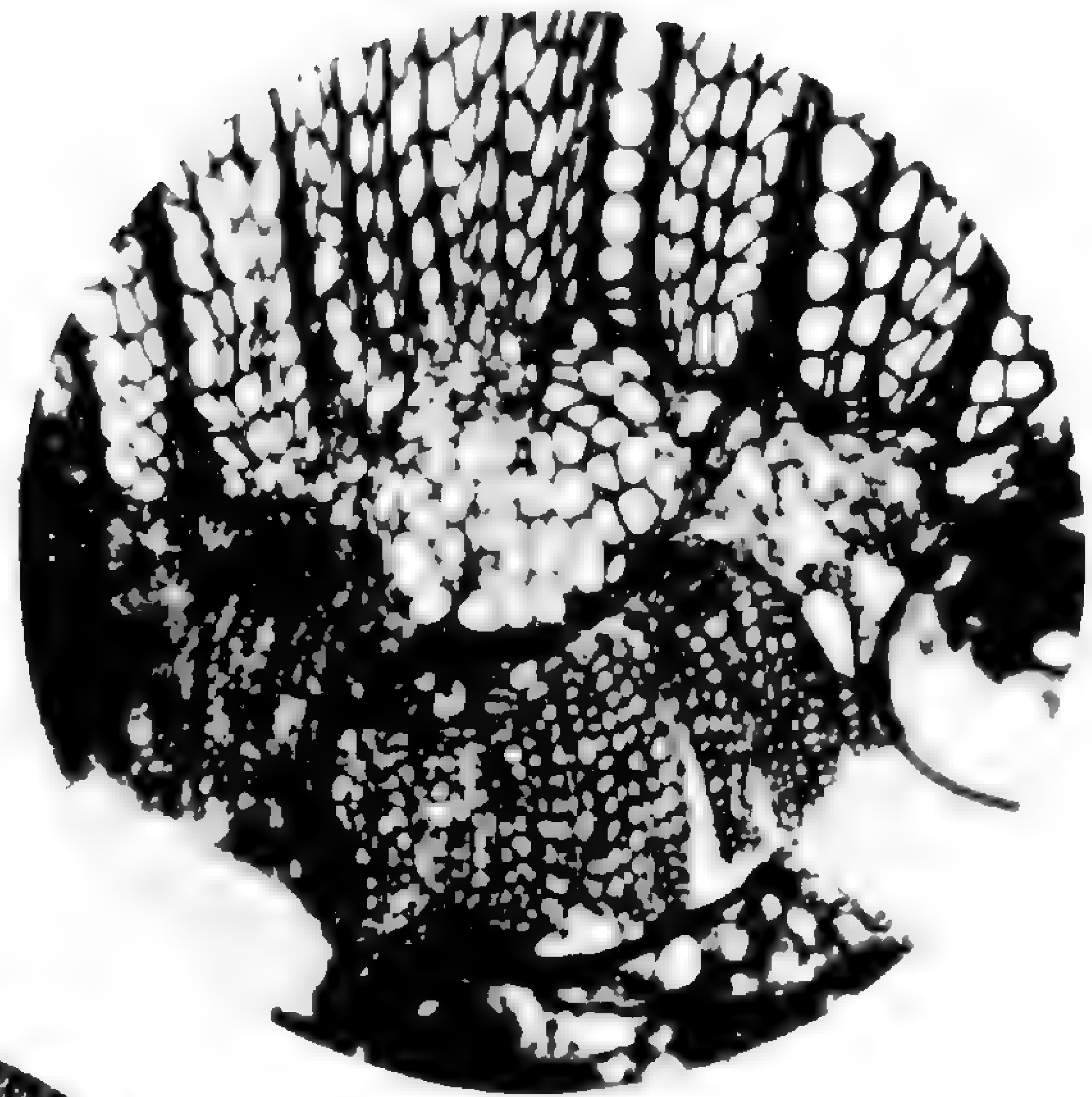

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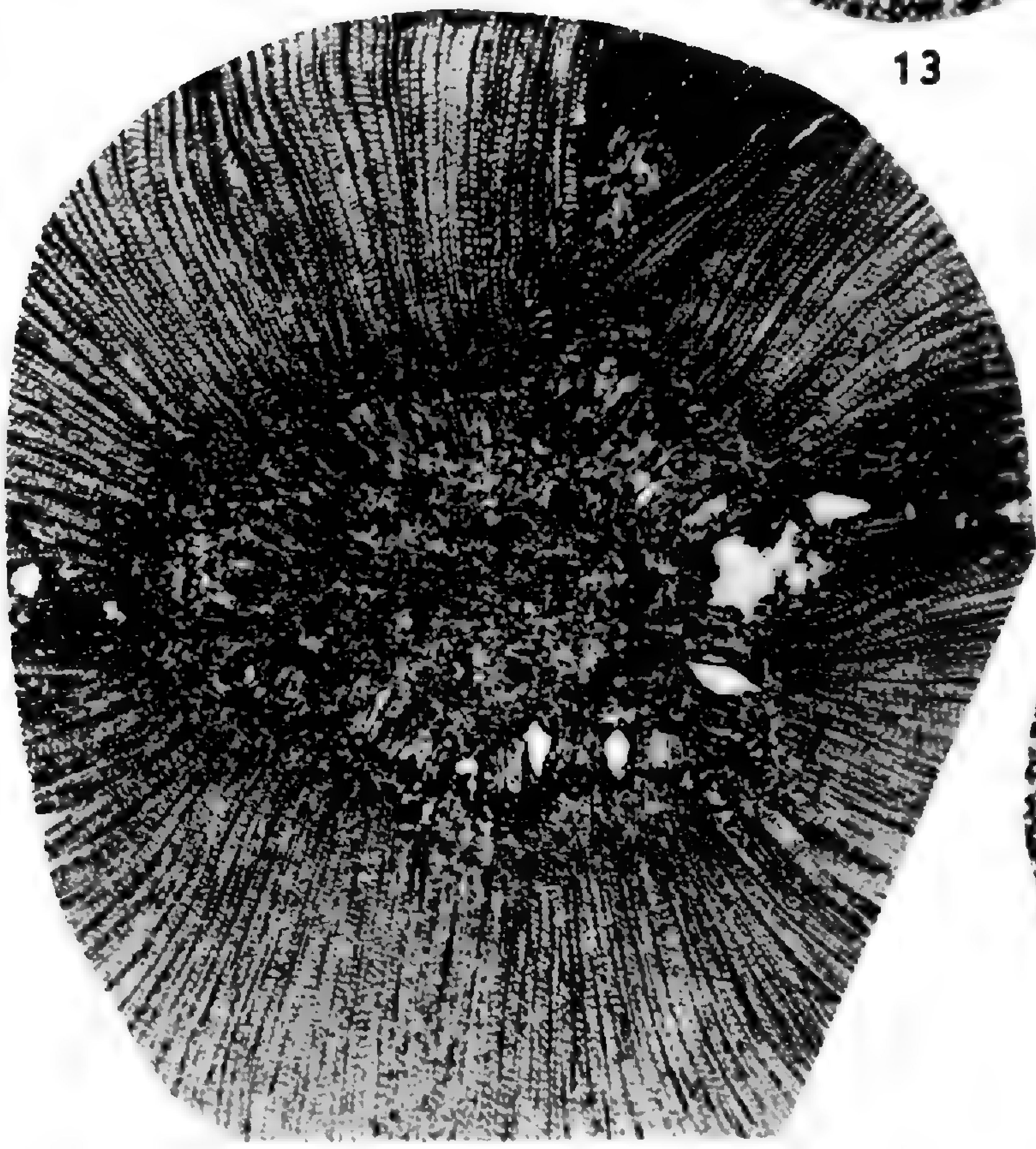

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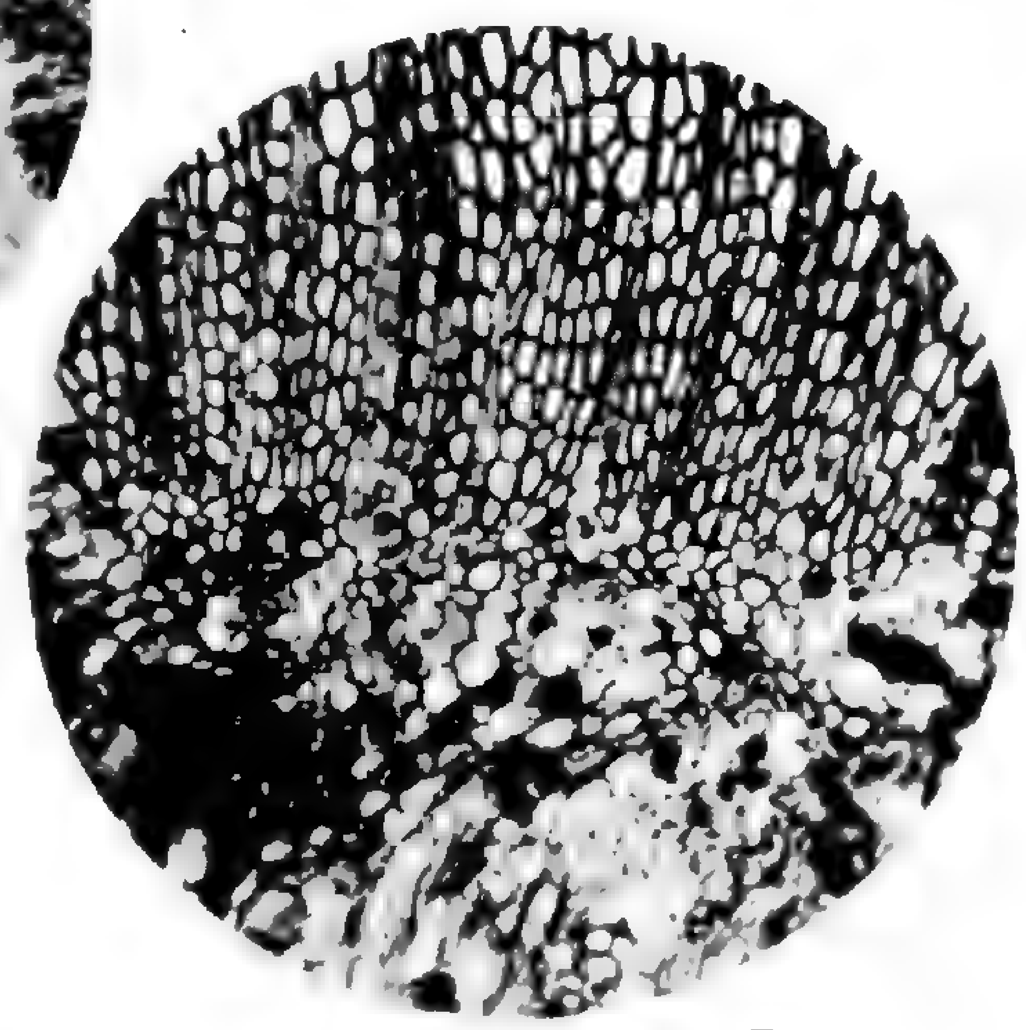

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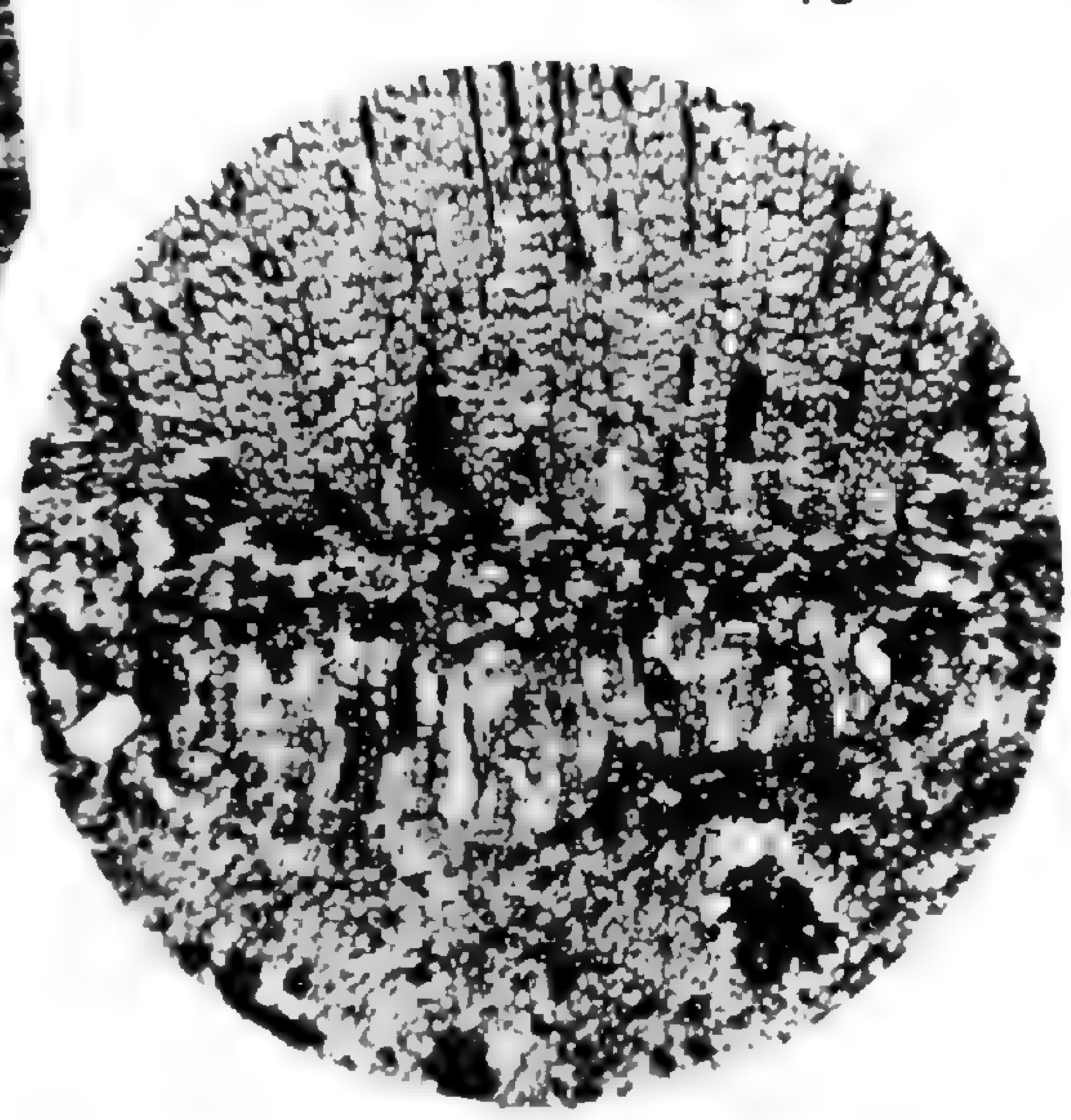

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ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 8

Fig. 17. *Lyginopteris oldhamia.* Manchester Coll. 1626. × 7.5.

Fig. 18. *Calamopitys saturni.* Berlin Coll. 74. × 33.

Fig. 19. *Lyginopteris oldhamia.* From an uncatalogued slide in the Scott Coll. (labeled 46) showing meristematic activity in the pith, with no lignification. × 14.

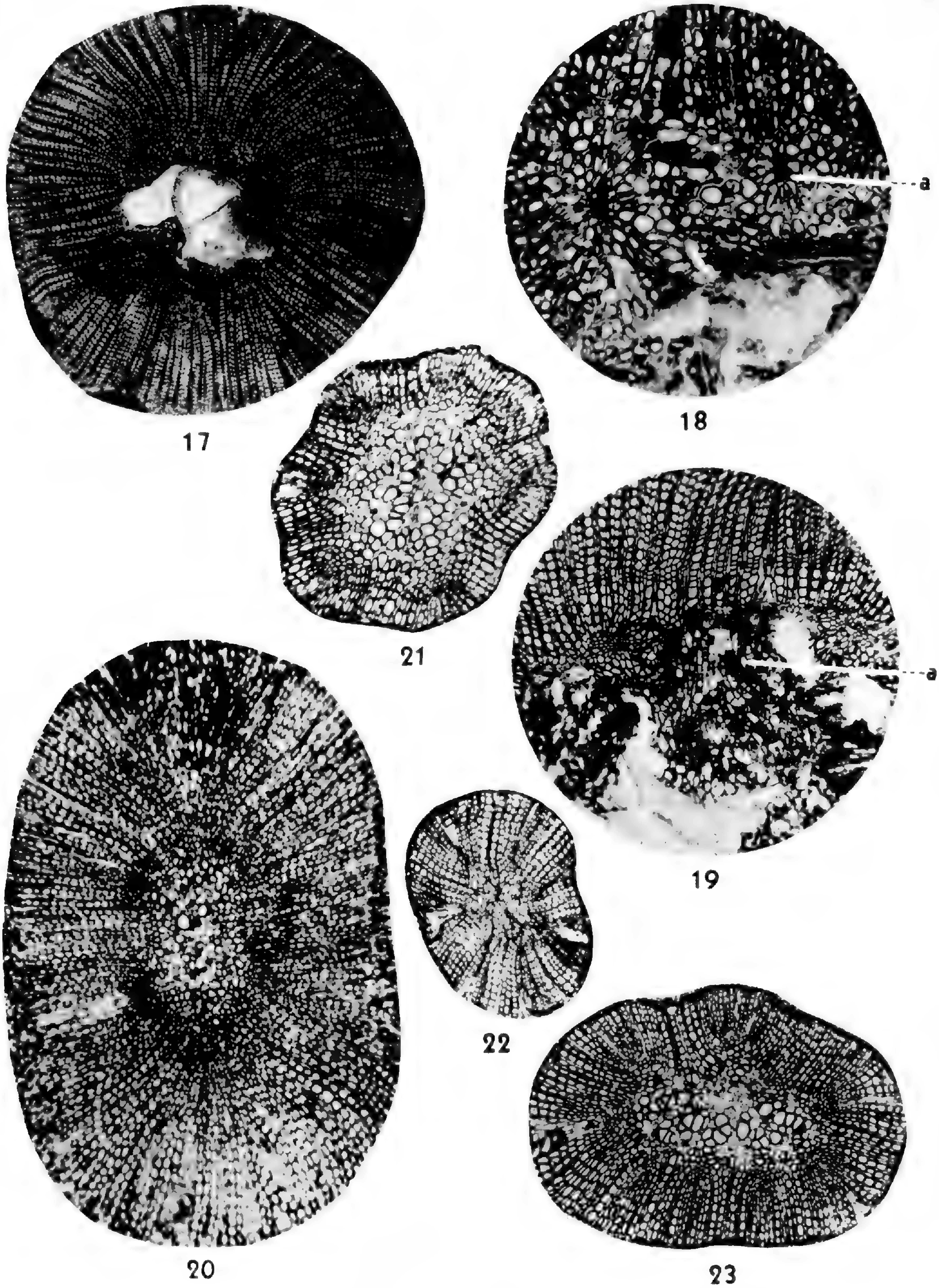
Lyginopteris oldhamia. Transverse sections of roots, all × 23.

Fig. 20. Scott Coll. 647.

Fig. 21. Scott Coll. 647.

Fig. 22. Manchester Coll. 1060.

Fig. 23. Scott Coll. 645.



ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

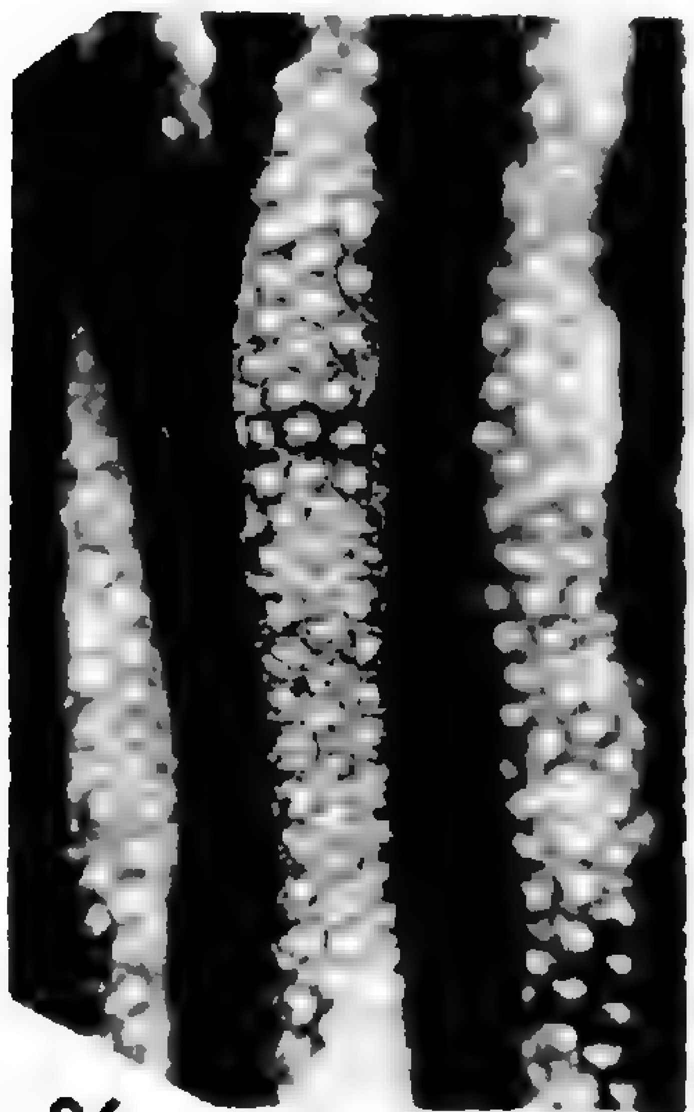
PLATE 9

Cycadoxylon anomalum. Pitting in the radial walls of the tracheids of the secondary xylem.

Fig. 24. Scott Coll. 651. × 185.
Fig. 25. Scott Coll. 651. × 100.
Fig. 26. Scott Coll. 651. × 185.
Fig. 27. Scott Coll. 651. × 146.

Calamopitys annularis.

Fig. 28. Tangential section through the secondary xylem. Berlin Coll. 49. × 17.
Fig. 29. Showing portion of incomplete primary xylem ring. Berlin Coll. 97. × 11.
Fig. 30. Primary body. Berlin Coll. 74. × 14.
Fig. 31. *Heterangium* sp. Showing pitting in tangential walls of secondary tracheids. Gordon Coll. 91. × 55.



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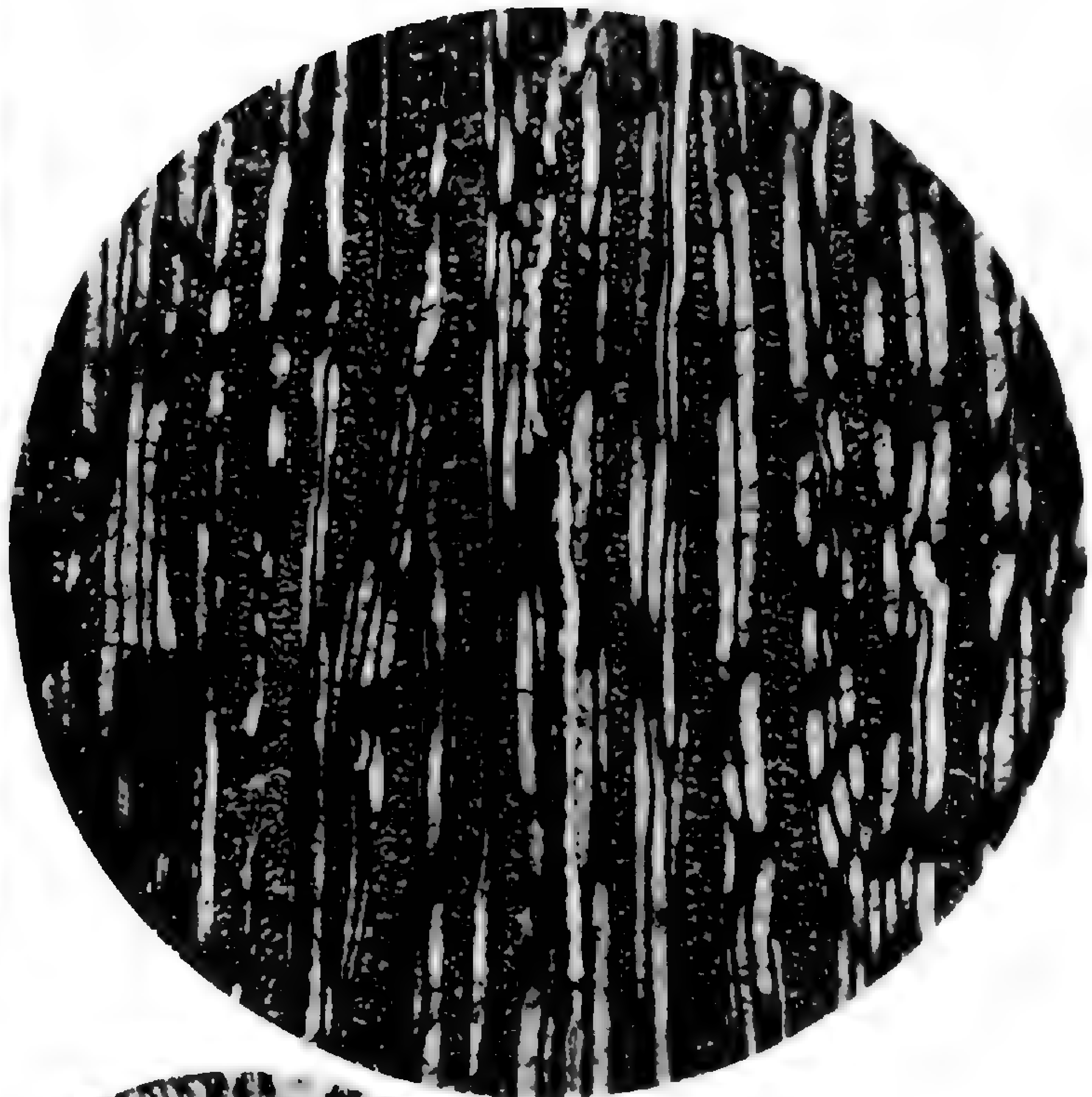

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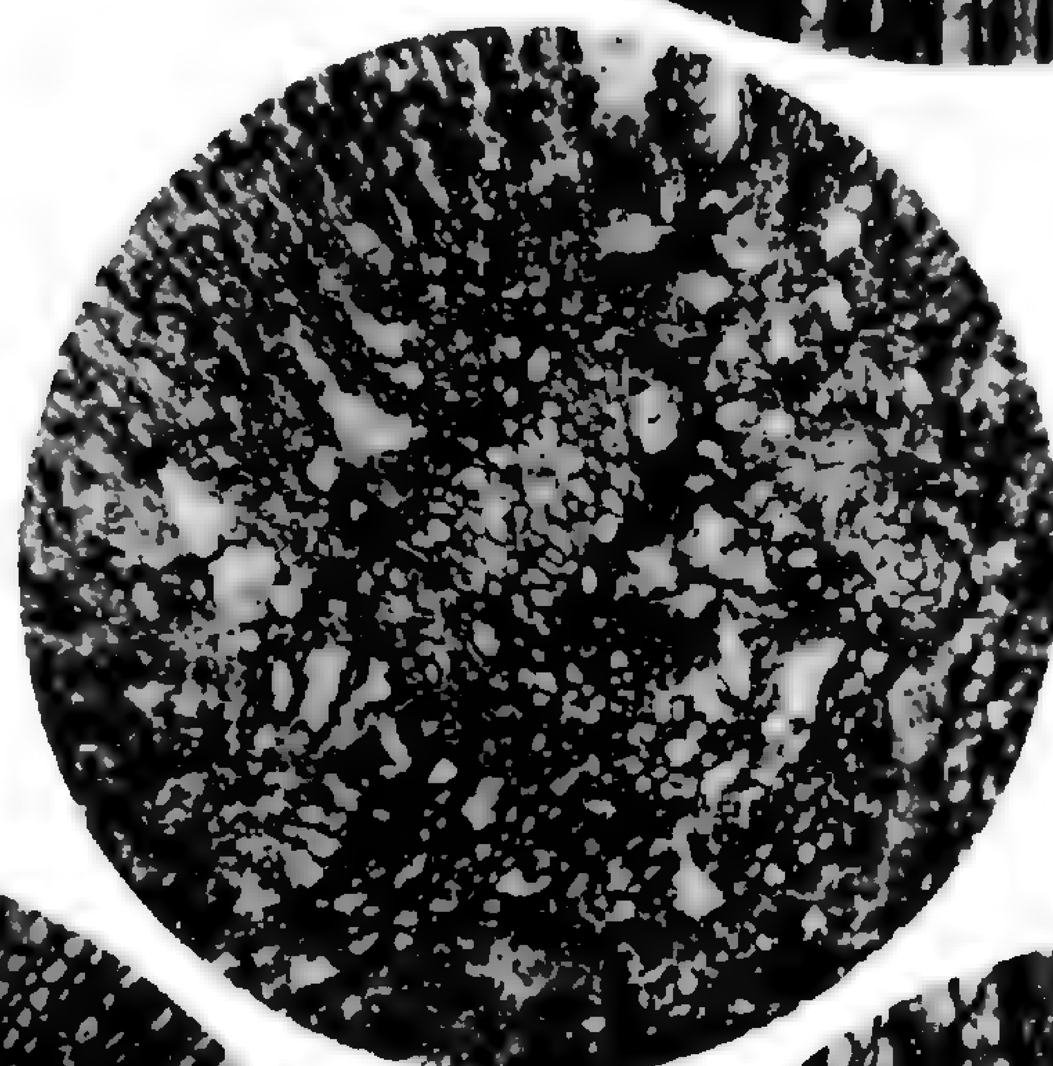

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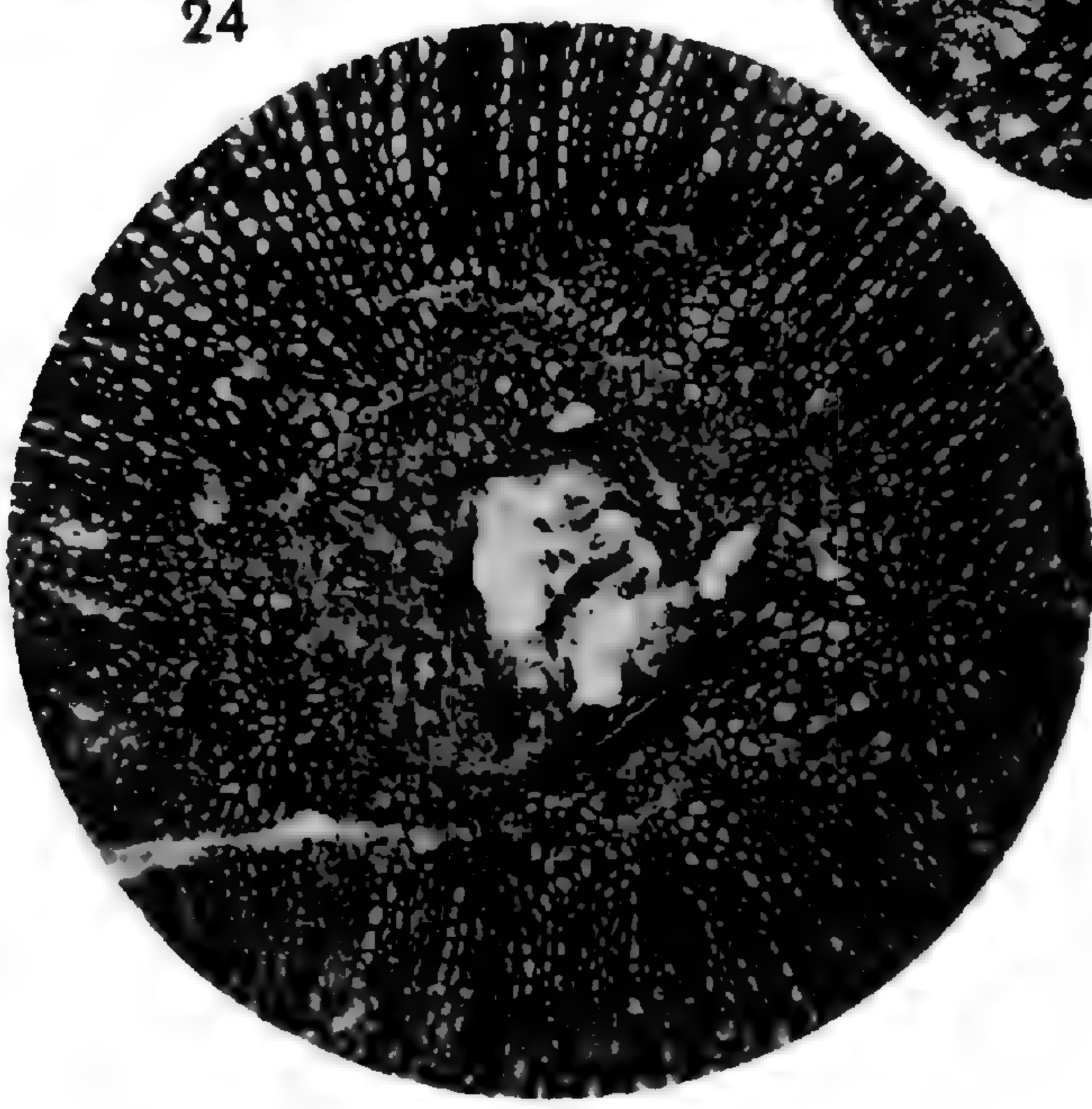

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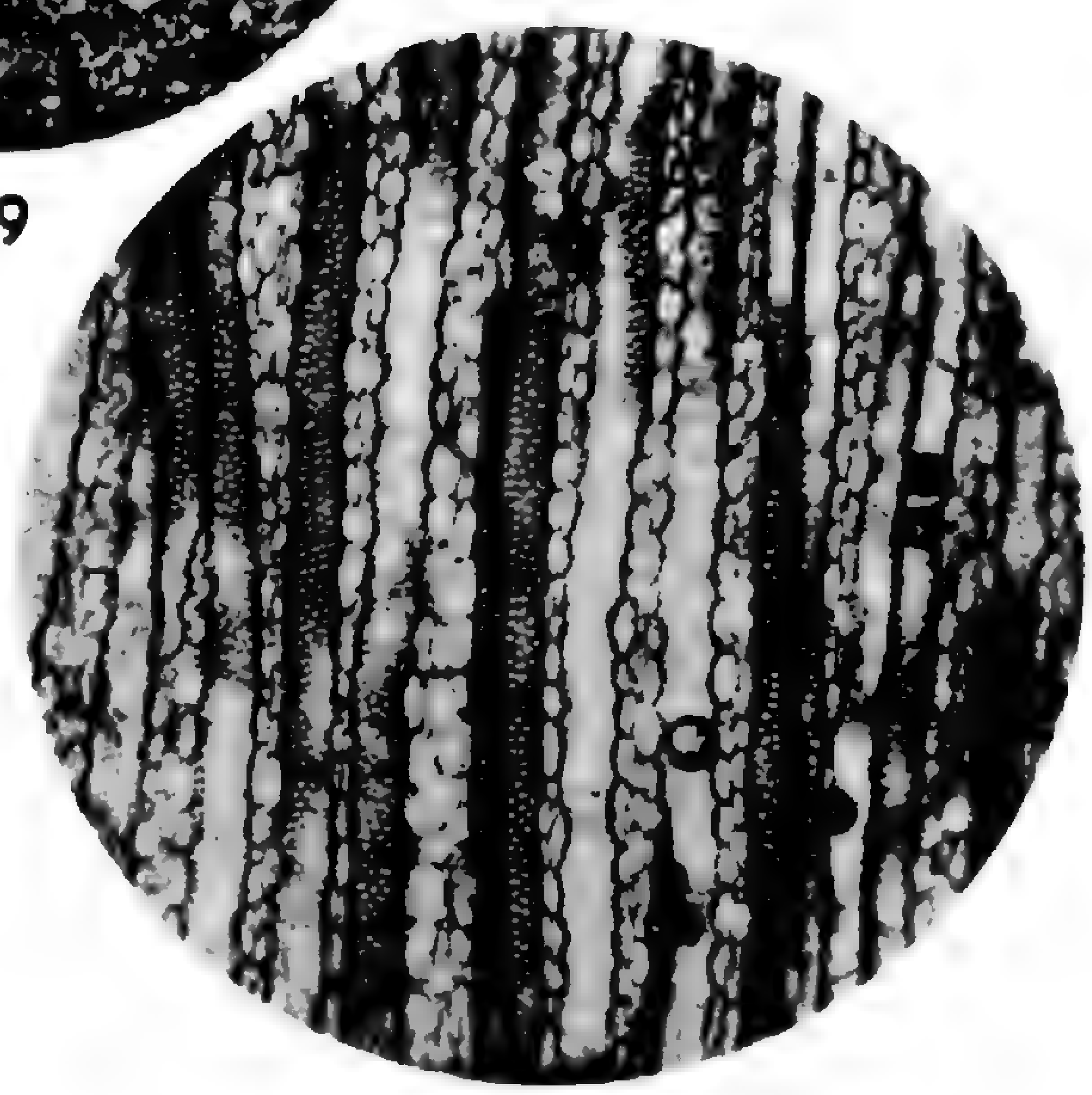


31

ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 10

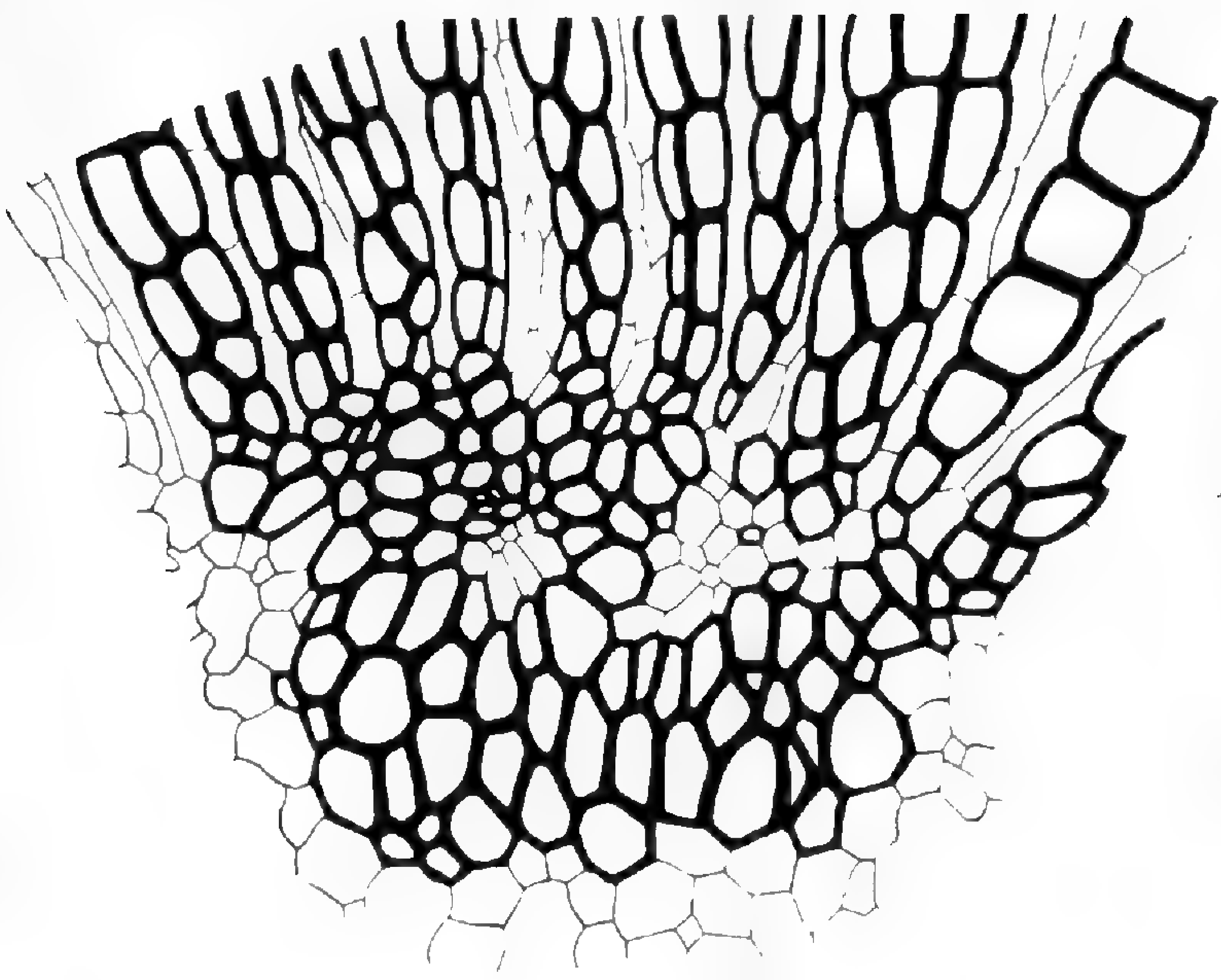
Lyginopteris oldhamia. Transverse sections showing variation in the nature of the primary xylem bundles, all × 65.

Fig. 32. The normal type of bundle. Williamson Coll. 1882.

Fig. 33. From the specimen with complete ring of centripetal secondary xylem (fig. 14). The primary xylem is for the most part not aggregated into distinct bundles but consists of a few scattered cells.

Fig. 34. University College (London) Coll. M22V(19).

Fig. 35. Manchester Coll. 1626.



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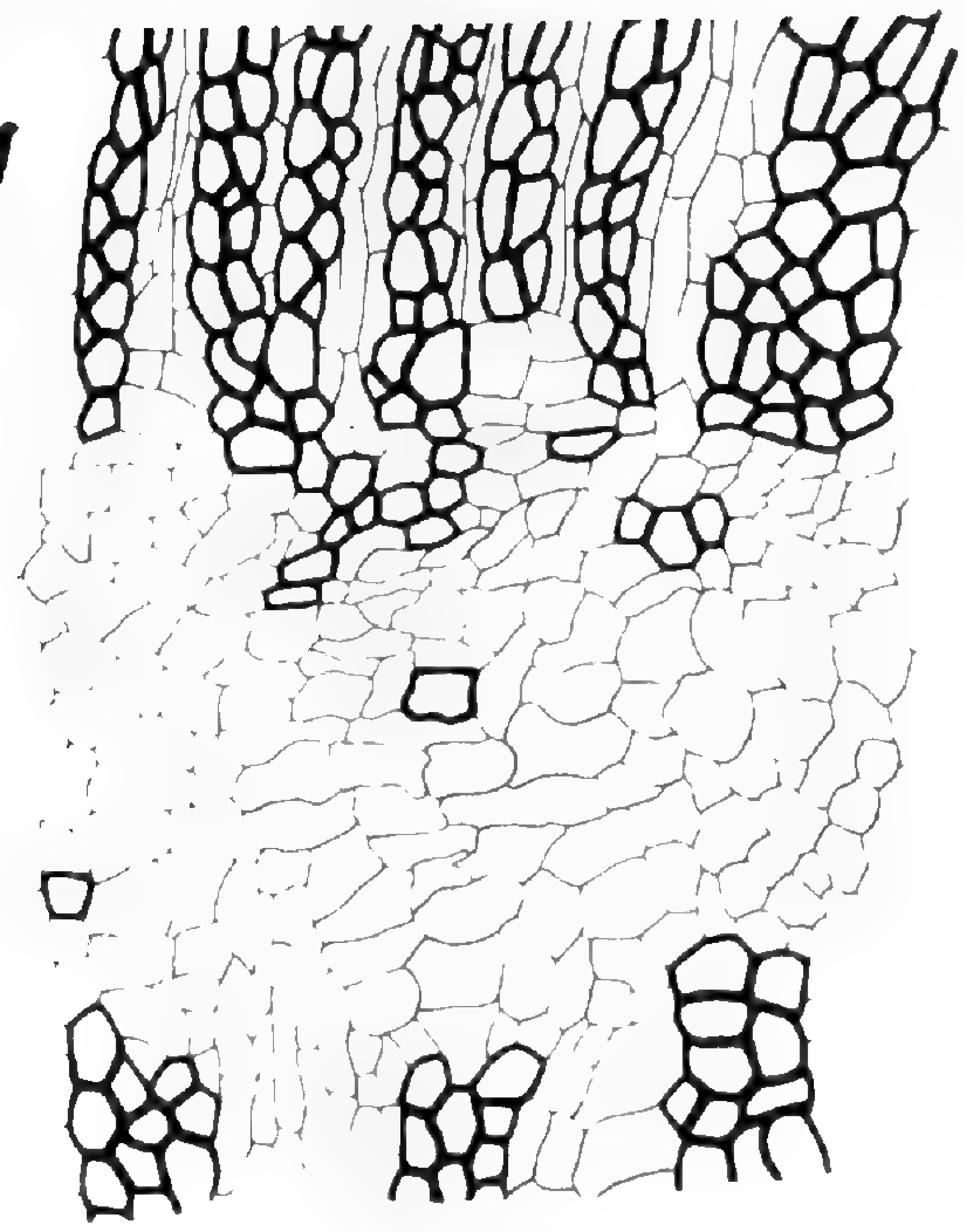

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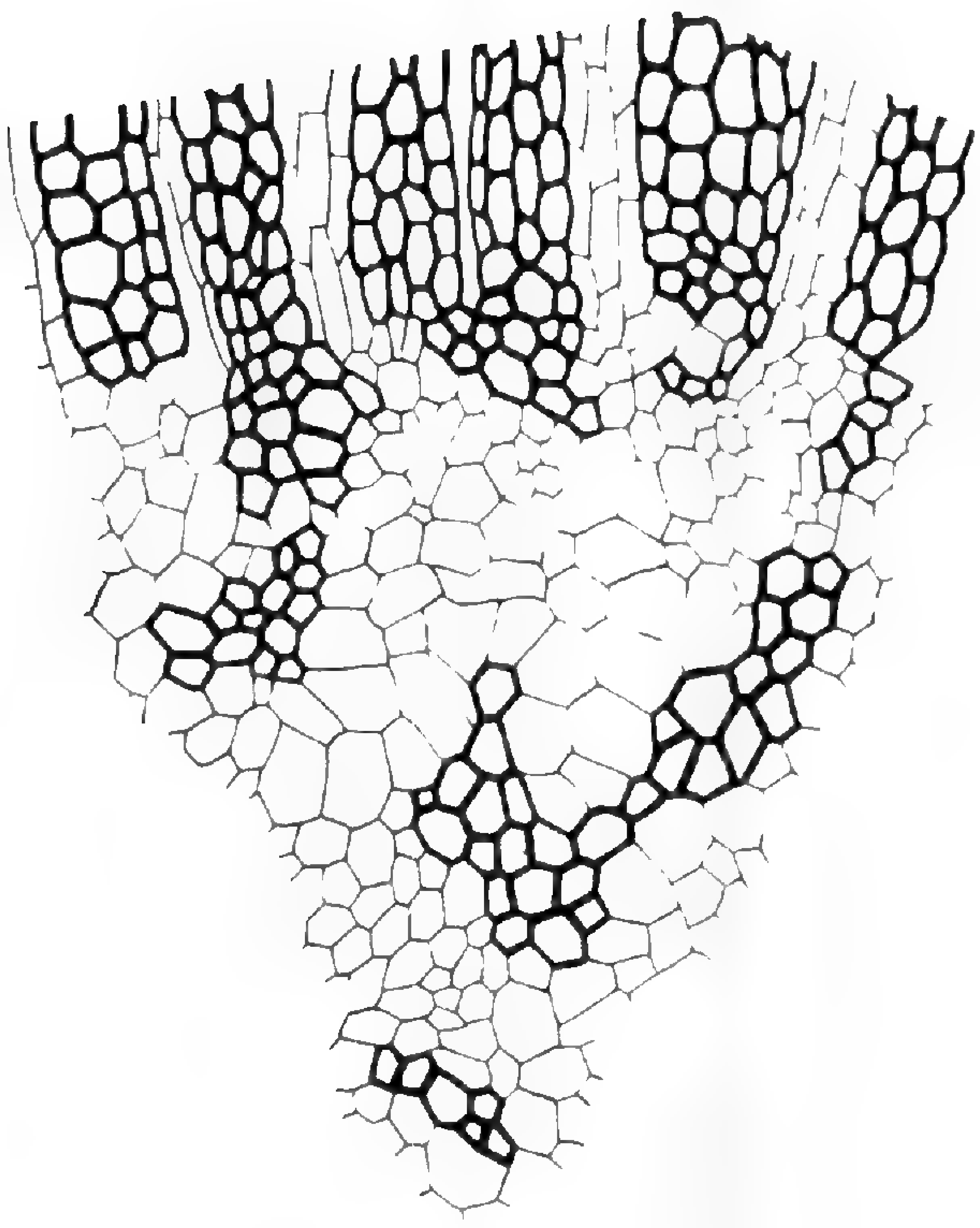

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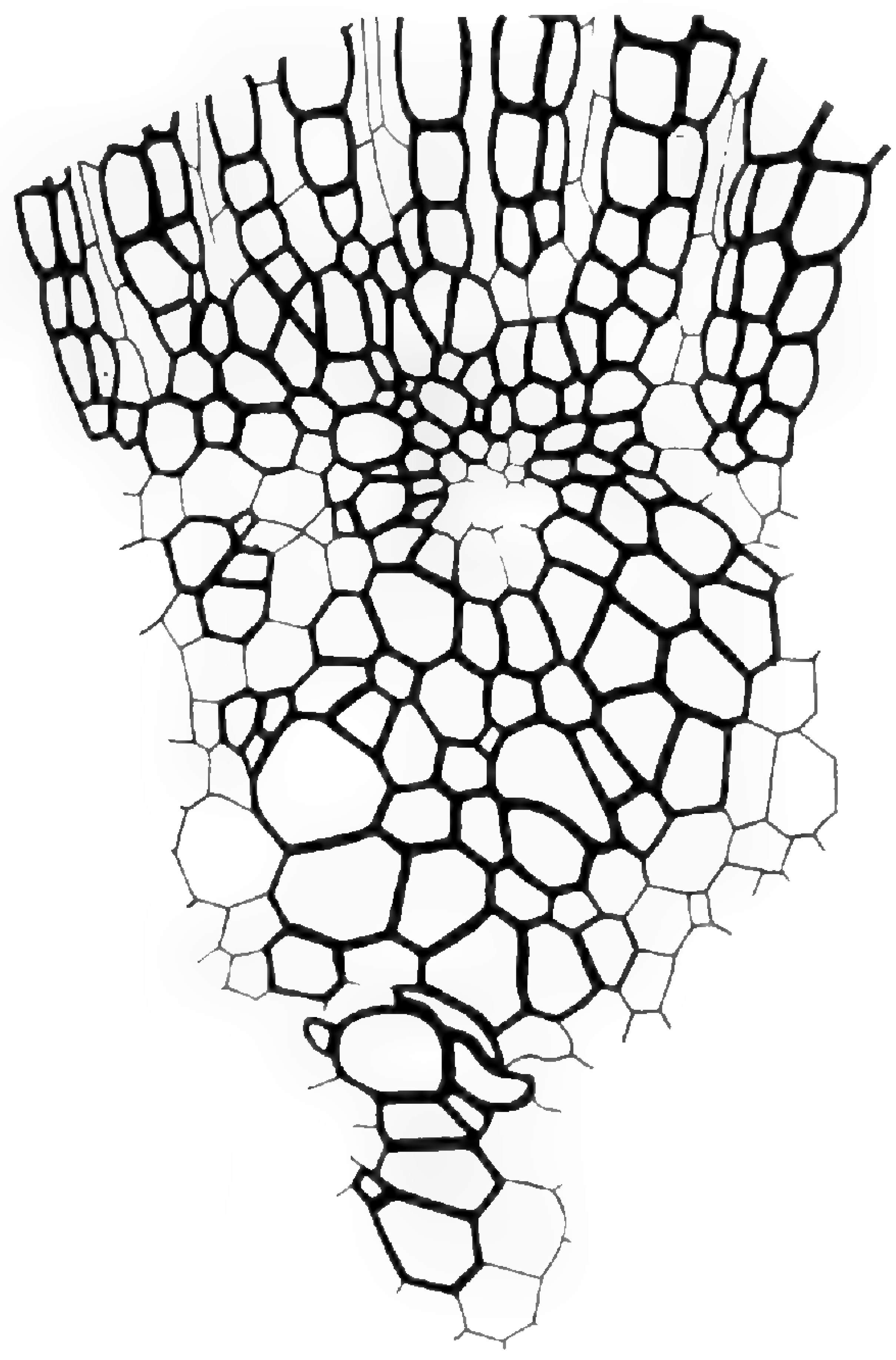

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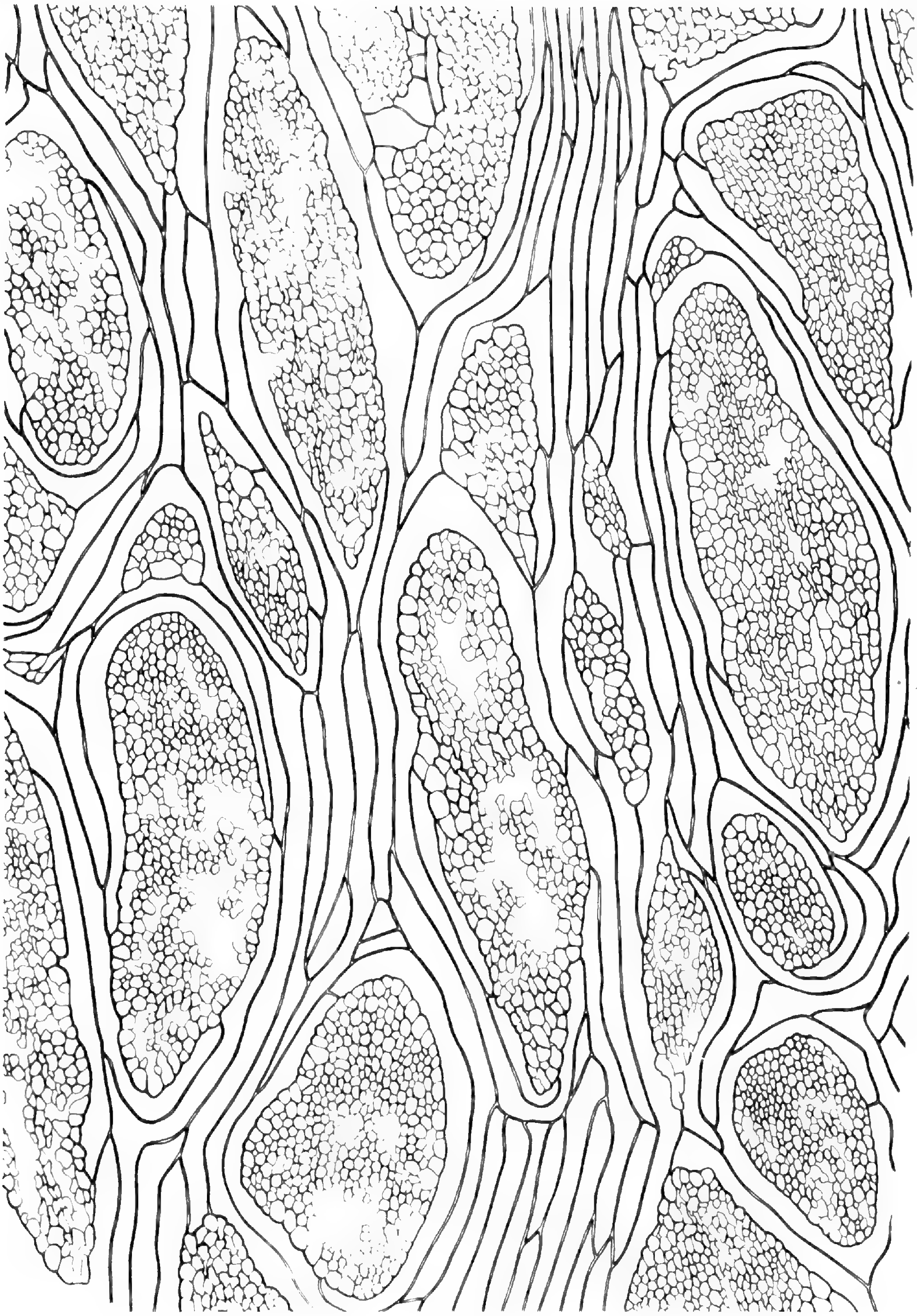
ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 11

Fig. 36. *Cycadoxylon anomalum.* Tangential section through the secondary xylem. × 40.



36

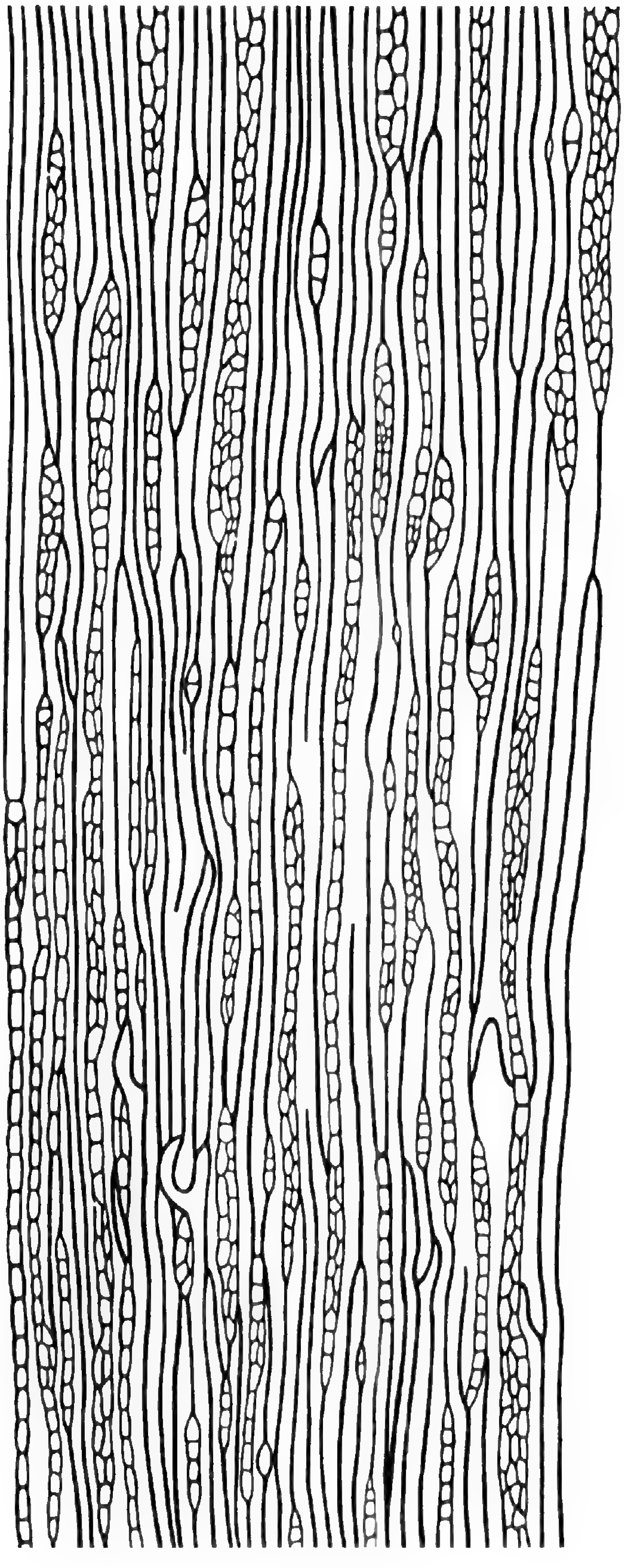
ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 12

Fig. 37. *Sphenoxylon eupunctata.* Tangential section through secondary wood. × 40.

Fig. 38. *Sutcliffia insignis.* Tangential section through secondary wood. × 40.



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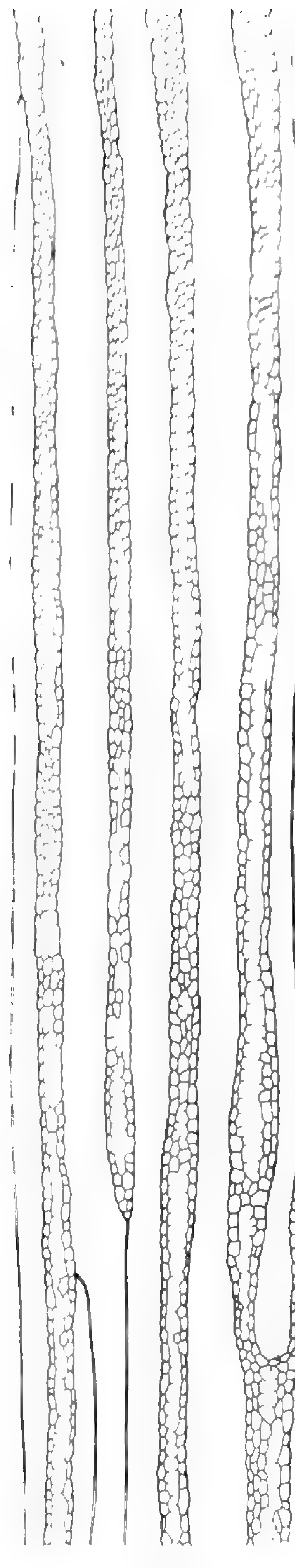


38

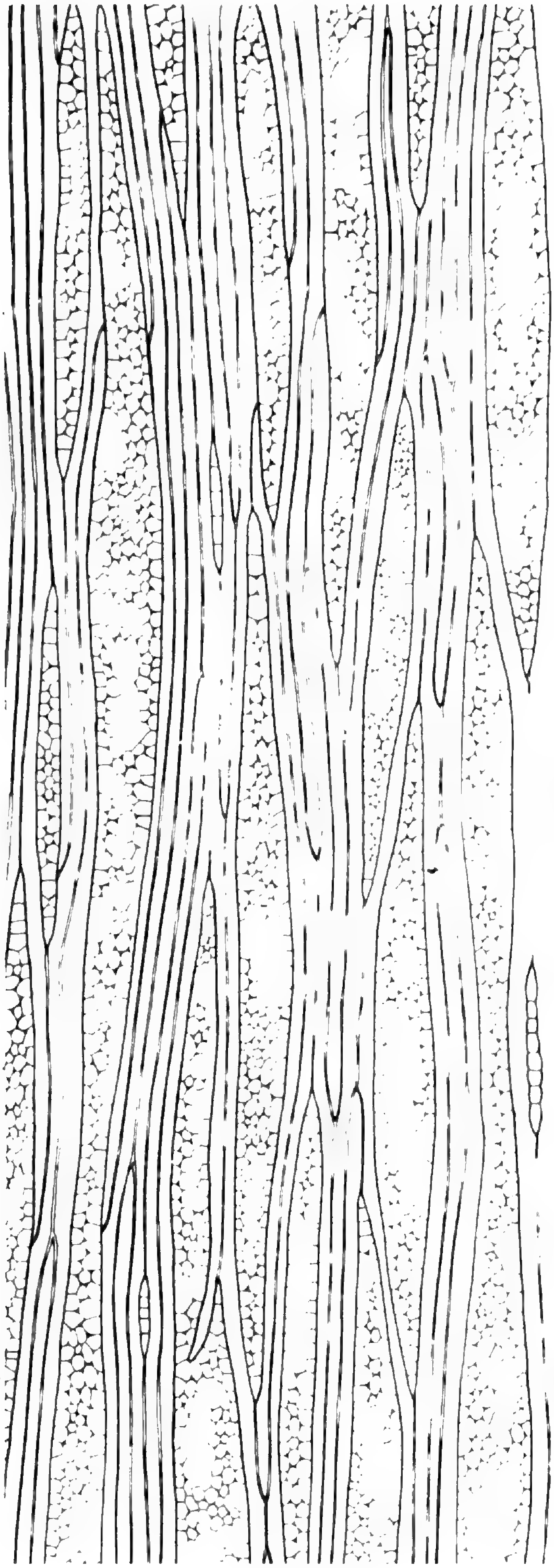
ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 13

Fig. 39. *Cycadoxylon robustum*. Tangential section through secondary xylem. × 40.

Fig. 40. *Megaloxylon Scotti*. Tangential section through secondary xylem. × 40.



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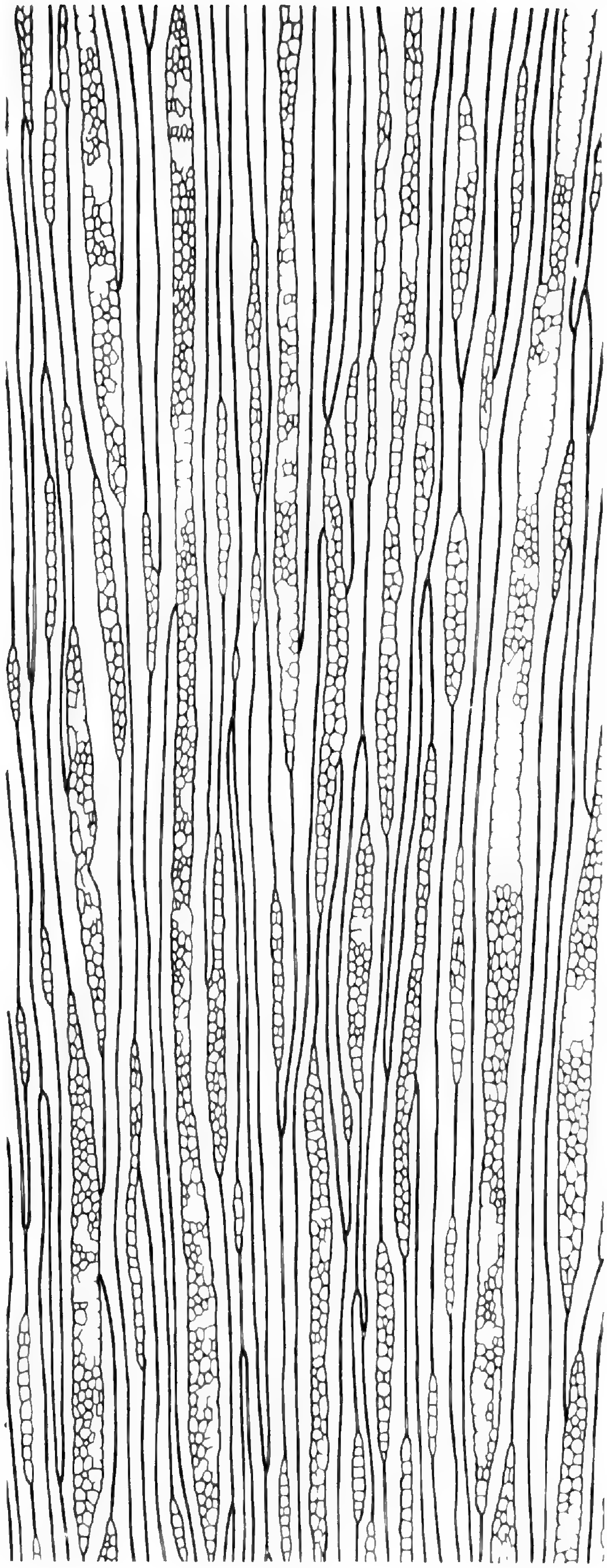


40

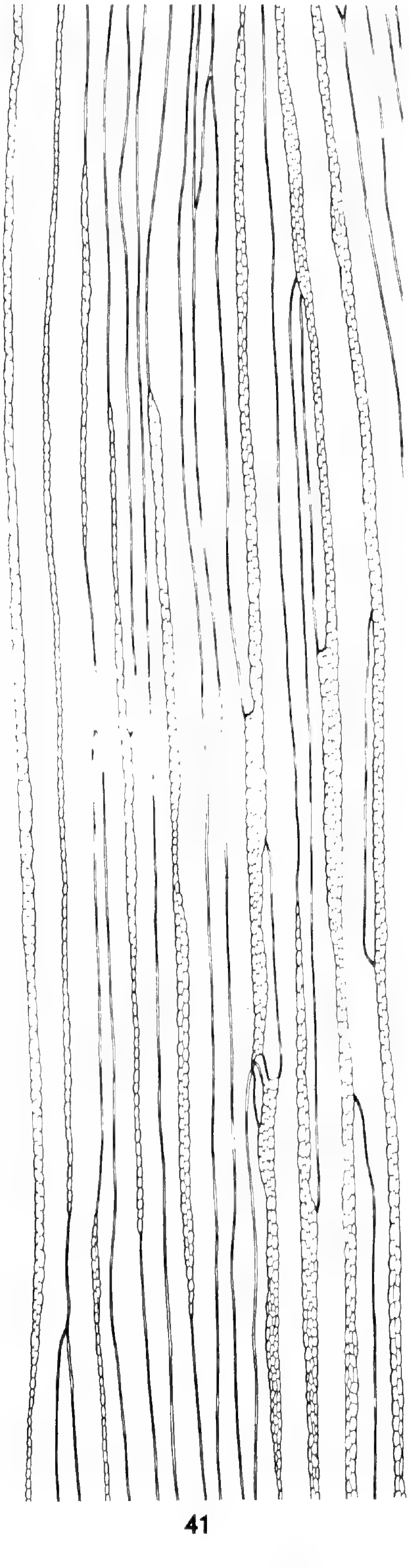
ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 14

Fig. 41. *Medullosa Noei.* × 40.

Fig. 42. *Lyginopteris oldhamia.* Showing increase in size of two rays in passing from the pith towards the periphery of the secondary xylem; *a*, the rays bordering on the pith; *b*, the rays about half-way out; *c*, the rays near the outside limit of the secondary xylem. × 40.



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a b c

42

ANDREWS — PTERIDOSPERM ANATOMY

Explanation of Plate

PLATE 15

Fig. 43. *Bilignea resinosa.* Tangential section through secondary wood. × 40.

Fig. 44. *Endoxylon zonatum.* Same as above.

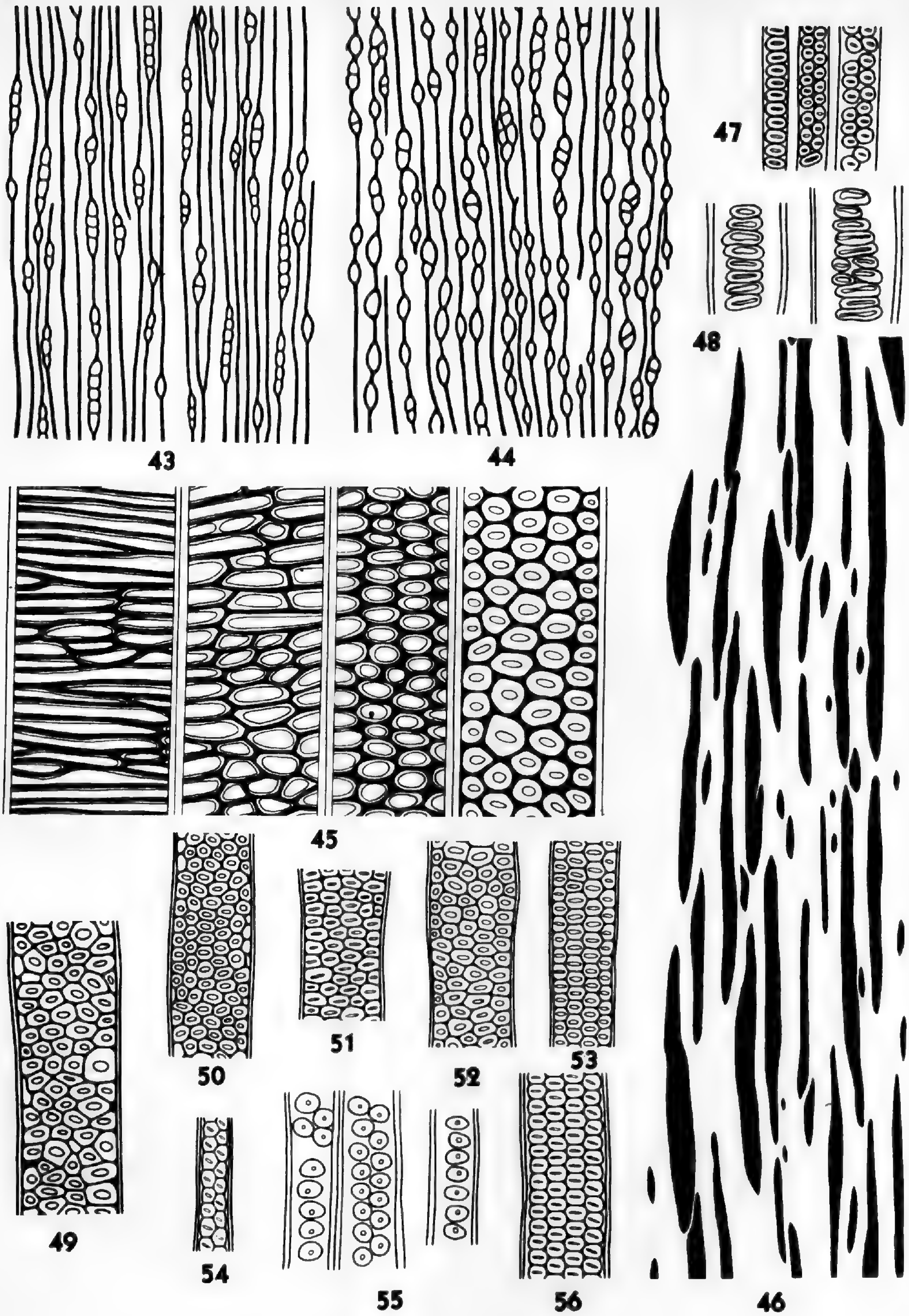
Fig. 45. *Stenomyelon tuedianum.* Longitudinal section through primary wood showing transition from protoxylem to metaxylem. × 300.

Fig. 46. *Medullosa Solmsii.* Tangential section through secondary wood. Rays in black. × 37.

Pitting in the tracheids of certain woods included within the Pteridospermae.

All figures of the radial walls of secondary tracheids, except 49, which is a metaxylem tracheid; figs. 49, 50, 51, 52, 53, traced from photographs; figs. 47, 48, 54, 55, 56, from camera-lucida drawings. All approximately × 170.

Fig. 47. *Mesoxylon multirame.* (Scott Coll. 2360).
Fig. 48. *Protopitys radicans.* (Kidston Coll. 3111).
Fig. 49. *Rhetinangium Arberi.* (Gordon Coll. 1077).
Fig. 50. *Rhetinangium Arberi.* (Gordon Coll. 986).
Fig. 51. *Calamopitys annularis.* (Berlin Coll. 101.44).
Fig. 52. *Stenomyelon tuedianum.* (From uncatalogued slide in the Scott Coll.).
Fig. 53. Same as above.
Fig. 54. *Dadoxylon* sp. (Scott Coll. 1508).
Fig. 55. *Bilignea resinosa.* (Kidston Coll. 2742).
Fig. 56. *Poroxylon Edwardsii.* (Scott Coll. 3336).



ANDREWS — PTERIDOSPERM ANATOMY

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A MONOGRAPH OF THE GENUS BAPTISIA[1]

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INTRODUCTION

Baptisia is a perennial herbaceous member of the Leguminosae which has been variously treated in different taxonomic publications. Small, who treated the group most thoroughly, placed it in the tribe Podalyrieae of the Fabaceae. It was included within the Podalyrieae, a subdivision of the Papilionaceae, by Britton and Brown. Gray's "Manual" regards it as a member of the Papilionoideae, a sub-family of the Leguminosae.

The genus *Baptisia* is confined to the eastern half of North America, embracing the general area from Maine to Florida, west to Minnesota, and south to Texas. *Baptisia tinctoria* and *B. leucantha* have been reported from Ontario, *B. Nuttalliana* and *B. minor* from Mexico adjacent to Texas; but such reports are rare as the genus is essentially one of the United States. In number of species it is most abundant in the eastern and southeastern states. Westward from the coast the number in-

[1] An investigation carried out in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

Issued May 10, 1940.

creases with the rising uplands and dwindles beyond the Appalachian range to fewer species but to a distinct group differing considerably from the extreme eastern and southeastern types. The genus is well represented throughout the Mississippi Valley, but there have been no collections west of the Rocky Mountains.

Taxonomically, the genus has gradually passed into a rather complicated state of affairs. The first species described were of the eastern states. As the country developed westward and more specimens were collected, attempts were made to fit them into the first descriptions. Frequently the plants in question were entirely new entities. In time the original descriptions were modified to include the newer types, and in a few instances the later collections outnumbered the earlier ones to such an extent that the true nature of the species as originally described was lost.

It was with the idea of straightening out as many of these problems as possible that the present investigation was undertaken. Herbarium material of the Missouri Botanical Garden constituted the principal basis for the study. In addition visits were made to Notre Dame University, the Field Museum of Natural History, the Gray Herbarium of Harvard University, the New York Botanical Garden, the Academy of Natural Sciences of Philadelphia, the United States National Museum, and the Charleston (S. C.) Museum, for the examination of type specimens and authentic material of the earlier species. Through the Missouri Botanical Garden loans were secured from twenty other American herbaria.

The examination of the above-mentioned material has resulted in a revised classification, the separation of several species into two or three categories, and the recognition of six new species, eight new varieties, and one new form. The discovery of eight clear-cut cases of hybridism, and a few additional suspected ones, contributed immeasurably to the solution of many problems. Species for which insufficient data are available have been relegated to a list of doubtful species.

Sincere appreciation is expressed to Dr. J. M. Greenman, Curator of the Herbarium of the Missouri Botanical Garden,

who suggested the problem and under whose guidance the work has progressed; and to Dr. George T. Moore, Director of the Missouri Botanical Garden, for the privileges afforded in the use of the library and herbarium. Thanks are due also to those in charge of the herbaria of those institutions whose specimens were made available; and to those in charge of the following institutions for the loans of books and photographic copies of references: Gray Herbarium of Harvard University, United States Department of Agriculture Library, and Musèum d'Histoire Naturelle. The author is extremely grateful to all who made special collections in the southeastern states and to temporarily inaccessible regions during the course of this investigation. Without this willing assistance the solution of many problems would have been impossible.

Taxonomic History of the Genus

Under the generic names of *Crotalaria* and *Sophora* Linnaeus published four species which have been absorbed by *Baptisia.* These are: *Crotalaria alba* and *C. perfoliata,*[1] and *Sophora tinctoria,* 1753,[2] and *S. australis* 1784.[3] In 1788 Walter[4] added two more under *Sophora,* namely *S. lanceolata* and *S. villosa. Sophora australis* was transferred to *Podalyria* by Willdenow[5] in 1799; and in 1803 Michaux[6] placed the other five in *Podalyria,* treating *S. lanceolata* Walt. as a synonym of *P. uniflora* Michx.

Ventenat[7] founded the genus *Baptisia* in 1808, basing his description on *Sophora alba* L. and *S. tinctoria* L. These two species were cited by him but were not accompanied by specific descriptions.

In 1811 Robert Brown[8] recognized *Baptisia* as a valid genus

[1] Linn. Sp. Pl. 2: 716, 714. 1753.
[2] Linn. Sp. Pl. 1: 373. 1753.
[3] Linn. Syst. Veg., ed. 14, 391. 1784.
[4] Walt. Fl. Car. 134, 135. 1788.
[5] Willd. in Linn. Sp. Pl., ed. 4, 2: 503. 1799.
[6] Michx. Fl. Bor. Am. 1: 263–265. 1803.
[7] Vent. Dec. Gen. Nov. 9. 1808.
[8] R. Br. in Ait. Hort. Kew., ed. 2, 3: 5, 6. 1811.

and referred thereto *B. alba, B. tinctoria, B. australis,* and *B. perfoliata,* giving a complete description of each species.

Nuttall[9], in 1818, treated *Baptisia* as a valid genus indigenous to North America, listed eight species, and added a new one, *B. leucophaea.* His *B. caerulea* is synonymous with *B. australis,* and *B. mollis* has since been transferred to *Thermopsis.* In 1821 Elliott[10] described *B. uniflora* Nutt. more fully as *B. lanceolata* and this specific name has stood since then. At the same time he described a new species, *Baptisia bracteata,* based on *Podalyria bracteata* Muhl.

Crotalopsis Michx. was designated as a generic synonym of *Baptisia* by DeCandolle[11] in 1825.

In 1837 Rafinesque[12] proposed four generic names—*Eaplosia, Lasinia, Pericaulon,* and *Ripasia*—for different entities of *Baptisia,* adding a few new specific descriptions. Neither the generic nor specific names have ever been recognized as anything but synonyms of *Baptisia.*

Torrey and Gray[13] described a new species, *B. leucantha,* in 1840, which is one of the dominant members of the group, having a distribution from Ontario to Minnesota, south to Louisiana and Texas.

From time to time several other new species have been described, most of them more or less localized in rather small areas; but no attempt will be made to go into a detailed account of their history. The species noted above are the typical representatives of the group; and, except for a few isolated species of doubtful status, they are the ones about which the greatest confusion has existed.

General Discussion of Problems and Conclusions

1. *Baptisia australis-B. minor* complex: *B. australis* has for many years been the classical "dumping ground" for material collected in the Middle West. There can be little doubt as to the

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[9] Nutt. Gen. N. Am. Pl. 1: 281, 282. 1818.
[10] Ell. Sketch Bot. S. Car. & Ga. 1: 467, 469. 1821.
[11] DC. Prodr. 2: 100. 1825.
[12] Raf. New Fl. N. Am. 2: 47–52. 1836 [1837].
[13] Torr. & Gray, Fl. N. Am. 1: 385. 1840.

true nature of *B. australis* because for no other species is there such a wealth of literature, copiously illustrated. As originally described, it is a beautiful blue-flowered, large-leaved, simple- and erect-branched species of the eastern states and responds very well to cultivation. Early in the nineteenth century it was introduced into European gardens, especially in England and France. This fact, incidentally, paved the way for a number of problems in synonymy as it was given a number of new names abroad. A comparison of illustrations and descriptions, however, leaves no question as to their identity.

Fig. 1. *Baptisia australis-B. minor* complex; *B. villosa.*

Throughout the Middle West a blue-flowered, smaller-leaved, dichotomously and divaricately branched plant was found in great abundance and was accepted as *B. australis.* For many years this smaller type has been taken for *B. australis,* and at least four-fifths of the material examined in the course of this investigation proved to be the plant of questionable status. A comparison with authentic *B. australis* makes it very clear that the more western type is specifically distinct. Discovery of the type specimen of *B. minor* Lehm. in the Gray Herbarium indicates that this fact was recognized as early as 1827.

However, Lehmann's name has been universally regarded as a synonym of *B. australis.* In 1861, it was again described as *B. texana* by Buckley; but this name was not even generally honored as a synonym of *B. australis.* Not until 1932, when Small, in Rydberg's "Flora of the Prairies and Plains of Central North America," described a new species, *B. vespertina,* from Missouri, Kansas and Texas, was any widespread cognizance of its existence manifested. But Small's name, which has been recognized in the last few years, must go into syn-

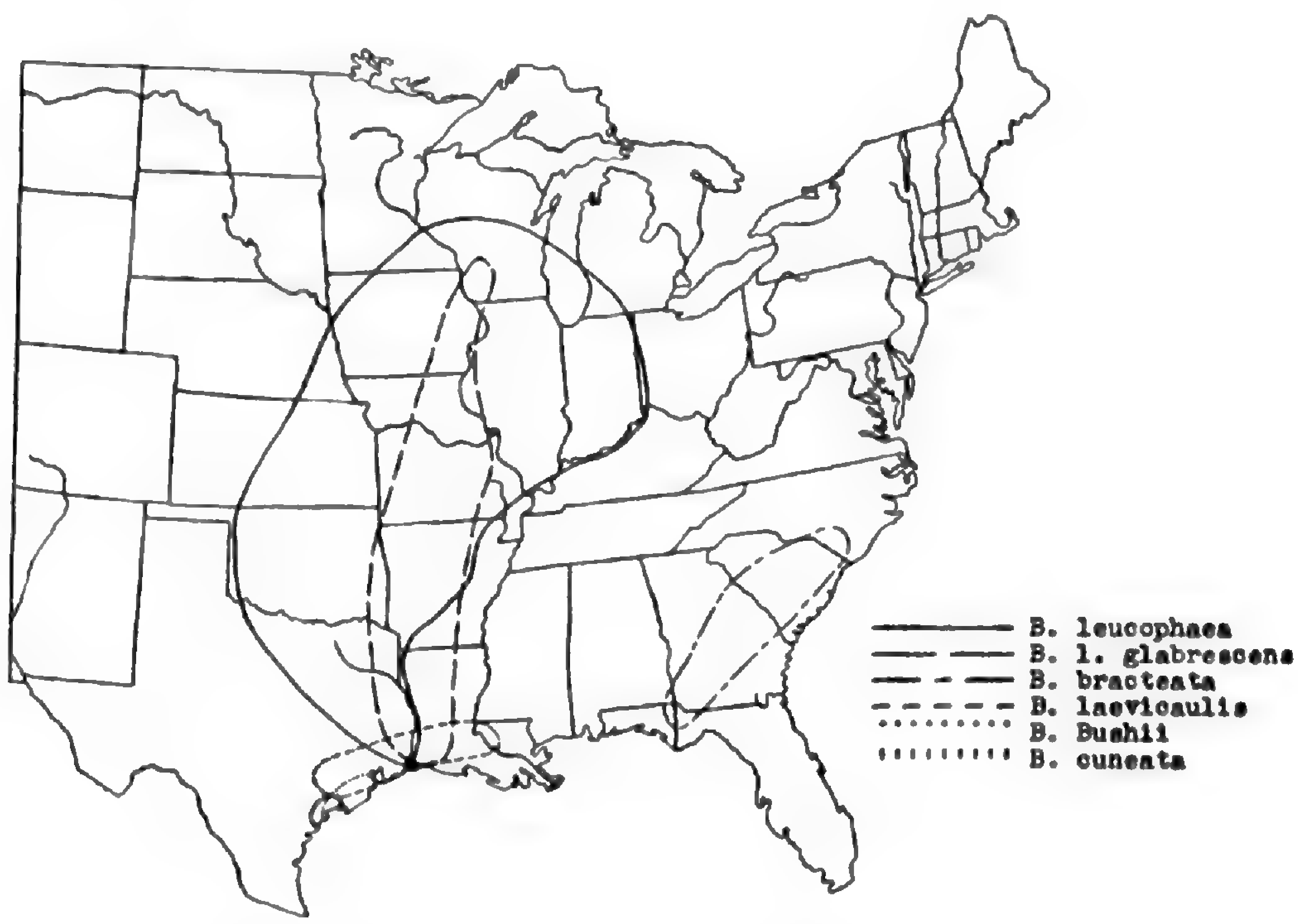

Fig. 2. *Baptisia bracteata-B. leucophaea* complex.

onymy along with *B. texana* Buckl. The true *B. australis* extends from Pennsylvania to southern Indiana, south to Virginia and Tennessee. It has been introduced in Vermont.

2. *Baptisia bracteata-B. leucophaea* complex: In the manuals, *B. bracteata* and *B. leucophaea* were treated as conspecific for several years and recognition was given to the earlier name, *B. bracteata.* In 1903, Small[14] recognized them as two distinct species, and his recognition has since been substantiated by most taxonomists. In a paper read by Dr. J. M.

[14] Small, Fl. Southeast. U. S., ed. 1, 600, 601. 1903.

Greenman[15] before the Illinois State Academy of Science at the East St. Louis meeting in May, 1933, the following differences were pointed out:

B. bracteata (Muhl.) Ell.	*B. leucophaea* Nutt.
1. Leaflets mostly 6–10 cm. long.	Leaflets averaging somewhat smaller.
2. Pedicels mostly less than 1.5 cm. long.	Pedicels more than 1.5 cm. long.
3. Pod not strongly reticulated, sparsely subappressed-pubescent.	Pod strongly reticulated, densely spreading-pubescent.
4. Plants of North Carolina and Georgia.	Plants of Central United States.

Further differences are indicated in the taxonomic section.

A variety of *B. leucophaea, B. leucophaea* Nutt. var. *laevicaulis,* from Louisiana and Texas, was proposed by Gray[16] in 1873, but no description accompanied the name; it was first described by Canby[17] in 1879. In 1895 Small[18] raised it to specific rank, describing it as *B. laevicaulis.* It has been confused with a glabrate variety of *B. leucophaea,* more extensive in range. The present treatment recognizes *B. laevicaulis* Small, and proposes for the more widespread type the name *B. leucophaea* var. *glabrescens.*

3. *Unique species of the southeastern states:* The southeastern states present a group of species in which there is marked fluctuation in morphological characters. Within this area there is a number of endemic species, especially in Florida but extending into South Carolina, Georgia and Alabama, which reveals rather interesting transitional stages, particularly in leaf characters. Trifoliolate, stipulate leaves are the rule in the genus and are invariably found in the species throughout the remainder of the distribution area. In the sandhills along the coastal plains of South Carolina and Florida, there is a species, *B. microphylla,* the lower leaves of which are trifoliolate and stipulate, the upper ones frequently simple, entire, clasping, or perfoliate. The transition is quite apparent for it

[15] Greenm. False Indigoes of the Mississippi Valley. Read at E. St. Louis meeting of Ill. State Acad. Sci. May, 1933.

[16] Hall's Pl. Texas 7. 1873.

[17] Bot. Gaz. 4: 132. 1879.

[18] Bull. Torr. Bot. Club **25**: 134. 1895.

is possible to trace the gradual fusion of the stipules with the lower leaflets and of the leaflets themselves from the base of the stem upwards. In the same type of locality, but in a more extensive area, occurs a species, *B. perfoliata,* in which the perfoliate habit is definitely established. The pinelands of central Florida yield a species, *B. simplicifolia,* which has simple, entire, sessile leaves without stipules. A close degree of relationship apparently exists between these aberrant forms and the *B. sphaerocarpa-viridis* complex in Louisiana, Arkansas, Texas and Oklahoma. The leaves of *B. sphaerocarpa* are normal, i.e., trifoliolate; however, while the lower leaves of *B. viridis* are trifoliolate, the upper ones, and those terminating the lateral branches, are frequently bifoliolate and ultimately unifoliolate. There are no fusion stages apparent. Further evidence of this affinity is found in the mature pods which are ligneous, quite thick, and subglobose as in *B. perfoliata.* Accompanying this common pod character, there is a tendency toward a distinct ferruginous coloring in *B. perfoliata, B. sphaerocarpa,* and *B. viridis,* instead of the blackening characteristic of most of the other species.

Another interesting group in this area consists of *B. LeContei,* native of the pinelands and scrub along the coastal plains of Georgia and Florida; *B. calycosa* from the pinelands of eastern Florida; and *B. hirsuta,* endemic to the dry sandy pinelands of western Florida. All three differ from the rest of the species in the possession of a pair of bractlets slightly above the middle of the pedicel in addition to the solitary subtending bract, which is a constant character within the group. They are distinguished also by unique calyx characters, a fact which prompted Small to place them in a separate tribe, Calycosae. Throughout the genus the calyx is normally campanulate, the lobes shorter than the tube. *B. LeContei* retains the campanulate character, departing from the prevailing type only in the elongated lobes which are about equal to the tube in length. But *B. calycosa* and *B. hirsuta* have a very reduced calyx-tube and conspicuous foliaceous lobes at least four times the length of the tube, frequently completely obscuring the corolla.

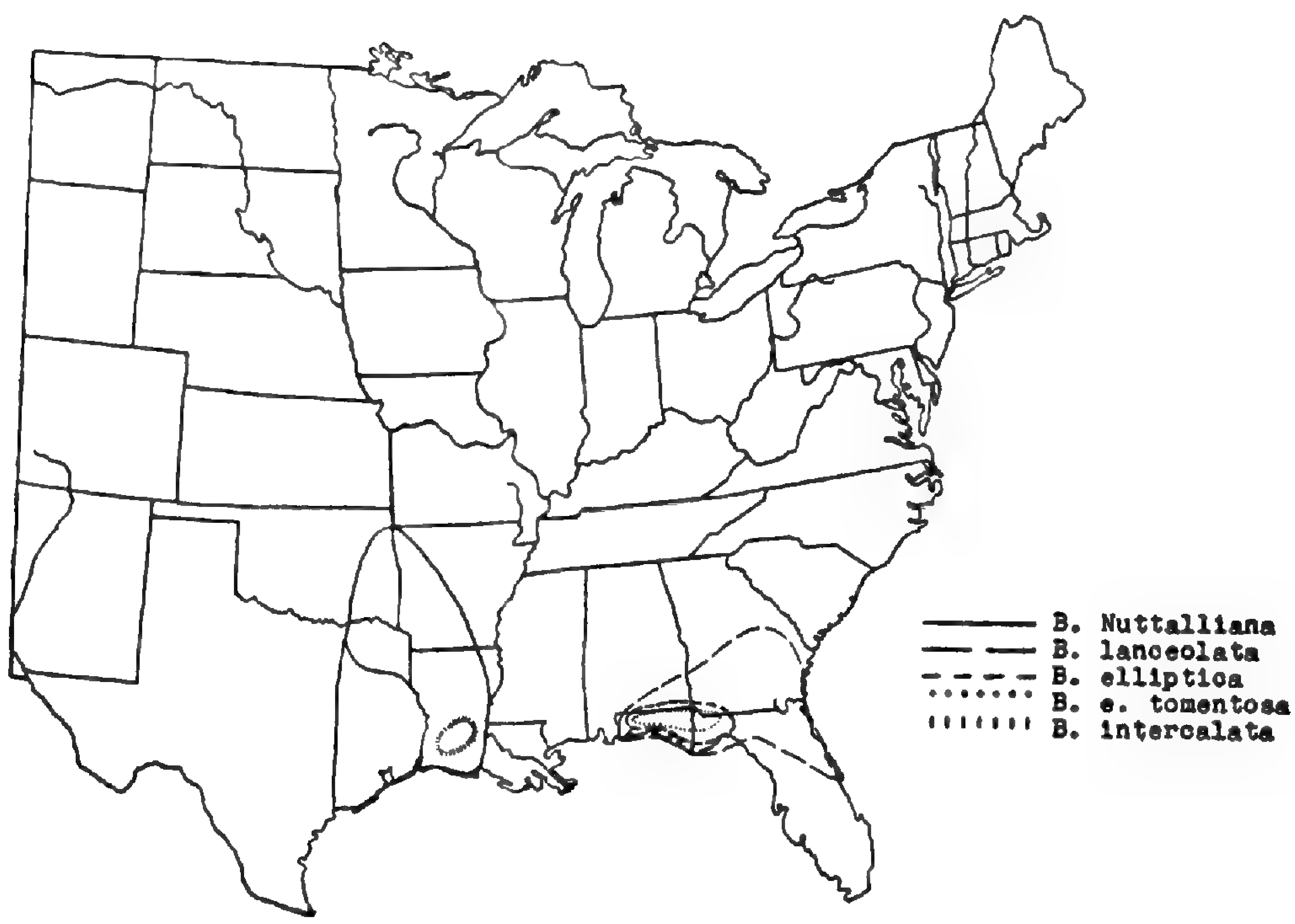

Fig. 3. Southeastern-southwestern affinities of *Baptisia*.

The affinities of *B. leucantha* in South Carolina, Georgia, Florida and Alabama furnished one of the most perplexing problems in the present study. After much hesitation the group, which, for the most part, has been heretofore accepted as *B. leucantha,* was separated into two new species: *B. psammophila,* principally of Florida but extending into Georgia; and *B. pendula* of Georgia, South Carolina and northern Florida. Two varieties were assigned to the latter species: var. *obovata* of central South Carolina, with reasonable cer-

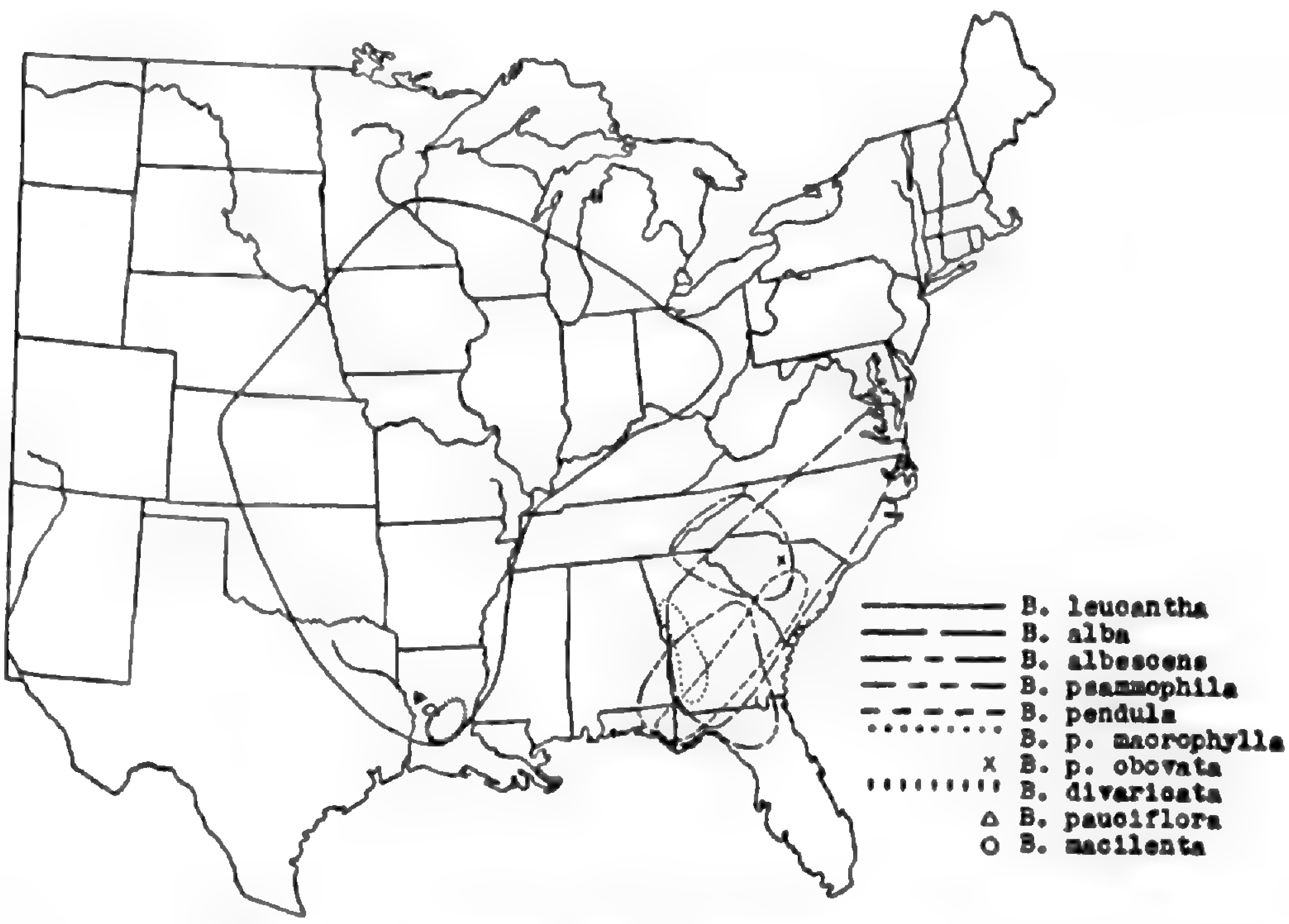

Fig. 4. *Baptisia alba-B. leucantha* complex.

tainty, and var. *macrophylla,* with considerable doubt. It occurs in Georgia, but a specimen found near Paducah, Kentucky, is identical with it. Further collections and detailed field study in the southeastern states are necessary before entirely satisfactory disposition can be made of these forms. In the light of specimens now in the major herbaria of the country, these conclusions seem the most plausible.

A new species and variety from along the Ochlockonee River in Florida have also been proposed: *B. riparia,* and var. *minima.* They are reminiscent of the *leucantha* alliance in that both blacken in drying; but the resemblance is only superficial as it is clearly distinguished on the basis of several characters.

The racemes are short, the flowers yellow, and the ovary pubescent.

4. *Hybridism:* The relatively frequent occurrence of hybridism, particularly in areas where the borders of the geographical ranges of some of the larger species overlap, has been the basis of much confusion. When it has been possible to establish with reasonable certainty the hybrid origin of a form, especially if it recurs in a number of localities in the vicinity of the suspected parents with a fair degree of intermediacy between them, binomials and descriptions have been proposed. There are a number of suspected cases, a few quite certain; but where direct evidence is lacking the plants in question are left "in statu quo" if they have previously been described, or described as novelties if not heretofore treated.

× *B. sulphurea* Engelm.: Dr. Engelmann was the first to suggest the idea of hybridity in *Baptisia* in his description of *B. sulphurea,*[19] pointing out that it grew in the presence of *B. sphaerocarpa* and *"B. australis" (B. minor).* Comparison of type material of *B. sulphurea* with the two other species leaves little doubt as to the wisdom of his assumption.

× *B. bicolor* Greenman & Larisey: Dr. Hitchcock[20] next called attention to the fact that *"B. australis" (B. minor)* and *B. leucophaea* hybridized in Kansas. Since then collections of the intermediate form have been made in southwestern Missouri and Oklahoma. It is one of the most definitely established cases in the genus. In general habit it more nearly resembles *B. minor,* but the flowers are bicolorous: the standard blue as in *B. minor,* the wings and keel yellow as in *B. leucophaea.* Back-crosses to *B. leucophaca* are apparently common.

× *B. intermedia* Larisey: In April, 1936, Dr. Harper[21] called to the attention of the author a case involving *B. viridis ("B. sphaerocarpa")* and *B. leucophaea* var. *glabrescens* in Louisiana. Specimens of *B. viridis* and the hybrid were forwarded for study, but unfortunately no collections of *B. leucophaea*

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[19] Engelmann, G. in Bot. Gaz. **3**: 65. 1878.

[20] Hitchcock, A. S. in Bot. Gaz. **19**: 42. 1894.

[21] Harper, R. M. in Torreya **38**: 121–124. 1938.

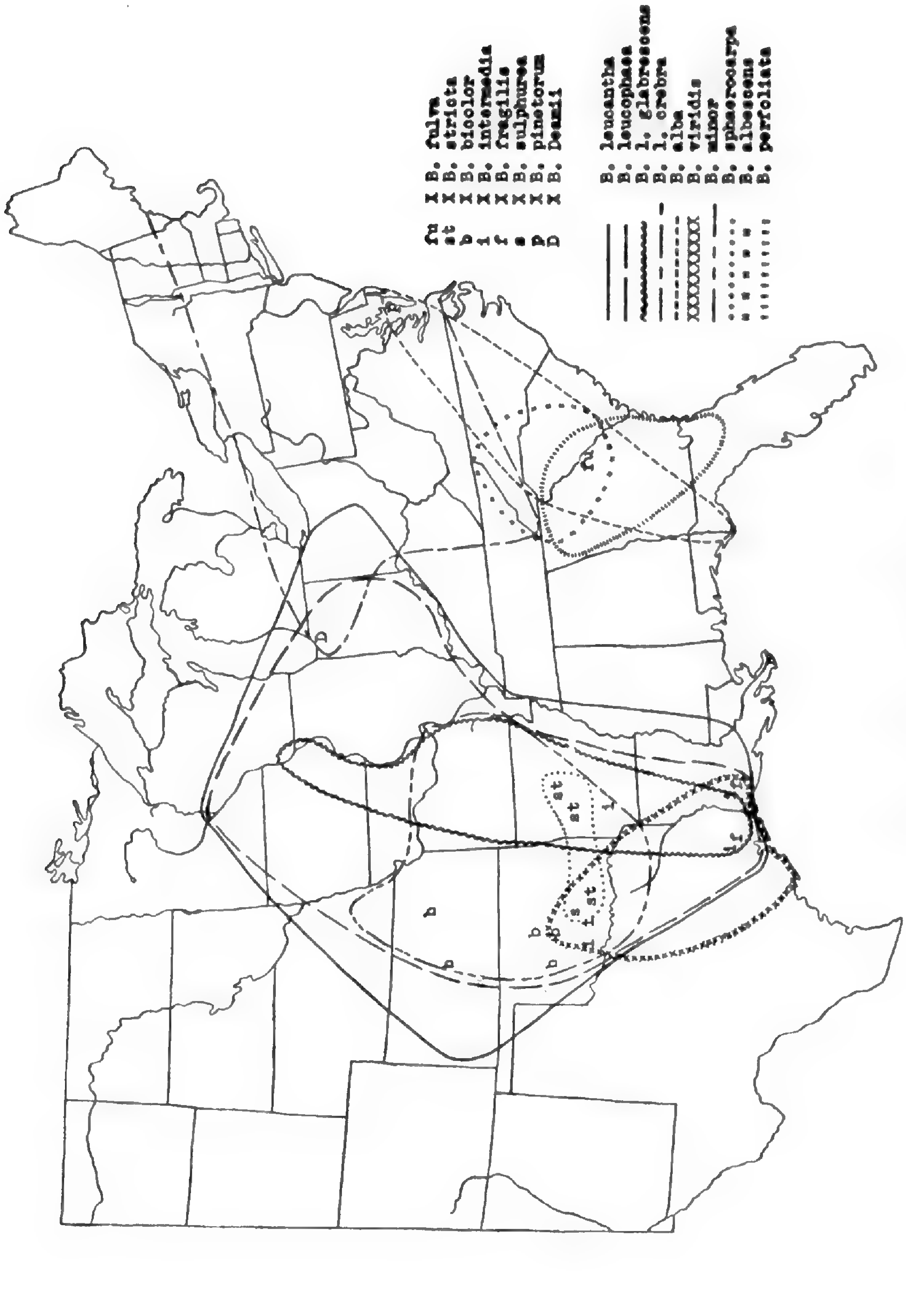

Fig. 5. Hybrid complexes of *Baptisia*.

var. *glabrescens* were made at the time. Photographs taken in the field, and a specimen collected from the same locality several years ago, however, leave no doubt as to its identity.

× *B. stricta* Larisey: The parents of this hybrid are apparently *B. leucophaea* and *B. sphaerocarpa.* This particular set-up has solved one of the greatest problems in the group. *B. villosa* (Walt.) Nutt., a southeastern coastal-plain species, has been reported in the manuals as occurring also in Arkansas. It has been generally supposed that these reports have been based on incorrect determinations of *B. Nuttalliana.* However, the discovery of specimens labelled "*B. villosa*" and collected by Nuttall in Arkansas dispelled that notion. The existence of several other questionable specimens from Texas and Oklahoma merely added to the confusion until careful study showed them to be intermediate between *B. leucophaea* and *B. sphaerocarpa;* and while there is more variability among them than in most of the other hybrids, there seems little doubt as to their status.

× *B. fragilis* Larisey: In southeastern Texas Dr. E. Anderson collected excellent flowering material of *B. viridis, B. leucantha,* and a hybrid between them. This has been the most ideal complex of all because specimens were taken from about sixty plants, making possible detailed comparative study of morphological characters. Arbitrary index values were assigned to the most significant characters, and the index value of a plant equaled the sum of the values of its various characters. In this way it was possible to plot the entire lot on a chart which grouped the two species at the opposite ends of the table, the hybrids in the middle, and back-crosses scattered in the direction of the respective parent species. Pollen counts were also made, revealing a variable but higher percentage of bad pollen than in either of the parent species. Specimens obviously belonging to similar complexes were found from another locality in Texas, and in Louisiana.

× *B. Deamii* Larisey: Through the kindness of Mr. C. C. Deam, study of a case of hybridism between *B. tinctoria* var. *crebra* and *B. leucantha* in low sandy woods in northern Indiana was made possible. This problem is one of the few where ample fruiting as well as flowering material has been available.

× *B. pinetorum* Larisey: A similar complex exists in a sandy pine woods in Accomac County, Virginia, between *B. tinctoria* var. *crebra* and *B. alba.* Collections of *B. tinctoria* var. *crebra* from this region are quite rare, but two specimens have been seen which are apparently authentic. The rest of the material is of *B. alba,* the hybrid, and back-crosses mostly to *B. alba.* While several specimens from this section are in a number of herbaria, a gift of a set of twenty specimens from

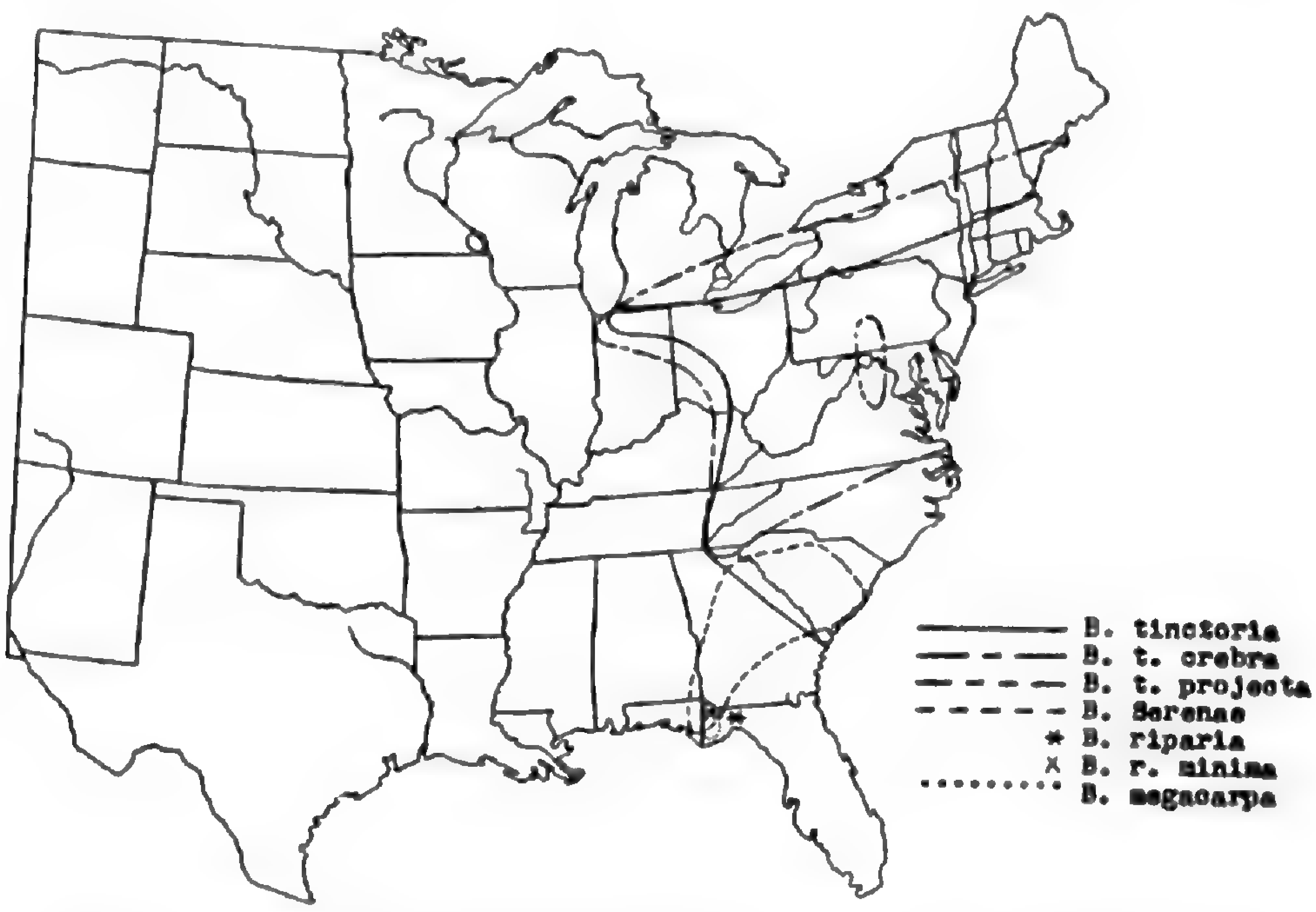

Fig. 6. *Baptisia tinctoria* complex; *B. riparia* and *B. megacarpa.*

Dr. Robert R. Tatnall and Dr. Frank M. Jones was an invaluable aid to the investigation.

× *B. fulva* Larisey: This hybrid occurs in the sand hills around Augusta, Georgia, and collections of it and the two parents—*B. albescens* and *B. perfoliata*—were made in 1900 by Mr. A. Cuthbert. The three specimens are in the herbarium of the New York Botanical Garden.

Suspected cases of hybridism for which there is no definite proof are *B. microphylla,* a probable cross between *B. perfoliata* and *B. tinctoria;* and *B. Serenae,* which has many characters intermediate between *B. alba* and *B. tinctoria.* However, the known hybrid between these two species is quite distinct from *B. Serenae;* and if it be of such remote origin, some other element has exerted a strong influence in the course of its evolutionary development.

Two new species are described herein from southern Louisiana, a region particularly rich in diverse forms, and where at least two cases of hybridism are known. *B. intercalata,* which is closely related to *B. Nuttalliana,* suggests hybridity; but there is no evidence. *B. macilenta* resembles × *B. fragilis* very strongly, but has a slightly pubescent pod; but there is undoubtedly an affinity with *B. leucantha.* Two new varieties of *B. leucantha* from this same area (var. *divaricata* and var. *pauciflora)* seem to bear a close relationship with *B. macilenta,* but are glabrous as is the true species.

Gross Morphology

Root: The roots are of the fibrous type and are not distinguished by any outstanding character peculiar to the group.

Stem: The underground stems consist of rather large, woody, perennial rhizomes which give rise to the aerial portion of the plant each year. The upright stems are usually terete, ribbed, stout or slender, succulent or firm, glabrous or pubescent, frequently glaucous; they are usually erect, but occasionally declining, sparingly or more often widely branched, the branches simple and erect, geniculate, or subdichotomous and divaricate.

Leaves: The leaves are typically ternately compound, subsessile to petiolate, stipulate, glabrous or pubescent, frequently glaucous on the lower surface; the leaflets are subsessile to petiolate, varying from broadly elliptic, narrowly elliptic, oblanceolate, obovate, to rhombic cuneate, apex acute to obtuse; the stipules vary from minutely setaceous, through deltoid, triangular-lanceolate, to large-foliaceous and may be persistent or caducous. In a few species the leaves are simple, sessile or perfoliate, without stipules.

Flowers: The flowers are perfect and normally borne in loose terminal or axillary racemes; occasionally they occur singly in the axils of the upper leaves.

Floral bracts: The floral bracts are lanceolate-setaceous to ovate-acuminate, foliaceous, deciduous or persistent.

Pedicels: The flowers are always pedicellate, the pedicels usually rather slender, varying in length from 1 to 4 centimeters.

Calyx: The calyx is almost universally campanulate, bilabiate, four- or five-parted; the upper lip may be entire, ovate or truncate, emarginate, or two-lobed; the lower lip is distinctly three-lobed, lobes deltoid-ovate to lanceolate, acuminate, usually shorter than the tube. Occasionally the calyx-tube is greatly reduced and the lobes assume a large foliaceous habit.

Corolla: The corolla is papilionaceous, irregular, the five parts arranged in the following manner: the upper one, standard or vexillum, broad and usually laterally reflexed, emarginate or entire, occasionally auriculate at the base; the two lateral ones, wings, enclosing the two lower ones which are more or less united to form the keel—the keel curving upward. The petals are more nearly equal in length than in most leguminous genera, but the standard is usually shorter than the others. The petals are deciduous.

Stamens: There are ten equal stamens, distinctive in that they are not united into a tube at the base. They are also deciduous.

Ovary and Mature Fruit: The ovary is superior, short-stipitate, with an incurved style and simple stigma, and may be glabrous or pubescent. The mature fruit is unilocular, unicarpellary, many-seeded, dehiscent, short- or long-stipitate, gradually or abruptly beaked, usually inflated, ligneous-coriaceous or rarely membranaceous, globose, ovoid, elliptic, oblongoid or cylindric, glabrous, strigillose, or pubescent.

Generic Affinities

Baptisia is most closely allied to the following genera, and has been involved with them in questions of synonymy: *Thermopsis, Sophora, Crotalaria* and *Podalyria.*

Thermopsis is a perennial herbaceous genus native of North America and Asia. In the United States it seems to have taken the place of *Baptisia* in the Far West. Its chief differences from *Baptisia* are found mainly in fruit characters: the pod is sessile or very short-stipitate, flat rather than inflated, and is linear or oblong, straight or curved.

Sophora is a rather widespread genus—shrubs or herbs in the temperate regions, and trees in the tropics. It is characteristic in having odd-pinnate leaves; a campanulate calyx which is very shortly five-toothed, at times the upper margin being almost entire; and the fruit is constricted between the seeds and indehiscent.

Crotalaria consists chiefly of tropical herbs, and the stipules are characteristically decurrent on the stems and branches, a condition never found in *Baptisia;* the calyx is bilabiate with a prominently two-lobed upper lip and a deeply three-lobed lower lip; the pod is globular to cylindric and the seeds loosen, giving the genus the common name Rattlebox.

Podalyria, the genus with which all the early *Baptisia* species were associated, is now restricted to a group of African shrubs which have united persistent stamens.

Economic Value

For a number of years certain species of *Baptisia,* especially *B. tinctoria,* constituted the source of a substitute for indigo. This fact contributed the generic name, as the word *Baptisia* comes from the Greek "βαπτιζειν," meaning to dip or dye. The Baptisias are frequently called False Indigoes. *Indigofera* is now used to a limited extent for the production of indigo, and *Baptisia* plays very little part in the industry today.

Abbreviations of Herbaria

MBG—Missouri Botanical Garden.
USN—United States National Museum.
GH—Gray Herbarium of Harvard University.
NYB—New York Botanical Garden.
ANSP—Academy of Natural Sciences of Philadelphia.
FM—Field Museum of Natural History.
UP—University of Pennsylvania.
UNC—University of North Carolina.
DU—Duke University.
CM—Charleston Museum.

CA—Clemson Agricultural College.
UF—University of Florida.
UG—University of Georgia.
OU—Ohio State University.
LB—Dr. E. Lucy Braun.
IU—Indiana State University.
CD—Charles C. Deam.
ND—University of Notre Dame.
LU—Louisiana State University.
TU—Tulane University.
UM—University of Minnesota.
UW—University of Wisconsin.
UN—University of Nebraska.
KA—Kansas State Agricultural College.
UO—University of Oklahoma.
OAM—Oklahoma Agricultural and Mechanical College.
UT—University of Texas.
NM—New Mexico College of Agriculture and Mechanical Arts.

Taxonomy

Baptisia Vent. Dec. Gen. Nov. 9. 1808; R. Br. in Ait. Hort. Kew., ed. 2, **3**: 5. 1811; Ell. Sketch Bot. S. Car. & Ga. **1**: 466. 1821; DC. Prodr. **2**: 100. 1825; Chapman, Fl. South. U. S., ed. 1, 110. 1860, ed. 2, 110. 1889, and ed. 3, 120. 1897; Torr. & Gray, Fl. N. Am. **1**: 383. 1840; Benth. & Hook. Gen. Pl. **1**: 466. 1862-67; Hoffm. in Engler & Prantl, Nat. Pflanzenfam. III. **3**: 200. 1894; Britton & Brown, Illust. Fl. North. U. S., ed. 1, **2**: 265. 1897, and ed. 2, **2**: 344. 1913; Small, Fl. Southeast. U. S., ed. 1, 597. 1903, and ed. 2, 597. 1913; Gray, New Man. Bot., ed. 7, 505. 1908; Rydb. Fl. Prairies and Plains Central N. Am. 455. 1932; Small, Man. Southeast. Fl. 674. 1933.

Crotalaria Dill. ex Linn. Gen. Pl., ed. 1, 218. 1737, in part.
Sophora Linn. Gen. Pl., ed. 1, 125. 1737, in part.
Podalyria Lam. Illust. **2**: 454. *pl. 327, fig. 3, 4.* 1793, in part.
Crotalopsis Michx. ex DC. Prodr. **2**: 100. 1825, in syn.
Eaplosia Raf. New Fl. N. Am. **2**: 51. 1836 [1837].
Lasinia Raf. New Fl. N. Am. **2**: 48. 1836 [1837].
Pericaulon Raf. New Fl. N. Am. **2**: 50. 1836 [1837].
Ripasia Raf. New Fl. N. Am. **2**: 48. 1836 [1837].

Perennial herbs with stout, woody rhizomes. Plant usually darkening, occasionally blackening, rarely remaining unchanged in drying, glabrous throughout, somewhat glaucous, or minutely to densely appressed-pubescent throughout or in parts, sometimes villous, rarely hirsute. Stems usually erect, occasionally declined, stout-succulent or slender-firm, terete, heavily to lightly ribbed, sheathed at the base with conspicuous scales; branches arising alternately from a single primary stem, or main stem diffusely branching from the base, secondary branches subdichotomous, geniculate or straight, ascending, divaricate, or lateral ones sometimes declined. Leaves alternate, usually trifoliolate, occasionally bifoliolate, simple or perfoliate, sessile to petiolate, usually stipulate, stipules minute, setaceous, lanceolate to ovate-cordate and foliaceous, persistent or deciduous; leaflets usually sessile, occasionally short-petiolate, obovate, oblanceolate to lanceolate, elliptic or rhombic, usually cuneate, apex acute, rounded, obtuse, retuse or slightly mucronate, firm or delicate. Flowers perfect, normally borne in terminal, axillary, or rarely intercalary racemes, occasionally borne singly in axils of the upper leaves; floral bracts setaceous-lanceolate to ovate-acuminate, foliaceous, deciduous or persistent; pedicels slender; calyx campanulate, bilabiate, four- to five-parted, upper lip entire, emarginate or two-lobed, lower lip distinctly three-lobed, lobes usually shorter than the tube, occasionally three to four times longer; corolla white, cream, yellow, blue or bicolorous, irregular, papilionaceous; petals 5, deciduous, standard reniform or suborbicular, usually laterally reflexed, occasionally auriculate, wings and keel erect, about equal in length; stamens ten, distinct, deciduous; ovary superior, stipitate, style incurved, stigma simple. Mature pod globose, ovoid, elliptic, oblongoid or cylindrical, usually inflated, ligneous to membranaceous, smooth, rugose or strongly reticulate, many-seeded, short- or long-stipitate, short- or long-beaked, beak incurved.

Distribution: North America: Vermont to Florida, west to Minnesota, south to Texas.

Type species: *Baptisia alba* (L.) Vent.

KEY TO THE SPECIES

1a. Leaves simple, exstipulate

1b. Leaves sessile, flowers racemose.........................*1. B. simplicifolia*

2b. Leaves perfoliate, flowers axillary.........................*2. B. perfoliata*

2a. Lower leaves trifoliolate, upper bifoliolate and unifoliolate, all stipulate.. .... *43. B. viridis*
3a. Leaves trifoliolate, stipulate
  1b. Stipules partially or wholly united with the leaflets
    1c. Leaflets 2.5–3 cm. long, 1–1.5 cm. broad........ *3. B. microphylla*
    2c. Leaflets 3.5–5.5 cm. long, 2–3 cm. broad........ *4. × B. fulva*
  2b. Stipules not united with the leaflets
    1c. Calyx-lobes equal to the tube, or longer
      1d. Calyx-lobes equal to the tube
        1e. Leaflets 1.5–2.5 cm. long........ *5. B. LeContei*
        2e. Leaflets 4–5 cm. long........ *6. B. LeContei* f. *robustior*
      2d. Calyx-lobes several times longer than the tube
        1e. Plant essentially glabrous........ *7. B. calycosa*
        2e. Plant hirsute........ *8. B. hirsuta*
    2c. Calyx-lobes shorter than the tube
      1d. Flowers both axillary and racemose
        1e. Leaflets spatulate to oblanceolate........ *9. B. lanceolata*
        2e. Leaflets broadly elliptic
          1f. Lower leaf-surface glabrate........ *10. B. elliptica*
          2f. Lower leaf-surface tomentose........ *11. B. elliptica* var. *tomentosa*
        3e. Leaflets obovate-cuneate
          1f. Racemes terminal........ *12. B. Nuttalliana*
          2f. Racemes intercalary........ *13. B. intercalata*
      2d. Flowers racemose
        1e. Flowers secund
          1f. Racemes declined
            1g. Leaflets oblanceolate-elliptic, 5–10 cm. long, softly pubescent .... *14. B. bracteata*
            2g. Leaflets narrowly oblanceolate-spatulate, 3–10 cm. long, villous
              1h. Stems villous........ *15. B. leucophaea*
              2h. Stems glabrous, or nearly so..*16. B. leucophaea* var. *glabrescens*
            3g. Leaflets rhombic-obovate, 4–7 cm. long, margins ciliate.... .... *17. B. laevicaulis*
            4g. Leaflets cuneate-obovate, 3–6 cm. long, margins not ciliate.. .... *18. B. cuneata*
          2f. Racemes not declined
            1g. Stems glabrous or glabrate........ *19. × B. intermedia*
            2g. Stems finely villous........ *20. × B. stricta*
            3g. Stems woolly-tomentose........ *21. B. Bushii*
        2e. Flowers not secund
          1f. Flowers white
            1g. Pod cylindrical, yellow-brown
              1h. Leaflets 2–3 cm. long, lower surface glabrous-glaucous.... .... *22. B. alba*
              2h. Leaflets 3.5–6 cm. long, lower surface finely pubescent.... .... *23. B. albescens*
            2g. Pod subglobose to elliptic-oblongoid, black
              1h. Racemes 1.5–2.5 dm. long, rarely exceeding the foliage

1i. Leaflets elliptic, apex acute, 4–6 cm. long, 1–2 cm. broad ....*24. B. pendula*
2i. Leaflets obovate, 2–3.5 cm. long, 1–1.5 cm. broad...... ....*25. B. pendula* var. *obovata*
3i. Leaflets broadly elliptic-obovate, apex obtuse-rounded, 4–6 cm. long, 2–2.5 cm. broad...................... ....*26. B. pendula* var. *macrophylla*
2h. Racemes 1–6 dm. long, exceeding the foliage
1i. Pod firm, inflated, smooth, rugose
1j. Branches ascending....................*27. B. leucantha*
2j. Branches divaricate
1k. Pod subglobose-ovoid, inequilateral.............. ....*28. B. leucantha* var. *divaricata*
2k. Pod elliptic-oblongoid.......................... ....*29. B. leucantha* var. *pauciflora*
2i. Pod thin, folded, strongly reticulate.................. ....*30. B. psammophila*
2f. Flowers cream or yellow
1g. Plant pubescent throughout.......................*31. B. villosa*
2g. Plant pubescent only in parts, essentially glabrous
1h. Racemes less than 1.5 dm. long
1i. Leaflets obovate-cuneate, less than 1.5 cm. long........ ....*32. B. tinctoria*
2i. Leaflets obovate-lanceolate-cuneate, more than 1.5 cm. long........................*33. B. tinctoria* var. *crebra*
3i. Leaflets spatulate-elliptic, 3–6 cm. long.....*38. B. macilenta*
4i. Leaflets obovate-lanceolate, 3.5–7 cm. long
1j. Leaflets glabrous........................*39. B. riparia*
2j. Leaflets pubescent along midvein.................. ....*40. B. riparia* var. *minima*
5i. Leaflets broadly elliptic, 4–5 cm. long......*41. B. megacarpa*
2h. Racemes more than 1.5 dm. long
1i. Pod firm but thin, rugose-reticulate
1j. Pod black
1k. Leaflets oblanceolate-cuneate, 1.5–4 cm. long...... ....*34. B. tinctoria* var. *projecta*
2k. Leaflets broadly obovate, 2.5–4.5 cm. long...... ....*35. × B. Deamii*
2j. Pod yellow- to purplish-brown
1k. Leaflets obovate, obtuse-rounded....*36. × B. pinetorum*
2k. Leaflets oblanceolate-elliptic, acute-rounded....... ....*37. B. Serenae*
2i. Pod ligneous, smooth
1j. Calyx-lobes lanceolate, nearly half the length of the tube
1k. Branches straight, leaflets 4.5–8 cm. long......... ....*42. B. sphaerocarpa*
2k. Branches geniculate, leaflets 2.5–5 cm. long........ ....*43. B. viridis*

2j. Calyx-lobes deltoid-ovate, one-fourth to one-third the length of the tube
1k. Stipules setaceous-caducous, leaflets 2.5–3.5 cm. long ....*44.* × *B. fragilis*
2k. Stipules lanceolate, 0.7–1 cm. long, usually persistent, leaflets 3.5–5 cm. long.........*45.* × *B. sulphurea*
3f. Flowers blue
1g. Branches ascending, leaflets 4–8 cm. long........*46. B. australis*
2g. Branches divaricate, leaflets 1.5–5.5 cm. long
1h. Plants of middle and southwestern United States..*47. B. minor*
2h. Plants of North Carolina, Georgia and Tennessee...... ....*48. B. minor* var. *aberrans*
4f. Flowers bicolorous.............................*49.* × *B. bicolor*

1. B. simplicifolia Croom in Am. Jour. Sci. **25**: 74. 1834; Jour. Acad. Nat. Sci. Phila. **7**: 96. 1834; Torr. & Gray, Fl. N. Am. **1**: 383. 1840; Chapman, Fl. South. U. S., ed. 3, 120. 1897; Small, Fl. Southeast. U. S., ed. 1, 598. 1903, and ed. 2, 598. 1913; Small, Man. Southeast. Fl. 675. 1933.

Eaplosia ovata Raf. New Fl. N. Am. **2**: 52. 1836 [1837].

Plant 1 m. or less high; stems firm, lightly ribbed, erect, much-branched, branches geniculate, ascending; leaves dark green, blackening in drying, simple, sessile, entire, margins revolute, blades firm, reticulate, glabrous, lustrous above, ovate, obtuse or retuse, 4–10 cm. long, 3–6 cm. broad; racemes terminal, compact, 1–2 dm. long; flowers pedicellate, pedicels 4–8 mm. long, the lowermost subtended by foliaceous bracts 1.5 cm. long, 1 cm. broad, the uppermost by smaller oblong or obovate persistent bracts 5 mm. long, 2 mm. broad; calyx campanulate, glabrous without, finely pubescent within, 5 mm. long, upper lip broad, entire or minutely cleft, lobes of lower lip ovate or oblong-ovate, 2.5–3 mm. long; corolla yellow, standard reniform, 1.2 cm. long, 1 cm. broad, wings and keel oblong, 1.5 cm. long; pod pubescent when young, glabrate at maturity, ellipsoid or ovoid, body 1–1.5 cm. long, long-beaked, beak slightly recurved, short-stipitate, stipe 4–6 mm. long.

Distribution: dry pinelands, Florida.

CITATION OF SPECIMENS:

FLORIDA: without definite locality, "Chapman mis. 1846" (MBG); Quincy, *Chapman* (USN,ANSP); "in pinetis ad Quincy," June, *Chapman* (GH); Quincy, 1835, *Chapman* (NYB); on Jackson Bluff road, Leon Co., 20 mi. west of Tallahassee, Aug. 1935, *Kurz* (MBG); near Quincy, coll. of 1833, *Loomis & Croom* (MBG, TYPE); in oak forest toward Springcrag near Shellpoint, July, 1843, *Rugel* (MBG, NYB); pinelands west of Ochlockonee River, Leon Co., Nov. 28, 1920, *Small, Harper & Gunter 9671* (NYB,GH); white cedar swamp east of Bristol, July 12, 1924, *Small, Small & De Winkeler 11450* (NYB); Black Jack oak scrub, Quincy, Sept. 8, 1931, *West* (MBG).

2. **B. perfoliata** (L.) R. Br. in Ait. Hort. Kew., ed. 2, **3**: 5. 1811; Ell. Sketch Bot. S. Car. & Ga. **1**: 467. 1821; DC. Prodr. **2**: 100. 1825; Lodd. Bot. Cab. **12**: *pl. 1104.* 1826; Hook. Bot. Mag. II. **5**: *pl. 3121.* 1831; Torr. & Gray, Fl. N. Am. **1**: 383. 1840; Chapman, Fl. South. U. S., ed. 3, 120. 1897; Small, Fl. Southeast. U. S., ed. 1, 598. 1903, and ed. 2, 598. 1913; Small, Man. Southeast. Fl. 675. 1933.

Crotalaria perfoliata L. Sp. Pl. **2**: 714. 1753.

Sophora perfoliata Walt. Fl. Car. 135. 1788.

Rafnia perfoliata Willd. in L. Sp. Pl. ed. 4, **3**: 949. 1800.

Podalyria perfoliata Michx. Fl. Bor. Am. **1**: 263. 1803; Pursh, Fl. Am. Sept. **1**: 307. 1814.

Pericaulon perfoliatum Raf. New Fl. N. Am. **2**: 51. 1836 [1837].

Pericaulon cordatum Raf. New Fl. N. Am. **2**: 51. 1836 [1837].

Plant less than 1 m. high, glabrous, somewhat glaucous; stems lemon- to tawny-yellow, widely branched, branches stiff, arching; leaves pale yellow-green, simple, perfoliate, mostly vertical, one-ranked due to alternate right and left torsion of the internodes, blades entire, leathery, orbicular to ovate, 5–10 cm. long, 3–8 cm. broad, rounded at both ends or notched at apex, finely reticulated; flowers axillary, solitary, pedicellate, pedicels 4–8 mm. long, ascending; calyx campanulate, densely pubescent within, 6–7 mm. long, upper lip usually deeply cleft, lobes deltoid, those of the lower lip ovate, 1.5–2.5 mm. long; corolla yellow, standard reniform, 0.8 cm. long, 1 cm. broad, wings and keel 1–1.3 cm. long; mature pods ligneous, rugose, ferruginous, ovoid to globose, 1–1.5 cm. long, 1 cm. broad, constricted at both ends, short-stipitate, stipe barely exceeding the calyx, abruptly short- and slender-beaked, beak usually breaking off.

Hybridizes with *B. albescens* in Georgia.

Distribution: sand hills and pine barrens, South Carolina to Florida.

CITATION OF SPECIMENS:

SOUTH CAROLINA: Aiken, May 1869, *Canby* (MBG,USN,GH,NYB,FM); Aiken, Aug. 1866, *Ravenel* (MBG); Aiken, June 1869, *Ravenel* (USN); Aiken, June and July 1870, *Ravenel* (NYB); Aiken, 1871, *Ravenel* (MBG); Aiken, June 1847, *Wallace* (CM).

GEORGIA: pine barrens, McRea, June 7, 1900, *Biltmore Herb. 1600a* (NYB); sandy soil, Summerville, July 21, 1905, *Biltmore Herb. 1600b* (UM); no definite locality, *Chapman* (USN); dry pine barrens, Oliver, July 6, 1901, *Curtiss 6833* (MBG,GH,NYB,UM,UN,KA); open oak woods, sand hills, Augusta, May 1900, *Cuthbert 178* (NYB); dry hills north of Belair, Richmond Co., May 22, 1899, *Eggert* (MBG); dry sandy soil at Butts, Emanuel Co., June 6, 1901, *Harper 802* (MBG,USN,NYB); among sand hills between Grovetown and Forrest, Columbia Co., June 10, 1902, *Harper 1310* (MBG,USN,GH,NYB); Louisville, May 1894, *Hopkins 2983, 2984, & 2988* (MBG); no definite locality, April 1903, *Prior ex Herb. Kew.* (USN); dry sand hills 5 mi. east of McBean, Burke Co., April 10, 1838, *Pyron & McVaugh 2457* (MBG); Augusta, Richmond Co., June 27–July 1, 1895, *Small* (NYB,UM); sandy pine barren hills north of Augusta, Sept. 21, 1883, *Smith* (USN); Waycross, April, *Williamson* (NYB).

FLORIDA: sandy pine land, Chuluota, Seminole Co., May 18, 1929, *Rapp 1* (NYB); sandy scrub, Orlando, June 17, 1929, *West* (MBG).

3. **B. microphylla** Nutt. in Jour. Acad. Nat. Sci. Phila. **7**: 97. 1834; Torr. & Gray, Fl. N. Am. **1**: 383. 1840; Chapman, Fl. South. U. S., ed. 1, 111. 1860, and ed. 2, 111. 1889; Small, Fl. Southeast. U. S., ed. 1, 598. 1903, and ed. 2, 598. 1913; Small, Man. Southeast. Fl. 675. 1933.

Baptisia stipulacea Ravenel in Ell. Soc. Nat. Hist. **1**: 38. *pl. 2.* 1856; Chapman, Fl. South. U. S. ed. 3, 121. 1897.

B. microphylla Nutt. var. *axillaris* Canby in Bot. Gaz. **4**: 130. 1879.

B. perfoliata (L.) R. Br. var. *lobata* Canby in Bot. Gaz. **4**: 130. 1879.

Pericaulon microphyllum Raf. New Fl. N. Am. **2**: 51. 1836 [1837].

Plant 1 m. or less high, glabrous; stem widely branched, lateral branches arising from a single, erect, primary stem; leaves deep yellow-green, blackening in drying, lowermost ternately compound, petiolate, petioles 2–6 mm. long, uppermost simple, sessile, entire, clasping or semiamplexicaul, occasionally perfoliate, leaflets firm, reticulate, obovate, cuneate, or broadly spatulate, rounded at apex or apiculate, 2.5–3 cm. long, 1–1.5 cm. broad; persistent stipules foliaceous, ovate, variable in size, partially or wholly united with the leaf-blades;

flowers axillary or racemose, the latter subtended by cordate, foliaceous bracts 4 mm. long, 3 mm. broad; pedicels semipersistent, 0.8–1 cm. long; calyx campanulate, pubescent within, 5–6 mm. deep, upper lip entire, truncate or slightly emarginate, lobes of the lower lip deltoid, 2–2.5 mm. long; corolla yellow, standard 9 mm. high, 1 cm. broad, wings and keel 1–1.2 cm. long; pod brownish-black, somewhat glaucous, cartilaginous, ovoid, rarely subglobose, constricted at both ends, body 1–1.3 cm. long, stipitate, stipe 4–8 mm. long, short-beaked, beak recurved.

Distribution: sand hills, coastal plain, South Carolina to Florida.

Citation of Specimens:

South Carolina: Aiken, May 1859, *Buckley* (MBG); Aiken, May 1869, *Canby* (MBG,USN,GH,NYB,FM); sand hills, Aiken, June, *Ravenel* (GH,type of *B. stipulacea* Rav., CM); dry sandy soil, Aiken, *Ravenel* (MBG,USN,ANSP,FM); Aiken, June 1853, Herb. A. Gray, *Ravenel* (NYB); Aiken, June 1868, *Ravenel* (NYB); Aiken, June 1869, *Ravenel* (USN); Aiken, July 1870, *Ravenel* (NYB); Aiken, June 1878, *Ravenel* (ANSP); Aiken, coll. of 1880, *Ravenel* (USN).

Florida: no definite locality, *Nuttall* (ANSP,type, NYB).

4. × **B. fulva** Larisey, hyb. nov.[22]

= *B. perfoliata* × *B. albescens.*

Height unknown; plant yellow-green throughout, drying deep tawny in parts; stem slender, firm, simply branched, branches ascending-spreading; leaves petiolate, petioles 3–7 mm. long, lowermost leaves trifoliolate, stipulate, stipules foliaceous, cordate-ovate, round at apex, amplexicaul, 0.5–2 cm. long, uppermost leaves bifoliolate to unifoliolate through irregular fusion of leaflets with stipules, leaflets obovate-cuneate, apex rounded to broadly acute, seldom retuse, 3.5–5.5 cm. long, 2–3 cm. broad; flowers axillary or in terminal racemes, racemes 1–1.5 dm. long; floral bracts foliaceous, cordate, acuminate, 0.5–1 cm. long; pedicels 3–5 mm. long; calyx-tube 5–6 mm. deep, upper lip truncate to slightly emarginate, lobes of the lower lip deltoid-ovate, 3 mm. long; corolla pale yellow, drying deep bronze, standard 1.2–3 cm. high, wings and keel

[22] Inter *perfoliatam* et *albescentem* media: foliola 3, 2, vel 1, obovata cuneata apice rotundata raro retusa; flores axillares vel racemosi; corolla flavo-fulva.

1.4–5 cm. long; mature pod parchment-like, ferruginous, reticulate, cylindrical, 2–2.2 cm. long, 0.5–0.7 cm. broad, abruptly short-beaked, long-stipitate, stipe 5–7 mm. long.

Distribution: open sandy pine woods, central-eastern Georgia.

Citation of Specimens:

Georgia: Waynesboro, 1860, *Cleveland* (UF); in open pine woods, sand hills, Augusta, May 25, 1900, *Cuthbert 177* (NYB,type, UF).

5. **B. LeContei** Torr. & Gray, Fl. N. Am. **1**: 386. 1840; Chapman, Fl. South. U. S., ed. 3, 121. 1897; Small, Fl. Southeast. U. S., ed. 1, 598. 1903, and ed. 2, 598. 1913; Small, Man. Southeast. Fl. 675. 1933.

Plant 1 m. or less high, minutely pubescent; stem slender, firm, diffusely branched, branches geniculate; leaves bright yellow-green, retaining color in drying, lowermost short-petiolate, petioles 2–4 mm. long, upper ones subsessile, leaflets cuneate-obovate to oblanceolate or spatulate, 1.5–2.5 cm. long, 1–1.5 cm. broad, margins revolute, apex usually slightly apiculate, rarely retuse; stipules minute, subulate, caducous, lower ones sometimes larger, 3–6 mm. long, 1 mm. broad, and persistent; racemes numerous, short, barely exceeding the foliage; pedicels slender, 2.5–3.5 cm. long, subtended by foliaceous, ovate bracts 7–9 mm. long, 3 mm. broad, and bibracteolate above the middle, bracteoles 3 mm. long, 1 mm. broad; calyx campanulate, 5–6 mm. deep, upper lip almost entire, lower lobes lanceolate or subulate-lanceolate, as long as the tube or longer, 3–4 mm. long; corolla yellow, standard suborbicular, 1 cm. high, 1 cm. broad, wings and keel 1–1.2 cm. long; pod yellow-brown to blackish, coriaceous, rugose or lightly reticulate, finely pubescent, ellipsoid, body 1.3 cm. long, up to 1 cm. broad, narrowed at both ends, stipe 5–7 mm. long, abruptly beaked, beak recurved.

Distribution: dry sandy plains, pine lands, and scrub, Georgia and Florida.

Citation of specimens:

Georgia: sandy soil, Twin Lakes, 12 mi. southeast of Valdosta, Lowndes Co., May 15, 1938, *Berryman* (MBG); no definite locality, *Le Conte* (NYB).

Florida: high pine land, Jessamine, Pasco Co., May 4–18, 1897, *Barnhart 2186* (FM); high pine land, Haines City, April 24, 1930, *Blanton 6429* (USN,GH);

sandy fields near Jennings, Hamilton Co., June 6, 1930, *Bright 4779* (CD); no definite locality, *Chapman* (USN,GH); Jacksonville, *Chapman* (NYB); Carrabelle, Oct. 1896, *Chapman* (MBG); dry pine barrens near Jacksonville, June, *Curtiss 694* (MBG,USN,GH,NYB,FM,UM,UN); dry pine barrens near Jacksonville, May 30, 1894, *Curtiss 4828* (USN,GH,FM,UM); no definite locality, ex Chapman, *Curtis* (GH); Waldo, *Gilman 803* (USN); Wakulla Co., Aug. 12, 1924, *Handley A 141* (USN); dry sandy pine barrens between Otter Creek and Panacea, Wakulla Co., July 19, 1925, *Harper 49* (GH,NYB); dry sand barrens between Sopchoppy and Panacea, Wakulla Co., June 19, 1910, *Harper 80* (GH,NYB,UM); high pine land, Columbia Co., 1898, *Hitchcock* (MBG); high pine land, Citrus Co., June–July, 1898, *Hitchcock 356* (FM); Hernando Co., June–July, 1898, *Hitchcock 357* (FM); between Medart and Panacea, Wakulla Co., May 5, 1935, *Kurz* (MBG); 3 mi. south of Woodville, Leon Co., May 29, 1935, *Kurz* (MBG); St. Nicholas, May 12, 1896, *Lighthipe* (WU,UM); south of Jacksonville, May 10, 1898, *Lighthipe 228* (MBG, WU,UM); dry sandy field north of Palm Harbor, Pinellos Co., April 25, 1930, *Moldenke 1039a* (MBG,NYB,DU); dry sandy field, Elfers, Pasco Co., April 25, 1930, *Moldenke 1061* (MBG,NYB,DU); in pinelands, Lake Jovita, April 18, 1927. *O'Neill* (MBG); "ad colles arenosos inter Volusia et Ft. Oclawaha, et prope Spring Garden," June–July, 1848, *Rugel 191* (NYB); scrub near Weekiwachee Spring, April 22, 1922, *Small 10413* (GH); sand hills west of Avon Park, De Soto Co., May 1, 1919, *Small & De Winkeler 9085* (NYB); oak ridge between Suwannee River and Trenton, April 28, 1924, *De Winkeler & Mosier 11328* (NYB); scrub between Perry and the Gulf of Mexico, near the mouth of Spring Warrior River, July 13, 1924, *Small, Small & De Winkeler 11453* (NYB); dry pine land, Gainesville, July 1, 1935, *West* (MBG); borders of swampy lake 20 mi. north of Tampa, June 17, 1939, *Woodson & Schery 115* (MBG).

6. B. LeContei Torr. & Gray, forma **robustior** Larisey, f. nov.[23]

B. LeContei Torr. & Gray ex Chapman, Fl. South. U. S., ed. 1, 111, 1860, ed. 2, 1889, and ed. 3, 1897, in part.

B. LeContei var. β Torr. & Gray, Fl. N. Am. **1**: 387. 1840.

As the species except: stem stout; leaflets obovate, 4–5 cm. long, 2.5–3 cm. broad; stipules 0.6–1.4 cm. long, 1–3 mm. broad; petioles 6 mm. long; racemes subtended by simple, stipulate leaves; bracts 2 cm. long, 1 cm. broad, bracteoles 1 cm. long, 0.3 cm. broad; standard 1.2 cm. high, wings and keel 1.4 cm. long.

Distribution: western Florida.

Citation of Specimens:

Florida: Marianna, coll. of 1838, *ex Herb. Chapman* (NYB,type).

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[23] Ab specie differt ramis crassis; foliolis obovatis 4–5 cm. longis 2.5–3.0 cm. latis, stipulis 6–14 mm. longis 1–3 mm. latis, petiolis 6 mm. longis; racemis basi foliis simplicibus stipulatis subtendentibus; bracteis 2 cm. longis 1 cm. latis, bracteolis 1 cm. longis 0.3 cm. latis; vexillo 1.2 cm. alto, alis carinaque 1.4 cm. longis.

7. B. calycosa Canby in Bot. Gaz. **3**: 65. 1878; Chapman, Fl. South. U. S., ed. 3, 122. 1897; Small, Fl. Southeast. U. S., ed. 1, 598. 1903, and ed. 2, 598. 1913; Small, Man. Southeast. Fl. 678. 1933.

Plant usually less than 1 m. high, blackening in drying, glaucous; stems slender, firm, glabrous, diffusely branched, branches usually straight, sometimes slightly geniculate; leaves short-petiolate, petioles 1–3 mm. long, leaflets spatulate, oblanceolate to narrowly cuneate, sparsely pubescent, 1–3 cm. long, 0.8–1 cm. broad; stipules elliptic or lanceolate, foliaceous, 1–2 cm. long, 3–5 mm. broad; racemes terminal, loose, usually straight, occasionally flexuous, rarely geniculate, 1–2 dm. long; pedicels slender, 3–4 cm. long, subtended by ovate-lanceolate bracts 1.5–1.8 cm. long, 5–8 mm. broad, bibracteolate above the middle, bracteoles 1.5 cm. long, 5 mm. broad, bracts and bracteoles foliaceous, persistent; calyx-tube short, 2–3 mm. deep, all five lobes foliaceous, sparingly ciliate, upper two united about half their length, remaining three ovate, obovate, or occasionally lanceolate, four times the length of the tube, 1–1.2 cm. long, 5–6 mm. broad; corolla yellow, scarcely surpassing the calyx-lobes, standard suborbicular, 1 cm. high, 1 cm. broad, wings and keel 1.2 mm. long; ovary glabrous, mature pod black, firm, reticulate, body broadly ovoid, 1 cm. long, barely exceeding the calyx, short-stipitate, short- and slender-beaked, beak slightly recurved.

Distribution: pine lands, eastern Florida.

Citation of Specimens:

Florida: near St. Augustine, *Floyd* (NYB); pine barrens, St. Augustine, *Floyd* (GH); sandy barrens, east Florida, 1878, *Floyd ex Herb. Canby* (MBG); dry pine barrens, July 1877, *Reynolds* (MBG,type, USN,GH); pine barrens, east Florida, July 1878, *Reynolds* (NYB); dry pine-oak woods south of Green Cove Springs, July 14, 1935, *West* (MBG); dry pine-oak woods, Penny Farms, July 14, 1935, *West* (MBG).

8. B. hirsuta Small, Fl. Southeast. U. S., ed. 1, 598, 1331. 1903, and ed. 2, 598. 1913; Small, Man. Southeast. Fl. 676. 1933.

B. calycosa Canby var. *villosa* Canby in Bot. Gaz. **12**: 39. 1887, not *B. villosa* (Walt.) Nutt.

Plant 0.3–1 m. high, hirsute throughout, with stiff, erect, ferruginous hairs, not blackening in drying, assuming reddish-brown cast; stems stout, diffusely branched, branches straight; leaves petiolate, petioles 3–8 mm. long, leaflets obovate, spatulate to narrowly cuneate, obtuse or apiculate, 1–3 cm. long, 0.8–1.2 cm. broad; stipules oblanceolate or oblong, elliptic, 1–1.5 cm. long, 3–5 mm. broad; flowers disposed in intercalary racemes, 7–20 cm. long, or occasionally in short terminal racemes; pedicels slender, 3–4 cm. long, subtended by foliaceous, ovate, elliptic bracts 1.5–2 cm. long, 5–9 mm. broad, bibracteolate above the middle, bracteoles lanceolate to narrowly elliptic, 1–1.2 cm. long, 2–3 mm. broad, bracts and bracteoles foliaceous, persistent; calyx-tube short, 2–4 mm. deep, lobes foliaceous, lanceolate, spatulate, rarely obovate, mucronate or apiculate, four times the length of the tube, 0.8–1.2 cm. long, 3–4 mm. broad, upper two united about half their length; corolla yellow, usually distinctly surpassing the calyx-lobes, standard suborbicular, slightly emarginate, 0.9–1.2 cm. high, 0.9–1.0 cm. broad, wings and keel 1–1.3 cm. long; ovary hirsute, mature pod brownish-black, pubescent, finely reticulate, body broadly ovoid, 1–1.3 cm. long, usually surpassing the calyx-lobes, long-beaked.

Distribution: dry sandy pine lands, western Florida.

Citation of Specimens:

Florida: high pine land near Crestview, May 22, 1930, *Blanton 6573* (MBG, USN,FM); dry pine woods, Walton Co., "De Funiak Springs, Wilson Co.," northwestern Fla., *Curtiss 699* (MBG,type, USN,NYB,FM,UM,UN); dry pine barrens, De Funiak Springs, June 21, 1897, *Curtiss 5899* (MBG,USN,GM,NYB,FM, UM,UN,KA,UF); dry pine barrens, Crestview, May 11, 1898, *Curtiss 6406* (MBG, USN,GH,NYB,UM,UN); pine barren, De Funiak Springs, May 8, 1892, *Mohr* (USN); flat woods, De Funiak, July 1896, *Rolfs 676* (MBG,FM,UF); De Funiak, May 18, 1906, *Tracy 9100* (MBG,USN,GH,FM,WU,UM,UN).

9. B. lanceolata (Walt.) Ell. Sketch Bot. S. Car. & Ga. **1**: 467. 1821; DC. Prodr. **2**. 100. 1825; Torr. & Gray, Fl. N. Am. **1**: 383. 1840; Chapman, Fl. South. U. S., ed. 1, 111. 1860, ed. 2, 111. 1889, and ed. 3, 121. 1897; Small, Fl. Southeast. U. S., ed. 1, 599. 1903, and ed. 2, 599. 1913; Small, Man. Southeast. Fl. 676. 1933.

B. uniflora (Michx.) Nutt. Gen. N. Am. Pl. **1**: 281. 1818; Spreng. Syst. **2**: 347. 1825.

Sophora lanceolata Walt. Fl. Car. 135. 1788.

Podalyria uniflora Michx. Fl. Bor. Am. **1**: 263. 1803; Pursh, Fl. Am. Sept. **1**: 307. 1814.

Lasinia reticulata Raf. New Fl. N. Am. **2**: 48. 1836 [1837].

Plant less than 1 m. high, minutely appressed-pubescent throughout, pubescence whitish, pale yellow to tawny; stem slender, firm, lightly ribbed, widely branched, main stem remaining distinct and erect, branches slightly geniculate, ascending-spreading; leaves subsessile to short-petiolate, petioles 2–4 mm. long; leaflets occasionally subsessile, more frequently short-petiolulate, petiolules 2–5 mm. (rarely 1 cm.) long; blades firm, reticulate, yellow-green, somewhat glossy above, glaucous below, blackening, 5–8 cm. long, 1–1.5 cm. broad, usually lanceolate, oblanceolate, spatulate, occasionally narrowly elliptic, always tapering toward the base, rounded, retuse or mucronate at apex, rarely acuminate; stipules triangular, lanceolate, setaceous, always minute, caducous; flowers single in axils of upper leaves, or in few-flowered racemes terminating the branches; pedicels 4–7 mm. (rarely 1 cm.) long, stout; calyx-tube 6–9 mm. deep, upper lip cleft about 1 mm., lobes of the lower lip deltoid, 2–3 mm. deep; corolla yellow, standard notched, 1.5–7 cm. high, 1.2–4 cm. broad, wings and keel 2–2.2 cm. high; ovary densely white- or tawny-pubescent; mature pod usually glabrate, woody, dark brown or black, subglobose or ovoid, 0.9–1.3 cm. broad, 1.5–2.2 cm. long, stipe exceeding the calyx 1–2 mm., long- and slender-beaked.

Distribution: dry sandy hills and pine barrens, Georgia, Florida, and Alabama.

Citation of Specimens:

Georgia: Tebeauville, April 1869, *Canby* (MBG,GH,NYB,FM); dry ground, Jesup, July 11, 1901, *Curtiss 6840* (MBG,USN,GH,NYB,UM,UN,KA); no definite locality, 1884, *Harden* (ANSP); dry pine barrens near Covena, Emanuel Co., April 5, 1904, *Harper 2095* (MBG,USN,GH,NYB); Vidalia, April 1914, *Huger* (MBG); Wayne Co., June 1893, *Kearney* (OU); no definite locality, *LeConte* (ANSP); dry pine barrens 4 mi. west of Folkston, Charlton Co., April 12, 1936, *Leeds 2559* (NYB,FM); sandy roadside 6½ mi. south of Irwinville, Irwin Co., Mar. 19, 1938, *Pyron & McVaugh 2122* (MBG); weed of sandy roadside 1 mi. south of Pelham, Mitchell Co., Mar. 21, 1938, *Pyron & McVaugh 2289* (MBG); dry sand hills 1 mi. south of Butler, Taylor Co., Mar. 22, 1938, *Pyron & McVaugh 2270* (MBG); pine barrens, Jesup, April 1893, *Ruth* (MBG,OU); common on drier upland sand ridges, usually in cut-over pine woods and pastures, Tift Co., May 15, 1935, *Stephens* (MBG).

FLORIDA: sandy woods 5 mi. north of Calhoun, Duval Co., Mar. 24, 1938, *Buchanan Jr.* (MBG); no definite locality, *Chapman* (USN); Apalachicola, July 1878, *Chapman* (FM); dry sandy pine land, De Land, *Harkness* (MBG); McClenny, Feb. 1887, *Heading* (UM); road to Lanark, 3 mi. west of Ochlockonee River, Franklin Co., May 29, 1935, *Kurz* (MBG); McClenny, Baker Co., April 4, 1898, *Lighthipe 565* (MBG,UM,UW); common, dry sandy pine woods, Green Cove Springs, Mar. and April, *Mohr* (USN); dry sandy pine land, McIntyre Co., May 4, 1930, *Moldenke 1130* (MBG,USN,NYB,DU); dry pine barrens, St. Augustine, Mar. 1878, *Reynolds* (MBG,USN,NYB,FM,OU); dry pine barrens, St. Augustine, early summer, 1880, *Reynolds* (MBG,NYB); dry pine barrens at head of Pellicier's Creek, St. Johns Co., Mar. 2, 1882, *Smith 447* (USN,FM); along roadside between Tamaco River Bridge and Ormond, Mar. 26, 1937, *Springer* (UF); Port Orange, Mar. 26, 1895, *Straub 79* (GH); dry pine-oak woods south of Green Cove Springs, July 14, 1935, *West* (MBG); dry pine-oak woods, Penny Farms, July 14, 1935, *West* (MBG).

ALABAMA: dry pine ridges, eastern shore, Mobile Bay, May 1880, *Mohr* (FM).

10. **B. elliptica** Small, Fl. Southeast. U. S., ed. 1, 599, 1331. 1903, and ed. 2, 599. 1913; Small, Man. Southeast. Fl. 676. 1933.

B. lanceolata (Walt.) Ell. var. β Torr. & Gray, Fl. N. Am. **1**: 384. 1840.

B. lanceolata (Walt.) Ell. ex Chapman, Fl. South. U. S., ed. 1, 111. 1860, ed. 2, 111. 1889, and ed. 3, 121. 1897, in part.

Plant usually less than 1 m. high, minutely tawny appressed-pubescent throughout; stem firm, ribbed, widely subdichotomously branched, branches strongly geniculate forming 135-degree angles; leaves usually sessile to short-petiolate, but petioles of the lower leaves sometimes 0.7–1 cm. long; leaflets petiolate, petioles 0.4–1 cm. long; blades firm, reticulate, glossy and blackening above, remaining dull and deep green below, 2–4 cm. broad, 8–13 cm. long, regularly narrowly to broadly elliptic, always tapering toward each end, more pronouncedly toward the base, but abruptly rounded, retuse or slightly mucronate, rarely acuminate at the apex, widest part usually just above the middle; lower leaflets occasionally lanceolate, upper ones rarely obovate-cuneate; stipules rarely lanceolate, 6 mm. long, subpersistent, usually setaceous, minute, caducous; flowers single in axils of upper leaves or in few-flowered racemes terminating the branches; floral bracts narrowly lanceolate to setaceous, caducous; pedicels 2–7 mm. (rarely 7 mm.) long, stout; calyx-tube conspicuously nerved, 0.7–1 cm. deep, upper lip cleft 1 mm. but not usually separating, lobes of lower lip deltoid, 3 mm. deep, 3–4 mm. wide at mouth of tube, notch frequently broadly curved rather than angled; corolla yellow, standard deeply notched, 1.8 cm. high, 1.7 cm. broad, wings and keel 2.5 cm. high, 1 cm. broad; ovary densely tawny-pubescent; mature pod glabrate or with remains of tawny pubescence, brownish-black, woody, ovoid to oblong, body 2 cm. long, 1–1.3 cm. broad, short-stipitate, stipe not exceeding the firm, persistent calyx, long-beaked.

Distribution: dry sandy pine lands, Florida and adjacent Georgia, and Alabama.

CITATION OF SPECIMENS:

GEORGIA: no definite locality, *Boykin* (ANSP).

FLORIDA: no definite locality, *Chapman* (GH,FM); middle Florida, *Chapman 190* (NYB); Apalachicola, *Chapman* (MBG); no definite locality, "*Chapman mis. 1846*" (MBG); Aspalaga, April 1898, *Chapman* (MBG); Quincy, *Chapman* (USN, ANSP); dry sandy soil near Apalachicola, April, *Curtiss 689* (NYB,TYPE, MBG, USN,GH,ANSP,FM,UM); swamps, Walton Co., summer 1885, *Curtiss* (NYB); Apalachicola, 1892, *DeVasey* (USN); dry pine barrens, 5 mi. south of Tallahassee, Leon Co., April 1, 1933, *Griscom 18393* (GH); southwest Leon Co., July 21, 1924, *Handley A-147* (USN); 20 mi. above mouth of Apalachicola River, May 5, 1926, *Howell 1165* (USN); dry pine land, Gretna, April 18, 1930, *Kincaid & West* (MBG); "in pinetis, inter Tallahassee et Quincy, Mai 1843," *Rugel* (MBG,NYB); dry pine barrens, Apalachicola, *Saurman* (ANSP).

ALABAMA: in high pine land, Atmore, April 17, 1935, *Blanton 263* (GH,NYB, FM); dry sandy pine woods, Baldwin Co., May 1879, *Mohr* (USN).

11. B. elliptica Small var. **tomentosa** Larisey, var. nov.[24]

As the species except: more pubescent throughout, but especially on the lower leaf surfaces, forming a dense, tawny, felt-like mat; leaflets more nearly acuminate, smaller, 7–9 cm. long, 2–3.5 cm. broad; flowers smaller, calyx 7–8 mm. deep, standard 1.3–5 cm. high, wings and keel 1.8–2 cm. high, rarely slightly larger.

[24] Ab specie differt omnino pubescentiore; foliis infra dense fulvo-tomentosis; foliolis fere acuminatis 7–9 cm. longis, 2.0–3.5 cm. latis; floribus minoribus, calyce 7–8 mm. alto, vexillo 1.3–5.0 cm. alto, alis carinaque 1.8–2.0 cm. longis raro maioribus.

Distribution: dry sandy pine lands, Florida and adjacent Alabama.

Citation of Specimens:

Florida: dry soil near Pensacola, April 13, 1899, *Biltmore Herb. 1595f* (MBG, NYB); dry pine land, Okaloosa, April 3, 1929, *Blackman & Enlow* (MBG); open pine woods near DeFuniak Springs, April 27, 1898, *Curtiss 6379* (MBG,TYPE, USN, GH,NYB,UM,UN); Lake City, *Rolfs 85* (MBG,FM); De Funiak, July 1896, *Rolfs 671* (MBG).

Alabama: pinelands, Loxley, June 22, 1933, *Bombard & Haas* (TU); Baldwin Co., May 1893, *Mohr* (MBG).

12. B. Nuttalliana Small, Fl. Southeast. U. S., ed. 1, 599. 1903, and ed. 2, 599. 1913; Cocks, The Leguminosae of Louisiana. La. State Mus. Nat. Hist. Surv. Bull. 1: 5, *pl. 6.* 1910.

B. uniflora Hook. Comp. Bot. Mag. **1**: 21. 1835, not *B. uniflora* (Michx.) Nutt.

B. lanceolata (Walt.) Ell. var. γ Torr. & Gray, Fl. N. Am. **1**: 384. 1840. (var. *uniflora* of authors).

B. lanceolata var. *uniflora* Torr. & Gray ex Canby in Bot. Gaz. **4**: 131. 1879.

B. lanceolata var. *texana* Holz. in Contr. U. S. Nat. Herb. **1**: 286. 1893.

B. texana (Holz.) Pollard & Ball in Proc. Biol. Soc. Wash. **13**: 133. April 1900, not *B. texana* Buckl.

B. confusa Pollard & Ball in Proc. Biol. Soc. Wash. **13**: 158. June 1900, not *B. confusa* Sweet.

B. nuculifera Greene, Leaflets Bot. Obs. **2**: 84. 1910.

Plant 4–11 dm. high, more or less densely pubescent throughout, occasionally glabrate in age, slightly blackening; stem slender, firm, much-branched, branches usually geniculate, ascending; leaves sessile to subsessile, petioles not usually exceeding 1 mm. in length; leaflets firm, reticulate, glossy above, dull below, oblong to obovate, cuneate at base, obtuse to rounded at apex, frequently emarginate, occasionally apiculate, 2.5–3.5 cm. long, 1.3–2 cm. broad, lateral leaflets converging; stipules deltoid, deltoid-lanceolate to setaceous, inconspicuous, usually caducous; flowers solitary in upper axils, or forming short terminal racemes; floral bracts narrowly lanceolate to setaceous, 2–4 mm. long, caducous; pedicels 2–5 mm. long; calyx-tube 7–9 mm. long, hirsute, deeply blackening, upper lip entire, barely cleft or distinctly emarginate, lobes of the lower lip deltoid or deltoid-lanceolate, apiculate, 3–4 mm. deep; corolla yellow, standard 0.8–1.5 cm. long, 0.6–1.2 cm. broad, wings and keel 1.7–2 cm. long; ovary thickly pubescent, mature pod somewhat glabrate, though usually more or less villous, blackish, coriaceous to ligneous, thick, subglobose to ovoid, 0.4–1.3 cm. long, 0.2–1.1 cm. thick, stipe not exceeding the calyx-lobes, beak short, recurved.

Distribution: Mississippi to Arkansas and Oklahoma, southwest to Texas; reported from adjacent Mexico.

CITATION OF SPECIMENS:

MISSISSIPPI: Madison, April 28, 1925, *Cook* (USN); Ridgeway, April 18, 1927, *Woodson & Anderson 1538* (MBG).

LOUISIANA: in pine hills in vicinity of Alexandria, June 3, 1899, *Ball 546* (USN, TYPE of *B. confusa* Pollard & Ball, MBG,NYB,GH,FN,UN); prairie along R.R. 3 mi. west of Lawtell, St. Landry Parish, April 26, 1936, *Brown 6253* (LU); along R.R. north of Roark, Acadia Parish, April 26, 1936, *Brown 6267* (LU); rare, pine-oak-hickory woods southeast of Columbia, Caldwell Parish, June 24, 1936, *Brown 6489* (LU); common in pine-hardwood woods southeast of Jena, Catahoula Parish, June 26, 1936, *Brown 6533* (LU); open pastures, Shreveport, April 13, 1910, *Cocks 1630* (TU); open fields, Shreveport, April 15, 1910, *Cocks* (MBG); Nachitoches, April 2, 1911, *Cocks* (TU); Shreveport, July 1909, "*Dickson & Cocks 1791*" (MBG); Calcasieu Parish, *Featherman* (LU); no definite locality, *Hale* (GH); in prairies, Opelousas, April 1880, *Langlois* (NYB,FM); in plains, Calcasieu Co., April 26, 1884, *Langlois 8* (NYB); in plains, Chataignier, St. Landry Co., May 12, 1885, *Langlois 7* (NYB); in prairie, Tokataite, Opelousas, May 20, 1885, *Langlois 29* (USN); Chataignier, June 21, 1885, *Langlois* (NYB); dry open woods, Natchitoches, May 10, 1915, *Palmer 7570* (MBG); low prairies, Jennings, Jefferson Davis Parish, May 15, 1915, *Palmer 7631* (USN); dry sandy highland, cut-over pine land, Pineville, Rapides Parish, April 3, 1935, *Smith 93* (LU); Shreveport, Aug. 4–6, 1897, *Tracy 3450* (MBG,USN).

ARKANSAS: common in pine woods, Fulton, May 12, 1900, *Bush 214* (MBG, USN,GH); common on prairie, Prescott, May 14, 1900, *Bush 264* (USN); prairies, Fulton, April 29, 1909, *Bush* (MBG); dry sand hills north of Texarkana, Miller Co., June 9, 1898, *Eggert* (MBG); open woods near Fort Smith, June 1835, *Engelmann 1002* (MBG); Camden, May 10, 1850, *Fendler* (MBG,GH); Malvern, May 1884, *Letterman* (MBG); Prescott, *Letterman* (MBG); no definite locality, *Nuttall* (NYB,ANSP); rocky ground along small stream near Mansfield, Sebastian Co., May 24, 1931, *Palmer 39303* (MBG,GH); dry woods on high bluff on Ouachita River about 1 mi. above Arkadelphia, Clark Co., May 18, 1912, *Wheeler* (MBG, FM); dry woods near Arkadelphia, Clark Co., May 1913, *Wheeler* (MBG,FM).

OKLAHOMA: open place, mountain side near Page, Le Flore Co., June 20, 1914, *Blakley 1428* (MBG,GH,UM); Pine Valley, Le Flore Co., May 4, 1935, *Goodman 2359* (MBG); common, open woods, Shawneetown, McCurtain Co., May 26, 1916, *Houghton 3800* (MBG).

TEXAS: Hughes Springs, Cass Co., May 9, 1903, *Biltmore Herb. 14783a* (MBG, USN,UM); common on prairie, Sulphur, May 11, 1900, *Bush 207* (USN); 6 mi. southwest of Oakwood, Leon Co., May 11, 1937, *Cory 21741* (MBG); 9 mi. northwest of Jefferson, Marion Co., May 19, 1937, *Cory 22836* (MBG); open woods, old fields, etc., San Augustine, *Crocket* (USN); Huntsville, June 3–12, 1908, *Dixon 64* (FM); Walker Co., May 6–12, 1910, *Dixon 525* (USN,FM); vicinity of Houston, Harris Co., May 22–June 12, 1910, *Dixon 607a* (FM); Troupe, Smith Co., April 19, 1899, *Eggert* (MBG); Spring, May 4, 1924, *Fisher* (DU); Shiro, Mar. 12, 1934, *Fisher 34104* (FM); Houston, 1914 *Hayden* (GH); Mansfield, Tarrant Co., May 1927, *Killian* (UT); Dalby, May 4, 1896, *Milligan* (USN); no definite locality, coll. of 1889, *Neally 71* (USN); no definite locality, coll. of 1889, *Neally 73* (USN, TYPE of *B. lanceolata* var. *texana* Holz.); sandy knolls, prairies, Columbia, Brazoria Co., April 12, 1914, *Palmer 5213* (MBG,USN); Arlington, May 1880, *Reverchon* (MBG); sandy woods, Dallas Co., June 1881, *Reverchon 11* (GH); sandy woods, Dallas, June 1882, *Reverchon 184* (MBG); common in sand, Big Sandy, May 27–28, 1901, *Reverchon 2652 & 2654* (MBG); sandy soils, Beaumont Co., April 25, 1903, *Reverchon 3739* (MBG); woods in Angelina Bottom, Angelina Co., May 7, 1903, *Reverchon 3740* (MBG); sandy woods 5 mi. from Polytechnic, Tarrant Co., April 22, 1921, *Ruth 62* (FM,UW,KA); in sandy woods near Polytechnic, Tarrant Co., April 27, 1925, *Ruth 621* (USN); Palestine, April 14, 1929, *Tharp 5420* (USN, UT); Montgomery Co., April 19, 1930, *Tharp* (UT); Henderson Co., June 6, 1932, *Tharp* (UT); Walker Co., July 9, 1920, *Warner 12* (USN,UT); Nacogdoches, June 15, 1931, *Whitehouse* (UT); abundant, dry, open ground near Gallatin, Cherokee Co., April 10, 1916, *Young* (GH,UT).

13. B. intercalata Larisey, sp. nov.[25]

Plant less than 1 m. high, finely pubescent throughout, often glabrate in parts; stem somewhat stout, firm, ribbed, slightly

[25] Herba vix 1 m. alta omnino molliter pubescens saepe plus minusve glabrata; caules crassiusculi firmi striati paulo geniculati late ramosi, ramis erectis raro paululo geniculatis sat elongatis virgatis glabratis. Folia inferiora brevi-petiolata, superiora subsessilia, foliolis obovatis vel ellipticis apice obtusis rotundatisve saepe emarginatis basi cuneatis 4–6 cm. longis 1.7–2.2 cm. latis firme membranaceis reticulate venosis supra saturate viridibus illustribus paulo nigrescentibus subtus opacis sat glaucis saepe glabratis marginibus nervo medio basi excepto, stipulis deltoideis aut deltoideo- aut ovato-lanceolatis 3–8 mm. longis persistentibus. Racemi intercalati 1.5–2.0 dm. longi, bracteis lanceolatis vel ovato-lanceolatis 0.8–1.2 cm. longis, 2–3 mm. latis persistentibus, pedicellis 0.9–1.3 cm. longis. Corolla lutea, vexillo 1.6 cm. longo et lato, alis et carina patulis inaequilateralibus auriculatis 2.0–2.2 cm. longis 7–8 mm. latis. Calycis tubum 7–9 mm. longum conspicue nervatum nigrescens extus sparse intus dense luteo-pubescens, labro superiore integro 4–5 mm. longo basi 5–6 mm. lato apice obtuse apiculato vel truncato usque ad 1 mm. lato, labri inferiori lobis deltoideis vel deltoideo-lanceolatis 3–4 mm. longis basi 2.5–3.0 cm. latis. Legumen subglobosum inaequilaterale longe stipitatum in rostrum paulo recurvatum gradatim contractum 1.5–7.0 cm. longum, 1.6–1.9 cm. latum tenue sed solidum juventate conspicue inflatum maturitate in rugas profundas corruens nigrescens valde reticulatum pubescens.

geniculate, widely branched, branches erect, only rarely lightly geniculate, elongate, virgate, glabrate; leaves subsessile above, lowermost petiolate, petioles 1–4 mm. long; leaflets firm, reticulate, glossy, dark green, slightly blackening above, dull, grayish below, usually glabrate except along the margins and midvein toward the base, obovate to elliptic, cuneate, apex obtuse to rounded, frequently emarginate, 4–6 cm. long, 1.7–2.2 cm. broad; stipules deltoid, deltoid-lanceolate, ovate-lanceolate, 3–8 mm. long, persistent; flowers borne in intercalary racemes 1.5–2 dm. long; floral bracts lanceolate to ovate-lanceolate, 8–12 mm. long, 2–3 mm. broad, persistent; pedicels 0.9–1.3 cm. long; corolla yellow, standard 1.6 cm. high, 1.6 cm. broad, wings and keel strongly curved, inequilateral, auriculate, 2–2.2 cm. high, 7–8 mm. broad; calyx-tube conspicuously nerved, blackening, finely pubescent without, densely tawny-pubescent within, 7–9 mm. long, upper lip entire, obtusely apiculate or truncate, blunt tip up to 1 mm. across, base 5–6 mm. across, 4–5 mm. deep, lobes of lower lip deltoid to deltoid-lanceolate, 3–4 mm. deep, base 2.5–3 mm. across; pod thin but firm, much inflated but collapsing at maturity into deep folds, black, strongly reticulate, pubescent, 1.5–7 cm. long, 1.6–1.9 cm. broad, subglobose, inequilateral, long-stipitate, long-beaked, beak slightly recurved.

Except for the unique manner in which the flowers are borne, this species bears a close superficial resemblance to *B. Nuttalliana* Small. It may possibly be a hybrid between the latter and *B. leucophaea* Nutt., but at present there is no concrete evidence for this assumption.

Distribution: prairies, western Louisiana.

Citation of Specimens:

Louisiana: in prairies, Calcasieu, April 26, 1884, *Langlois* (NYB, type); in plains, Calcasieu Co., April 26, 1884, *Langlois* (NYB); plains, Chataignier, St. Landry Co., May 19, 1885, *Langlois* (NYB).

14. **B. bracteata** Muhl. ex Ell. Sketch Bot. S. Car. & Ga. **1**: 469. 1821; DC. Prodr. **2**: 100. 1825; Small, Fl. Southeast. U. S., ed. 1, 600. 1903, and ed. 2, 600. 1913; Small, Man. Southeast. Fl. 677. 1933.

B. leucophaea Nutt. ex Chapman, Fl. South. U. S., ed. 1, 112. 1860, ed. 2, 112. 1889, and ed. 3, 122. 1897, in part.

B. saligna Greene, Leaflets Bot. Obs. **2**: 84. 1910.

Podalyria bracteata Muhl. Cat. Pl. Am. Sept. 42. 1815, *nomen subnudum.*

Lasinia bracteata Raf. New Fl. N. Am. **2**: 50. 1836 [1837].

Plant 3–6 dm. high, more or less softly and loosely pubescent throughout, darkening but not blackening in drying; stem stout, ribbed, subdichotomously branched, branches divaricate; leaves petiolate, petioles 0.3–1.2 cm. long, leaflets firm, oblanceolate to obovate or elliptic-obovate, cuneate, apex acute or obtuse, 5–10 cm. long, 2–3.5 cm. broad, lower surface finely reticulate at maturity; stipules wide-subulate, acuminate, 2–4 cm. long, persistent; racemes axillary, 1–2 dm. long, secund, declined; floral bracts lanceolate to ovate-lanceolate, 1–3 cm. long, persistent; pedicels 1–1.5 cm. long; calyx-tube 1 cm. deep, upper lip emarginate or distinctly 2-lobed, lobes of the lower lip deltoid-ovate, 4–5 mm. long; corolla cream or yellow, standard 1.8–2 cm. high, 1.5–1.7 cm. broad, wings and keel 2.2–2.5 cm. long; pods ligneous, body elliptic, 3–4 cm. long, 1.5–1.7 cm. broad, sparsely subappressed-pubescent, slightly reticulate, gradually tapering into a slender beak, stipe equalling the calyx in length.

Distribution: dry sandy woods, North Carolina, south to Georgia and Alabama.

Citation of Specimens:

North Carolina: no definite locality, *Curtis* (NYB); vicinity of Wilmington, April 14–17, 1911, *Bartram & Long* (ANSP).

South Carolina: Columbia, May 9, 1899, *Canby & Sargent 20* (GH); dry sandy soil, Anderson, Aug. 4, 1919, *Davis 9142* (MBG); Morehead's woods near Anderson, May 4, 1920, *Davis 1315a* (MBG,USN); dry open woods, Anderson, May 4, 1920, *Davis 1315b* (UT); Watson's woods, Anderson, Anderson Co., May 4, 1920, *Davis 1315c* (MBG,UM,UT); Columbia, April 14, 1867, *Doggett* (UW); Anderson, *Gibbes* (NYB); dry woods near Seneca River, Clemson College, Oconee Co., April 18, 1906, *House 1862* (MBG); vicinity of Batesburg, Lexington Co., April 29, 1911, *McGregor 25* (USN); sandy open woods near Irmo, Lexington Co., April 19, 1932, *Palmer 39958* (MBG,GH); Aiken, 1880, *Ravenel* (USN); Aiken, April 7, 1888, *Smith* (ANSP); woods, Columbia, June 1891, *Taylor* (UM); dry open woods in clayey soil northwest of Saluda, April 27, 1932, *Weatherby 6140* (NYB,USN,GH).

Georgia: Wrightsboro, *Chapman* (NYB); in open oak woods, Augusta, April 24, 1900, *Cuthbert 179* (NYB); dry open woods, Augusta, April 29, 1902, *Cuthbert* (UF); dry woods, Athens, April 1897, *Harper* (NYB); Winterville, April 22, 1925, *Maguire E3379* (UG); Oconee Heights, Clarke Co., April 25, 1923, *Miller E3383* (UG); Madison Springs, *Ravenel* (GH); Athens, April 15, 1910, *Rice & Rast E3391* (UG); in oak woods, head of Cloverhurst, Athens, April 25, 1928, *Reade E3381* (UG); oak woods, Experiment, April 25, 1899, *Riegel* (KA); "in montibus supra Casseville, Ga. sup., April 1845," *Rugel 190* (NYB); Tallapoosa, April & May, 1900, *Way 31* (USN,TYPE of *B. saligna* Greene); Royston, May 3, 1928, *Wherry* (NYB).

Alabama: dry cherty woods on south slope of Craig Mtn., Cherokee Co., June 22, 1936, *Harper 3528* (MBG,USN,NYB,GH); Talladega Mtns., June 26, 1911, *Howell 779* (USN).

15. B. leucophaea Nutt. Gen. N. Am. Pl. **1**: 282. 1818; DC. Prodr. **2**: 100. 1825, in part; Torr. & Gray, Fl. N. Am. **1**: 385. 1840, in part; Chapman, Fl. South. U. S. ed. 1, 112. 1860, ed. 2, 112. 1889, and ed. 3, 122. 1897, in part; Curt. Bot. Mag. III, **27**: *pl. 5900.* 1871; Small, Fl. Southeast. U. S., ed. 1, 601. 1903, and ed. 2, 601. 1913; Rydb. Fl. Prairies & Plains Central N. Am. 455. 1932.

B. bracteata (Muhl.) Ell. ex Britton & Brown, Illust. Fl. North. U. S., ed. 1, **2**: 266, *fig. 2052.* 1897, and ed. 2, **2**: 345, *fig. 2456.* 1913; Gray, New Man. Bot. ed. 7, 506. 1908.

Lasinia bracteata Raf. New Fl. N. Am. **2**: 50. 1836 [1837].

Plant 3–8 dm. high, tawny-villous to woolly-tomentose throughout; stems stout, heavily ribbed, simply branched, branches divaricate; leaves subsessile to short-petiolate, petioles not usually more than 3 mm. long; leaflets oblanceolate, spatulate, or narrowly elliptic, apex acute, slightly apiculate, rarely retuse, 3–10 cm. long, 1–2 cm. broad, leathery, strongly reticulate, lateral leaflets more or less decurrent on the petioles; stipules ovate- to cordate-lanceolate, acuminate, foliaceous, 2–4 cm. long, persistent; racemes axillary, 1–2 dm. long, secund, declined; floral bracts ovate- to cordate-lanceolate, acuminate, 1–3 cm. long, persistent; pedicels slender, 1–4 cm. long; calyx-tube 1 cm. deep, strigillose, upper lip slightly emarginate to distinctly two-lobed, lobes of the lower lip deltoid-lanceolate, 3–4 mm. long; corolla white, cream, or yellow, standard 2.2 cm. high, 2 cm. broad, wings and keel 2.4–2.7 cm. long; mature pod ovoid-elliptic, 4–5 cm. long, 1.5–2.5 cm.

broad, firm, strongly reticulate, densely spreading-pubescent, short-stipitate, stipe not exceeding the calyx, body tapering gradually into a short and slender beak.

Hybridizes with *B. viridis* in Louisiana, Arkansas, and Oklahoma; with *B. sphaerocarpa* in Arkansas and Oklahoma; and with *B. minor* in Missouri, Kansas, and Oklahoma.

Distribution: open woods and prairies, Michigan and Indiana to Minnesota, southwest to Arkansas and Texas. Introduced along railroads in Massachusetts.

CITATION OF SPECIMENS:

MASSACHUSETTS: by RR. between Woods Hole and Falmouth, July 1922, *Taylor* (ANSP).

MICHIGAN: prairie, Kalamazoo Co., Aug. 1, 1838, *Wright* (NYB).

INDIANA: RR., Benton Co., May 20, 1929, *Barce, Barce & Welch 6126* (IU); open black- and pin-oak woods 0.5 mi. west of Crisman, Porter Co., July 10, 1920, *Deam 31,562* (GH,IU); dry roadside about 4 mi. southwest of Crown Point, Lake Co., July 12, 1920, *Deam 31,625* (CD); open flat black oak woods about 4 mi. southwest of Lake Village, Newton Co., July 13, 1920, *Deam 31,683* (CD); frequent along RR. right-of-way 1 mi. south of Wanatah, LaPorte Co., *Deam 36,708* (CD); roadside knoll 3.5 mi. southwest of Lowell, Lake Co., June 5, 1924, *Deam 40,522* (CD); right-of-way of Monon RR., 4 mi. south of Medarysville, Pulaski Co., June 7, 1924, *Deam 40,570* (IU); common in sandy soil on RR. right-of-way about 3 mi. west of Monticello, White Co., May 22, 1932, *Deam 51,926* (IU); frequent, wooded promontory on high bank of the Wabash River at Black Rock, about 3.25 mi. southeast of Greenhill, Warren Co., May 29, 1933, *Deam 53,840* (IU); rare, Jasper Co., June 12, 1924, *Welch 5858* (IU).

KENTUCKY: open woods and prairies near Paducah, McCracken Co., June 17, 1920, *Palmer 17928* (MBG); dry bank between Murray and Pine Bluff Ferry, Callaway Co., July 23, 1937, *Smith & Hodgdon 4197* (USN, NYB).

WISCONSIN: St. Croix Falls, Aug. 20, 1900, *Baker* (GH); low ground, Arena, Iowa Co., June 15, 1929, *Breakey* (UW); no definite locality, *ex Herb. Chapman* (NYB); hillside, 1 mi. south of Milton, Rock Co., May 30, 1930, *Fernholz & Wadmond* (UW); Madison, May 23, 1891, *Cheney* (UW); Blue Mounds, May 30, 1894, *Cheney* (UW); Friendship, Adams Co., July 21, 1927, *Davis* (UW); prairie hillside, Battle Mtn., De Soto, Vernon Co., July 23, 1934, *Fassett 17792* (UW); open sand and pine barrens north of Angelo, Monroe Co., July 25, 1934, *Fassett 16468* (UW); prairie summit of Bogus Bluff, Gotham, Richland Co., Aug. 11, 1934, *Fassett 16641* (UW); sand bank near Rising Sun, 7 mi. north of Mt. Sterling, Crawford Co., Aug. 12, 1934, *Fassett 17790* (UW); RR., Bangor, La Crosse Co., Sept. 10, 1934, *Fassett 17791* (UW); gravel hill, Sheridan, Waupaca Co., Sept. 15, 1934, *Fassett 16541* (UW); sandy roadside near Lemonweir, 3 mi. southeast of Mauston, Juneau Co., Sept. 17, 1934, *Fassett 16540* (UW); prairie relic, 3 mi. south of Livingston, Grant Co., Sept. 23, 1934, *Fassett 17793* (UW); sandstone ledge near Highway K, 3 mi. south of Mt. Ida, Grant Co., Sept. 17, 1935, *Fassett 17794* (UW); in sand, Camp Douglas, Juneau Co., Oct. 7, 1934, *Fassett & Bushnell 16565* (UW);

prairie relic, roadside, County Trunk Highway B, east of Tunnel City, Monroe Co., Oct. 7, 1934, *Fassett & Bushnell 16729* (UW); dry soil, Necedah Mound, Necedah, Juneau Co., May 22, 1932, *Fassett & Drescher 14217* (UW); sand dunes, Waumandee Terrace, Fountain City, Buffalo Co., Aug. 25, 1927, *Fassett & Wilson 4365* (UW); river bank, Janesville, Rock Co., May 24, 1931, *Hagen* (UW); Madison, coll. of 1861, *Hale* (MBG,UW); prairie, June 16, 1883, *Hasse* (NYB); Boscobel, June 1884, *Hasse* (NYB); thinly oak-covered, morainic "island" west of University Creek bridge, University Bay, Madison, May 30, 1908, *Heddle 1095* (UW); RR., northwest of Black Earth, Dane Co., Aug. 3, 1916, *Heddle 2504* (UW); rich wooded hillside 1.5 mi. southeast of Ithaca, Richland Co., June 10, 1912, *Lansing 3442 (38455)* (UW); Milwaukee, *Lapham* (ANSP, UW); Beloit, June 1886, *Maxwell* (UW); sandy hillside, Leyden, Rock Co., May 30, 1928, *Mead* (UW); Kilbourn City, Columbia Co., June 10, 1901, *Meredith* (ANSP); Pine Bluff, Dane Co., May 28, 1929, *Oelmiller* (UW); La Crosse Co., July 16, 1887, *Pammel* (MBG); sandy soil, top of hill between Eau Claire and Chippewa Falls, July 9, 1915, *Rosendahl & Butters 3155* (UM); Poynette, June 6, 1890, *Russell* (UW); no definite locality, *ex Herb. Torrey* (NYB); Fairchild, Eau Claire Co., May 23, 1894, *Weinzirl* (UW).

ILLINOIS: Aurora, June 1881, *Bassett* (ANSP); prairies about Salem, May 1880, *Bebb* (ANSP); prairies north of Woodlawn, Jefferson Co., May 16, 1898, *Eggert* (MBG); dry soil along RR., Chillicothe, May 15, 1880, *Fisher* (KA); black oak association, Shirland, June 26, 1908, *Gleason* (GH); sand dunes, Bath, Aug. 14, 1913, *Gleason* (GH); prairies, Menard Co., 1861, *Hall* (USN); Troy Grove, June 3, 1893, *Hapeman* (UW); roadsides, Port Byron, June 22, 1892, *Harper* (UW); rare, dry prairies, Peoria, May 1894, *McDonald* (GH, NM); Augusta, April 1843 (1844–?), *Mead* (MBG,NYB,GH,ANSP); Romeo, May 9, 1896, *Merner 14864* (UW); rare, field south of Elmhurst, July, *Moffatt 148* (UM); uncommon, prairies near Chicago, Aug. 3, 1892, *Moffatt 646* (UW); sandy barrens near Oquawka, May 1875, *Patterson* (MBG,ND,UW); near Naperville, May 27, 1898, *Powell 17572* (UW); prairie, Kinkade's, Richland Co., Sept. 13, 1919, *Ridgway 909* (GH); prairies, Will Co., May 9, 1896, *Umbach* (MBG,ANSP,UM); prairies, Romeo, May 22 & July 26, 1897, *Umbach* (MBG,GH,UM); prairies, Lisle, May 19, 1900, *Umbach 11964* (UW).

MINNESOTA: St. Cloud, *Campbell* (ANSP); dry dunes, sand prairie, Weaver, Wabasha Co., Aug. 28, 1926, *Fassett & Hotchkiss 3436* (UM); dry soil, Winona Co., July 1886, *Holzinger* (UM); bluff slopes, Winona Co., June 1901, *Holzinger* (UM); Lake City, Sept. 1884, *Manning* (GH, UM); Spring Grove, June 3, 1902, *Rosendahl 289* (UM); Winnebago Valley, Houston Co., May 1901, *Wheeler 1034* (UM).

IOWA: prairie, Decatur Co., May 25, 1904, *Anderson* (MBG); Page Co., May 11, 1891, *Barkley* (MBG); dry prairies, Wesley, May 24, 1898, *Breithaupt 9286* (UW); low prairie, Black Hawk Co., June 6, 1929, *Burk 301* (MBG); along road to Moorland near Fort Dodge, Webster Co., May 29, 1904, *Churchill 2051* (UN); near Angus, Boone Co., May 19, 1904, *Churchill 2052a* (UN); near Carbon, Adams Co., May 23, 1905, *Churchill 2052b* (UN); dry prairie, Armstrong, Emmet Co., May 19, 1887, *Cratty* (MBG,USN); Vinton, *Davis* (UW); prairie, Fayette, May 14, 1894, *Fink* (GH, UM); Johnson Co., May 13, 1895, *Fitzpatrick & Fitzpatrick* (MBG); roadside west of Stockport, Van Buren Co., June 1924, *Graves 2114* (MBG); along RR., Cone City, Muscatine Co., May 1926, *Graves* (MBG); Elmyra, *Hitchcock* (MBG); Iowa City, June 22, 1889, *Hitchcock* (KA); Grinnell, May 21, 1877, *Jones* (ANSP); thickets and open ground above limestone bluffs of Mississippi River near Keokuk, Lee Co., May 20, 1929, *Palmer 35866* (OH); New Albin, July 22, 1897, *Pammel 590* (MBG,USN,GH); Ames, May 1903, *Pammel* (GH); Emmet Co., July 1926, *Pammel & Fisk* (MBG); Davenport, coll. of 1848, *Parry* (NYB); Fort Dodge, May 29, 1909, *Somes 3095* (USN).

MISSOURI: Sedalia, April 30, 1925, *Archias 3* (MBG); on prairie, Jackson Co., May 8, 1864, *ex Herb. Broadhead* (MBG); common, Montier, May 15, 1894, *Bush 73* (MBG,ND); introduced, uncommon, Courtney, Jackson Co., May 25, 1896, *Bush 304* (MBG); prairies, Pettis Co., May 7, 1935, *Bush 14763* (MBG); rocky woods, Eagle Rock, May 9, 1936, *Bush 15386* (MBG); hillsides, Grundy Co., May 10, 1936, *Bush 7* (MBG); hillsides, Grundy Co., May 10, 1936 *Cruikshanks 7* (MBG); dry prairies, La Grange Co., May 9, 1912, *Davis 1323* (MBG); dry open woods, McCune Station, Pike Co., May 20, 1919, *Davis 4401* (MBG,UM); Carson, Howell Co., June 27, 1878, *Eggert* (MBG); Kirkwood, St. Louis Co., May 12, 1879, *Eggert* (MBG); "in Waldern," St. Louis Co., May 16, 1879, *Eggert* (MBG); open places, St. Louis Co., May 16, 1879, *Eggert* (GH); Missouri RR., north of Webster, St. Louis Co., May 16, 1879, *Eggert* (MBG); South Webster, St. Louis Co., June 21, 1887, *Eggert* (MBG); St. Louis, May 1843, *Engelmann* (MBG); siliceous hills of Washington Co., Nov. 1845, *Engelmann* (MBG); Allenton, May 23, 1892, *ex Herb. Glatfelter* (MBG); south slope, Shepard Mtn., Arcadia, Iron Co., May 26, 1918, *Greenman 3888* (MBG); Windsor Springs, June 13, 1891, *Hitchcock* (MBG); St. Louis, May, *James in Long's Expedition* (NYB); Allenton, July 17, 1884, *Kellogg* (MBG); open woods near RR., east of Mansfield, Ozark Mtns., June 5–12, 1911, *Lansing 3196* (USN,GH); Allenton, *Letterman* (MBG); Allenton, St. Louis Co., Aug. 13, 1933, *Lodewyks 41* (MBG); common on prairie, Waldo Park, Jackson Co., May 2, 1897, *Mackenzie* (UM); common, prairies, Hickman's Mills, Jackson Co., May 14, 1899, *Mackenzie 13184* (UW); St. Louis, *Nuttall* (ANSP,TYPE); along RR. between Greentop and Sublette, Adair Co., May 16, 1938, *Ownbey & Ownbey* (MBG); common on prairie, Webb City, Jasper Co., May 7, 1902, *Palmer 128* (MBG); open ground near river, Monticello, Lewis Co., June 26, 1933, *Palmer & Steyermark 40679* (MBG); wet prairies, St. Louis, April 1842, *Riehl 342* (NYB); along Mo. South. RR., Reynolds Co., May 2, 1908, *Smith 274* (UW); prairie northeast of Springfield, Aug. 21, 1912, *Standley 9129* (USN); dry upland glade 2 mi. southeast of Osage Hills, St. Louis Co., May 5, 1928, *Steyermark 933* (MBG); natural prairie between Caplinger Mills and Stockton, about 3 mi. north of Stockton, Cedar Co., July 13, 1934, *Steyermark 13421* (MBG); Rose Hill, May 8, 1887, *Wislizenus 725* (MBG); Shepard Mtn., Ironton, May 9, 1925, *Woodson 324* (MBG); Greene Co., April 28, 1888, *Weller* (MBG).

ARKANSAS: Fort Smith, 1853-4, *Bigelow* (NYB,USN); glades Carroll Co., May 9, 1936, *Bush 15376* (MBG); wooded sandstone hillside, Boston Mtns., Cass, Franklin Co., April 25, 1935, *Fassett 17364* (UW); scarce, dry hillsides, Fayetteville, May, *Harvey* (UM); dry prairies and hills, northwest Arkansas, May, *Harvey 7* (NYB); rocky hillsides, base of Rich Mtn., Polk Co., April 28, 1935, *Lodewyks 203* (MBG); open rocky hillsides, Eureka Springs, Carroll Co., May 12, 1914, *Palmer 5563* (MBG,USN); rocky open ground, near Hot Springs, Garland Co., April 13, 1924, *Palmer 24494* (MBG); rocky open woods, Sugarloaf Mtn., near Midway, Sebastian Co., April 8, 1928, *Palmer 33276* (MBG); no definite locality, *Pitcher* (ANSP); Fayetteville, June 1925, *Watts* (UW).

NEBRASKA: near Lincoln, Lancaster Co., May 27, 1873, *Aughey* (UN); Lincoln, Lancaster Co., May 20, 1904, *Bates 3180* (GH,UM,UN); Valparaiso, Saunders Co., May 16, 1879, *Cleburne* (UN); prairies, Tecumseh, Johnson Co., May 1895, *Corson* (UN); frequent locally on prairie near Fremont, Dodge Co., May 1894, *Engberg* (UN); rich bottoms and upland prairies, Platte Valley 50 mi. above Monk, June 1857, *Hayden* (MBG); no definite locality, coll. of 1869, *Hayden* (ANSP); common on high prairie along RR., 5 mi. west of Lincoln, Lancaster Co., May 20, 1934, *Morrison 951* (MBG); Wahoo, Saunders Co., June 1890, *ex Herb. Rydberg* (UN); over whole prairie, flowering on south slope, May 12, 1927, *Steiger* (UN); Lincoln, Lancaster Co., May 1887, *Weber* (MBG,UN); Lincoln, Aug. 1898, *Williamson* (ANSP).

KANSAS: 1 mi. west of Pleasanton, May 14, 1929, *Anderson* (MBG); prairies, McPherson, June 1887, *Bodin* (UM); prairie, Greenwood Co., May 1, 1879, *Broadhead* (MBG); Lawrence, Douglas Co., May 19, 1892, *Carleton* (KA); Garrison, May 10, 1886, *Cleburne* (UN); Perry, Jefferson Co., Oct. 12, 1896, *Clothier* (KA); Marshall Co., July 25, 1897, *Clothier & Whitford* (KA); Atchison Co., Aug. 2, 1897, *Clothier & Whitford* (KA); Miami Co., Aug. 8, 1897, *Clothier & Whitford* (KA); Linn Co., Aug. 9, 1897, *Clothier & Whitford* (KA); Labette Co., Aug. 18, 1897, *Clothier & Whitford* (KA); Montgomery Co., Aug. 19, 1897, *Clothier & Whitford* (KA); Elk Co., Aug. 20 & 21, 1897, *Clothier & Whitford* (KA); Cowley Co., Aug. 22, 1897, *Clothier & Whitford* (KA); Sumner Co., Aug. 28, 1897, *Clothier & Whitford* (KA); Harvey Co., Aug. 24, 1897, *Clothier & Whitford* (KA); Sedgwick Co., Aug. 24, 1897, *Clothier & Whitford* (KA); Woodson Co., Aug. 29, 1897, *Clothier & Whitford* (KA); Coffey Co., Aug. 31, 1897, *Clothier & Whitford* (KA); Osage Co., Sept. 2, 1897, *Clothier & Whitford* (KA); near Valley Center, 1880, *Edmondson* (OU); Cloud Co., 1930, *Fraser 329* (UW, KA); Perley's Hill north of Emporia, May 9, 1891, *Gillett* (KA); Roper, Wilson Co., May 5, 1896, *Haller* (KA); abundant on sandy soil 2 mi. southwest of Iron Mound, Saline Co., April 19, 1930, *Hancin 156* (KA); hilltop near Manhattan, Riley Co., May 21, 1920, *Herr* (KA); Eureka, Greenwood Co., July 1892, *Hitchcock* (KA); White Water, Butler Co., July 1892, *Hitchcock* (KA); Olathe, Johnson Co., Aug. 1892, *Hitchcock* (KA); Chase Co., Aug. 1895, *Hitchcock* (KA); Marion Co., Aug. 1895, *Hitchcock* (KA); Cherokee Co., May 1896, *Hitchcock* (KA); Geary Co., June 1896, *Hitchcock* (KA); Allen Co., July 1896, *Hitchcock* (KA); Franklin Co., July 1896, *Hitchcock* (KA); Chautauqua Co., Aug. 8, 1896, *Hitchcock* (KA); Montgomery Co., Aug. 1896, *Hitchcock* (KA); Kingman Co., Aug. 23, 1898, *Hitchcock* (KA); Atchison Co., Oct. 3, 1896, *Hitchcock* (KA); Manhattan, Riley Co., May 10, 1888, *Kellerman* (MBG,KA); upland prairie west of Wabaunsee, Wabaunsee Co., April 29, 1927, *Maus 51* (KA); upland prairie north of Auburn, Shawnee Co., July 4, 1927, *Maus 843* (KA); Reno Co., 1898, *Murphy* (KA); near Altamont, Labette Co., May 11, 1924, *Nelson* (KA); White City, Morris Co., May 17, 1893, *Norton* (KA); prairie, Riley Co., June 17, 1895, *Norton 77* (MBG,KA,NM); Chapman Twp., Ottawa Co., May 17, 1888, *Panton 12* (KA); Topeka, Shawnee Co., May 5, 1879, *Popenoe* (KA); Arkansas City, 1881, *Price* (KA); Emporia, May 4, 1890, *Tyler* (MBG); near Eldorado, Butler Co., May 12, 1897, *Smith* (ANSP); Wichita, Sedgwick Co., May 1929, *Wellman* (UW); Cowley Co., April 1898, *White* (MBG,KA).

OKLAHOMA: rocky prairie, Wichita Nat. Forest, April 26, 1930, *Angst 1427* (UO); woods west of Tecumseh, May 2, 1932, *Barkley 136* (UO); dry upland 3 mi. east of Norman, April 22, 1928, *Barkley* (UO); prairie 2 mi. east of Norman, May 19, 1924, *Bruner* (UW,UO); 7 mi. northeast of Mangum, April 30, 1931, *Bull 110* (UO); common on prairies, Sapulpa, July 22, 1894, *Bush 59* (MBG); common, Sapulpa, May 4, 1895, *Bush 1115* (MBG,ND); without definite locality, 1877, *Butler* (MBG); wooded mountain side, north of Wilburton, Latimer Co., June 13, 1930, *Clark 2821* (UO); vicinity of Fort Sill, April 17, 1916, *Clemens 11622* (MBG); low hills, Asher, Pottawatomie Co., April 10, 1936, *Demaree 11970* (MBG); low clay hills, sandy ridges, Antlers, Choctaw Co., April 10, 1936, *Demaree 11995* (MBG,NYB); Norman, April 6, 1915, *Emig 437* (MBG); 6 mi. northwest of Stillwater, May 18, 1931, *Featherly* (MBG); prairie east of Boyd, May 14, 1927, *Fielder 59* (UO); wasteland near Atoka, April 6, 1928, *Folsum 65* (UO); common, gravelly hillsides near Tishomingo, Johnston Co., April 8, 1916, *Houghton 3603* (MBG); on roadsides and in pastures, Norman, Cleveland Co., April 24, 1917, *Jeffs* (UO); prairie, northeast of Oklahoma City, April 29, 1928, *Johnston* (UO); vicinity of Fort Tawson, Choctaw Co., May, *Leavenworth* (NYB); Muskogee Co., April 10, 1927, *Little 1257* (UO); Stillwater, May 1, 1897, *Myers* (OU); open woods at Interstate Bridge, southern Oklahoma, April 11, 1928, *Nelson 10817* (MBG); chiefly on the False Washita River between Fort Cobb and Fort Arbuckle, coll. of 1868, *Palmer 119* (NYB); open woods on mountain side near Page, LeFlore Co., Sept. 9, 1913, *Stevens 2762* (UM).

TEXAS: near Lyons, Burleson Co., Mar. 1927, *Martin 7242* (UT); Bonham, April 13, 1896, *Milligan* (USN); Denison, Grayson Co., April 10, 1933, *Polson 14* (UT); no definite locality, coll. of 1839, *Mohr* (USN); prairies, Paris, April 10, 1904, *Reverchon* (MBG); no definite locality, *Wright* (ANSP).

SOUTH DAKOTA (?): no definite locality, coll. of 1865, *ex Herb. Glatfelter* (MBG).

16. B. leucophaea Nutt. var. **glabrescens** Larisey, var. nov.[26]

As the species except less pubescent throughout, and stem glabrous.

Distribution: prairies and rocky open woods, Wisconsin, southwest to Louisiana and Texas.

CITATION OF SPECIMENS:

LOUISIANA: prairies, Crowley, Mar. 24, 1908, *Brainerd* (GH); prairie, Minden, April 15, 1901, *Trelease* (MBG); open woods near Chestnut, Natchitoches Parish, April 19, 1934, *Wherry* (UP).

WISCONSIN: valley of the Wisconsin River, near Pedanwell Rock, Juneau Co., July 18, 1894, *Cheney* (UW); sand at foot of Trempealeau Mtn., Trempealeau Co., June 1, 1935, *Fassett & Hansen 17368* (UW); roadside, Fall Creek, Eau Claire Co., June 15, 1928, *Kunz 102* (UW); Camp Douglas, July 7, 1890, *Mearns 225* (USN).

MISSOURI: Rolla, April 28, 1915, *Bridge* (LB); woods, Grandin, May 8, 1905, *Bush 2755* (MBG); open woods, Pontiac, April 24, 1934, *Bush 13304* (MBG);

[26] Ab specie differt omnino minore pubescentia et caule glabro.

wooded hills, Lane's Prairie, May 8, 1934, *Bush 13469* (MBG); Potosi, June 3, 1892, *Dewart* (MBG); Victoria, July 1, 1871, *Douglass* (MBG); Ironton, May 12, 1893, *Eggert* (MBG); Allenton, May 2, 1896, *Eggert* (MBG,NYB); Meramec Highlands, 1905, *ex Herb. Glatfelter* (MBG); near Arcadia, Iron Co., May 1925, *Greenman 4780* (MBG); Victoria, April 10, coll. of 1890, *Hitchcock* (MBG); Iron Mountain Lake, Iron Co., May 13, 1928, *Kellogg 1798* (MBG); Pilot Knob, Iron Co., May 10, 1936, *Larisey 4* (MBG,TYPE); flinty hill, Allenton, May 15, 1898, *Letterman* (MBG,USN); Jefferson Co., May 2, 1926, *Mathias 833* (MBG); dry upland soil, about 3 mi. south of Catawissa, Franklin Co., May 12, 1929, *Steyermark 886* (MBG); upland cherty woods above limestone bluffs along Big Piney River, near Hooker, Pulaski Co., May 4, 1934, *Steyermark 8059* (MBG); prairie opening along RR. between Versailles and Stover, Morgan Co., July 8, 1934, *Steyermark 13213* (MBG); cherty upland woods 3 mi. south of Corkery, Dallas Co., July 20, 1934, *Steyermark 13799* (MBG).

ARKANSAS: woods, Fulton, April 14, 1905, *Bush 2321* (MBG); rocky woods, Marion Co., April 24, 1934, *Bush 13334* (MBG); dry woods near Eureka Springs, May 8, 1902, *Canby, Sargent & Bush 27* (GH); on Grand Prairie about 0.5 mi. west of Screeton Prairie Co., May 1, 1923, *Harper 27* (USN,GH,NYB,ANSP); on roadside 3 mi. east of Logan Gap Road on Highway 270, Montgomery Co., April 27, 1935, *Lodewyks 174* (MBG); rocky ground, foot of Maumelle Mtn., near Pinnacle Station, Pulaski Co., June 1, 1923, *Palmer 23012* (MBG); rocky open ground near High Point, Garland Co., April 25, 1924, *Palmer 24547* (MBG); Judsonia, April 30, 1877, *Reynolds* (OU); on clay hills, Hot Springs, July 10, 1931, *Runyon 1465* (USN).

OKLAHOMA: low hills by Big Taxodium, Broken Bow, McCurtain Co., April 11, 1936, *Demaree 12061* (NYB); prairie near Ardmore, Carter Co., *Stevens 74* (MBG).

TEXAS: Fannin Co., *Milligan* (NM); Goliad, Feb. 1927, *Williams 7* (ANSP).

17. B. laevicaulis (Gray) Small in Bull. Torr. Bot. Club **25**: 134. 1895; Small, Fl. Southeast. U. S., ed. 1, 601. 1903, and ed. 2, 601. 1913; Cocks, The Leguminosae of Louisiana. La. State Mus. Nat. Hist. Surv. Bull. 1: 6, *pl. 7*. 1910.

B. leucophaea Nutt. var. *laevicaulis* Gray in Hall's Pl. Texas, 7. 1873, *nomen nudum;* Canby in Bot. Gaz. **4**: 132. 1879.

B. oxyphylla Greene, Leaflets Bot. Obs. **2**: 84. 1910.

Plant 3–7 dm. high, darkening in drying, tawny-pubescent to villous in parts; stem stout, ribbed, glabrous, widely subdichotomously branched, branches divaricate; leaves subsessile to short-petiolate, petioles stout, channelled, semiamplexicaul, 2–4 mm. long, leaflets obovate to rhombic, strongly cuneate, apex acute, mucronate, 4–7 cm. long, 2–3.5 cm. broad, firm, finely reticulate, glabrous on both surfaces, ciliate along the margins and midvein, lateral leaflets more or less decurrent along the petiole; stipules ovate-lanceolate, acuminate, 1–3.5 cm. long, reticulate, ciliate along the margins, persistent; racemes axillary, 1–2.5 dm. long, secund, declined; floral bracts ovate- to cordate-lanceolate, 1–2.5 cm. long, reticulate, ciliate along the margins, persistent; pedicels slender, 1.5–3.5 cm. long; calyx-tube 1 cm. deep, glabrate within, densely ciliate along the margins, strongly nerved, upper lip distinctly two-lobed, lobes of the lower lip lanceolate-acuminate, 4–5 mm. long; corolla cream or yellow, standard suborbicular, deeply emarginate, 2 cm. high, 2 cm. broad, wings and keel 2.2–2.4 cm. long; ovary densely villous, mature pod ovoid-elliptic, inflated, 3–4 cm. long, 1.5–2.5 cm. broad, brownish-black, strongly reticulate, more or less appressed pubescent, long-stipitate, stipe exceeding the calyx 3–4 mm., body tapering gradually into a slender beak.

Distribution: prairies, Louisiana and Texas.

Citation of Specimens:

Louisiana: longleaf-slash pine flat woods east of Hammond, Tangipohoa Parish, April 22, 1934, *Brown 3956* (LU); pine woods, St. Helena Parish, April 24, 1934, *Brown 5206* (LU); pine flat woods east of Hammond, Tangipohoa Parish, June 2, 1935, *Brown 6345* (LU); cut-over longleaf pine hills north of Montpelier, St. Helena Parish, April 3, 1936, *Brown 6192* (LU); pine-hardwood ridge in prairie area north of Crowley, Acadia Parish, April 26, 1936, *Brown 6272* (LU); prairie along RR., west of Crowley, Acadia Parish, April 26, 1936, *Brown 6282* (LU); prairie along RR., Esterwood, Acadia Parish, April 26, 1936, *Brown 6291* (LU); common on "Hallaway" prairie near Hallaway Church east of Pineville, Rapides Parish, June 23, 1936, *Brown 6433* (LU); Pearl River, Oct. 1901, *Cocks* (NYB, type of *B. oxyphylla* Greene, (ND); open fields, Bayou LaCombe, April 1909, *Cocks 1790a* (TU); cleared pine woods, Bayou LaCombe, April 2, 1910, *Cocks 1790b* (NYB); prairies, Crowley, April 2, 1911, *Cocks* (TU); pine barrens, Covington, April 1913, *Cocks* (TU); no definite locality, *Hale* (ANSP); no definite locality, *Hale 210* (NYB,type); close soil, Alexandria, *Hale* (GH); in prairies, Opelousas, April 1880, *Langlois* (NYB); in prairies, Calcasieu, April 25, 1884, *Langlois* (NYB); in plains, Calcasieu Co., fl. April 26, 1884, *Langlois* (NYB); Chataignier, fr. May 20, 1884, *Langlois 4* (NYB); in plains, Chataignier, St. Landry Co., May 20, 1885, *Langlois 5* (NYB); in prairie, "Fakataite," near Chataignier, June 21, 1885; *Langlois* (NYB); in pine woods near St. Martinsville, May 1, 1893, *Langlois* (UM); low prairies, Jennings, Jefferson Davis Parish, May 15, 1915, *Palmer 7614* (MBG,USN,ANSP); sandy soil, roadsides, and cut-over pine land, 2 mi. north of Tioga, Rapides Parish, April 6, 1935, *Smith 97* (LU).

Texas: Colorado River, April 1828 (1849–?), *Berlandier 289* (MBG,USN,NYB, UW); Virginia Point, April 15, 1899, *Bray 22* (USN,UT); common on prairies, Columbia, April 9, 1899, *Bush 67* (MBG); Fayette Co., 1892, *Crawford 29* (USN); on Carizo sands, Terrell land, Wilson Co., Mar. 25, 1937, *Cutler* (MBG); occasional on sand, 4 mi. south of Bandera, Bandera Co., Mar. 26, 1937, *Cutler 881* (MBG); sand hills north of Longview, Gregg Co., April 19, 1899, *Eggert* (MBG); prairies north of Houston, Harris Co., April 21, 1899, *Eggert* (MBG); Houston, April 24, 1937, *Fisher 37267* (USN); wet prairies, Houston, April 10, 1872, *Hall 161* (MBG, USN,GH,NYB); Beaumont, May 1, 1936, *Hooks* (UT); Brenham, May 21, 1934, *Lehman* (UT); prairies west of Brazos, April 1939, *Lindheimer* (MBG); prairies northwest of Houston, May 19, 1840, *Lindheimer 51* (MBG); near Houston, April 1842, *Lindheimer* (MBG,GH); no definite locality, *Lindheimer & Buckley* (ANSP); Victoria, Victoria Co., Mar. 30, 1905, *Lewton 73* (USN); Victoria, April 28, 1905, *Maxon 3812* (USN); prairies of the Rio Grande, *Meyer 7844* (NYB); sandy prairies, Columbia, Brazoria Co., Mar. 24, 1914, *Palmer 5001* (MBG); prairies, Ganado, Jackson Co., Mar. 6, 1916, *Palmer 9072* (MBG); prairies near Houston, Harris Co., April 15, 1928, *Palmer 33316* (MBG,GH); 20 mi. east of Houston, May 10, 1936, *Penfound 1–16* (UT); common in sand, Big Sandy, May 27, 1901, *Reverchon* (MBG); near Houston, May 6, 1899, *Rose 4192* (USN,GH,NYB); San Marcos and vicinity, *Stanfield* (NYB); Hallettsville, June 11, 1923, *Tharp 2295* (USN,UT); sandy oak woods, Goliad, July 1, 1925, *Tharp 3504* (USN,UT); Lovelady, April 20, 1933, *Tharp* (UT); dry sandy soil near Hearne, Robertson Co., Mar. 28, 1930, *Wolff 1385* (USN); no definite locality, *Wright* (GH).

18. **B. cuneata** Small in Bull. Torr. Bot. Club **25**: 139. 1898; Small, Fl. Southeast. U. S., ed. 1, 601. 1903, and ed. 2, 601. 1913.

Plant essentially glabrous, leaf margins slightly pubescent in bud; stem firm, ribbed, sparingly branched, branches subdichotomous, ascending; leaves subsessile, occasionally short-petiolate, petioles 2–4 mm. long, leaflets obovate, cuneate, mucronate, 3–6 cm. long, 2.5–3.5 cm. broad, leathery, barely reticulated, glabrous, slightly discolored in drying; stipules lanceolate to ovate-lanceolate, 0.5–1 cm. long, persistent; racemes 1 dm. long, opposite the branches, erect; floral bracts lanceolate to ovate-lanceolate, acuminate, 1–2 cm. long, lowermost sometimes 3 cm. long, usually persistent; pedicels slender, 1.5–2.5 cm. long, 3.5 cm. long in fruit; calyx-tube reticulate, 1 cm. deep, 8–9 mm. wide, only slightly pubescent within, upper lip emarginate, lobes separating widely at shallow cleft, lobes of the lower lip ovate, acute, 4–5 mm. deep; corolla pale cream, standard deeply notched, 2 cm. high, 2 cm. broad, wings and keel 2–2.2 cm. high; ovary glabrous, occasionally ciliate along sutures; pods ovoid-elliptic, 2 cm. long, 1.3 cm. broad, brownish-black, firm, rugose, pubescent within, long stipitate, stipe 1.3 cm. long, abruptly long-beaked, beak 1.8 cm. long.

Distribution: in sand near the coast, Texas.

CITATION OF SPECIMENS:

TEXAS: "Las Animas de Matamoros al Rio de las Neueces," April 1834, *Berlandier 2554* (GH,NYB,ANSP); Victoria, April 6, 1900, *Eggert* (MBG); along Neueces Bay, Neueces Co., April 3, 1894, *Heller 1523* (NYB,TYPE, MBG,USN,GH, ANSP,OU,UN); sandy hills below Sarito, May 14, 1928, *Tharp 5963* (USN,UT); Redfish Bay, Mar. 5, 1934, *Tharp* (UT); Katherine, Mar. 25, 1907, *York* (UT).

19. × **B. intermedia** Larisey, hyb. nov.[27]

= *B. leucophaea* var. *glabrescens* × *B. viridis.*

Plant 0.5–1 m. high, tawny-, or occasionally whitish-pubescent throughout, darkening slightly in drying; stem somewhat stout, firm, heavily ribbed, pubescent when young, glabrate in age, primary stem geniculate, simply but widely branched, branches ascending; leaves compound, short-petiolate, petioles stout, semiamplexicaul, channeled, 2–5 mm. long; leaflets spatulate-elliptic to oblanceolate, occasionally rhombic-cuneate, acute, rarely retuse at the apex, somewhat delicate but firm, reticulate, pubescent above and below when young, glabrate in age, frequently ciliate along the margins and midvein, 5–7 cm. long, 1.5–2.5 cm. broad; stipules ovate, cordate-lanceolate to lanceolate, reticulate, 0.5–1.2 cm. long, usually persistent; racemes axillary, compact, erect, slightly flexuous, 1–3 dm. long; flowers numerous, closely spaced, ascending; floral bracts ovate- to cordate-lanceolate, reticulate, 0.8–1.5 cm. long, persistent; pedicels slender, 0.5–1 cm. long; calyx-tube 0.8–1 cm. deep, upper lip entire, barely cleft to slightly emarginate, lobes of the lower lip lanceolate, 4–5 mm. long; corolla yellow, standard 1.6–1.8 cm. high, 1.4–1.6 cm. broad, wings and keel 2–2.2 cm. long; ovary densely pubescent, mature pod unknown.

Distribution: prairies, Louisiana and Texas.

CITATION OF SPECIMENS:

LOUISIANA: pine-hardwood ridge in prairie area north of Crowley, Acadia Parish, April 26, 1936, *Brown 6273* (LU); prairie west of Crowley, Acadia Parish, April 26, 1936, *Brown 6276* (LU); prairies, Lake Charles, April 1914, *Cocks* (TU); no definite locality, May, *Hale 309* (ANSP); prairie about 1 mi. west of Crowley, Acadia Parish, April 7, 1936, *Harper 3476* (MBG,TYPE, USN,GH,NYB,ANSP).

TEXAS: Rosenberg, April 5, 1900, *Eggert* (MBG); Houston, April 2, 1930, *Fisher 71* (USN).

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[27] Inter *leucophaeam* et *viridem* media. Herba 0.5–1.0 m. alta, ramis ascendentibus. Folia composita, foliolis elliptico-spatulatis vel oblanceolatis fere rhombo-cuneatis apice acutis raro retusis. Racemi axillares erecti paulo flexuosi.

20. × **B. stricta** Larisey, hyb. nov.[28]

= *B. leucophaea* × *B. sphaerocarpa.*

B. villosa Nutt. ex Britton & Brown, Illust. Fl. North. U. S., ed. 1, **2**: 266, *fig. 2051.* 1897, in part, and ed. 2, **2**: 345, *fig. 2455.* 1913, in part; Gray, New Man. Bot., ed. 7, 506. 1908, in part.

Plant finely tawny-villous throughout, darkening into deep brown or black in drying; stem erect, simply branched, branches ascending; leaves subsessile to short-petiolate, petioles 1–2 mm. long; leaflets oblanceolate-elliptic, apex rounded, only rarely retuse, 4–7 cm. long, 1–2 cm. broad, lateral leaflets usually converging; stipules ovate-lanceolate, acuminate, usually 1–2 cm. long, sometimes less, horizontal or pendulous, usually persistent; racemes opposite the branches, erect, compact, 1–2 dm. long, flowers ascending, slender pedicels closely appressed to axis, 1–2.5 cm. long; calyx-tube 0.8–1 cm. deep, upper lip barely cleft, lobes of the lower lip lanceolate, 3–4 mm. deep; floral bracts persistent, lowermost sometimes foliaceous, ovate-acuminate, 1–1.5 cm. long, uppermost lanceolate, usually less than 1 cm. long; corolla yellow, standard 1.5 cm. long, wings on keel 2 cm. long; ovary densely villous, mature pod unknown.

Distribution: prairies, Arkansas and Oklahoma.

CITATION OF SPECIMENS:

ARKANSAS: Baker Springs, Howard Co., April 22, 1909, *Kellogg* (MBG); no definite locality, *Nuttall* (ANSP, TYPE, NYB); 3 mi. north of Kirby, April 14, 1932, *Wilkins 1417* (USN).

OKLAHOMA: prairies, Bryan Co., April 21, 1932, *Blain 238* (USN); prairie, 10 mi. north of Limestone Gap, May 18, 1877, *Butler* (MBG).

21. B. Bushii Small, Fl. Southeast. U. S., 600, 1331. 1903, and ed. 2, 600. 1913.

Plant 5–7 dm. high, more or less woolly-tomentose throughout; stem stout, ribbed, diffusely branched, branches subdichotomous; leaves sessile to short-petiolate, petioles less than 3 mm. long, pale green, leaflets sessile, blades thick, oblanceolate to rhombodial, cuneate, acute or obtuse, 3–6 cm. long, 1.5–2.5

[28] Inter *leucophaeam* et *sphaerocarpam* media; foliolae oblanceolato-ellipticae apice rotundatae raro retusae; racemi axillares non secundi, flores erecti; corolla flava.

cm. wide, finely reticulate; stipules ovate-lanceolate to lanceolate, 0.5–2 cm. long, persistent; racemes numerous, axillary, 1–2 dm. long, secund, somewhat flexuous, ascending; floral bracts ovate to ovate-lanceolate, 1–2 cm. long, persistent; pedicels slender, 0.5–3 cm. long; calyx-tube 1 cm. deep, upper lip entire, subconnate or emarginate, lobes of the lower lip deltoid-lanceolate, 2–3 mm. long; corolla cream-yellow, standard 1.8–2 cm. high, 1.4–1.6 cm. broad, wings and keel 2.2–2.4 cm. long; ovary villous, mature pod ligneous, ovoid, inflated, 2 cm. long, 1.5 cm. broad, strigillose, rugose, somewhat reticulate, stipe equalling the length of the calyx, long-beaked, beak equalling the length of the body.

Distribution: prairies, eastern Texas.

Citation of Specimens:

Texas: common on prairie, Columbia, April 9, 1899, *Bush 68* (NYB,type, MBG, USN,GH,ND); Boca Chica, Cameron Co., Mar. 31, 1933, *Clover 769* (NYB); "Rio Brazos," 1833, *Drummond* (GH); Sutherland Springs, April 2, 1932, *Jones 29325* (MBG); on flats by Gulf of Mexico near Corpus Christi, April 6, 1932, *McKelvey 1743* (USN,GH); Aransas Pass, San Patricio Co., May 1913, *Orcutt 5963* (MBG); Galveston, April 18, 1906, *Tracy 9346* (MBG,USN,GH,NYB,UP,UM,UW,UN,UT).

22. B. alba (L.) Vent. Dec. Gen. Nov. 9. 1808, without description; R. Br. in Ait. Hort. Kew. ed. 2, **3**: 6. 1811, with description; Ell. Sketch Bot. S. Car. & Ga. **1**: 468. 1821; DC. Prodr. **2**: 100. 1825; Torr. & Gray, Fl. N. Am. **1**: 386. 1840; Chapman, Fl. South. U. S., ed. 1, 112. 1860, ed. 2, 112. 1889, and ed. 3, 122. 1897; Britton & Brown, Illust. Fl. North. U. S., ed. 1, **2**: 267, *fig. 2053*. 1897, in part, and ed. 2, **2**: 346, *fig. 2457*. 1913, in part; Small, Fl. Southeast. U. S., ed. 1, 600. 1903, and ed. 2, 600. 1913; Gray, New Man. Bot., ed. 7, 506. 1908; Small, Man. Southeast. Fl. 677. 1933.

B. albiflora Raf. New Fl. N. Am. **2**: 47. 1836 [1837].

Crotalaria alba L. Sp. Pl. **2**: 716. 1753.

Sophora alba L. Syst. Nat., ed. 12, **2**: 287. 1767; Syst. Veg., ed. 13, 325. 1774.

Podalyria alba Willd. in L. Sp. Pl., ed. 4, **2**: 503. 1799.

Plant 2 m. or less high, virtually glabrous, occasionally sparingly pubescent in parts; stem slender, dull yellow to purplish-brown in age, somewhat glaucous, subdichotomously branched, branches geniculate, divaricate, lower ones frequently declined; leaves petiolate, petioles 0.4–1.2 cm. (average 0.5–0.8 cm.) long, occasionally slightly pubescent, leaflets spatulate-oblanceolate to obovate, cuneate, apex usually rounded, slightly apiculate or retuse, rarely acute, 2–3 cm. long, 0.8–1.0 cm. wide, glabrous and glaucous beneath; stipules minute, deltoid-lanceolate to setaceous, mostly caducous; racemes 2.5–5 dm. (average 4 dm.) long, flowers subverticillate; floral bracts oblanceolate, 5–7 mm. long, sometimes ciliate at margins, caducous; pedicels usually shorter than the calyx, 2–4 mm. long, though at times twice as long as the calyx, 0.8–1 cm. long; calyx-tube 4–5 mm. deep, usually as wide as deep, upper lip entire, lobes of lower lip deltoid to broadly ovate, 1.5–2.5 mm. long; corolla white, standard sometimes splotched with purple, reflexed, 1–1.2 cm. high, 1.1–1.3 cm. wide, wings and keel less than 1.5 cm. long; fruit cylindrical, inflated, dusky brown, 2.5–3 cm. long, 0.5–1 cm. broad, long-stipitate, stipe 0.8–1 cm. long, abruptly short-beaked.

Hybridizes with *B. tinctoria* var. *crebra* in eastern Virginia.

Distribution: dry sandy pinelands, eastern Virginia south to Florida.

Citation of Specimens:

Virginia: Accomac, Aug. 1923, *Jones* (UP); in open stand of *Pinus Taeda*, 3.5 mi. north of Accomac, Accomac Co., June 29, 1928, *Jones* (MBG); in dry sandy field north of Accomac, Accomac Co., May 19, 1930, *Moldenke 1253* (MBG, NYB,UP,DU); open pine woods 4 mi. north of Accomac, Accomac Co., May 31, 1937, *Tatnall 3363* (ANSP); sandy soil in open pine woods 4 mi. north of Accomac, Accomac Co., June 29, 1928, *True* (UP).

North Carolina: Guilford, July 1895, *Ashe* (MBG); Asheboro, June 1898, *Ashe* (FM); Statesville, June 6, 1879, *Gray, Sargent, Redfield & Canby* (ANSP); woods, Statesville, June 6, 1879, *Redfield 11701* (MBG); Statesville, June 1878, *Hyams* (USN).

South Carolina: sand dunes, southern border of Williamsburg Co., May 21, 1930, *Bright 2955* (ANSP); Aiken, May 1869, *Canby* (MBG,USN,GH,NYB,ANSP, FM); Columbia, May 9, 1899, *Canby & Sargent 19* (GH); Aiken, May 1888, *Darlington* (FM); Anderson Co., 1885, *Gibbes* (NYB); woods near Clemson, Pickens Co., May 18, 1907, *House 3359* (NYB); vicinity of Columbia, May 1888, *McCarthy* (USN); Columbia, June 4–7, 1894, *MacFarlane* (UP); Aiken, April 1871, *Smith* (UP); dry pine woods, Columbia, April 1890, *Taylor* (FM); dry sandy open longleaf pine woods near North, Orangeburg Co., April 26, 1932, *Weatherby 6111* (USN,GH,NYB).

Georgia: Augusta, *Curtis* (ANSP); Augusta, June 1894, *MacFarlane & Davis*

(UP); dry sandy field south of Kingsland, Camden Co., May 12, 1930, *Moldenke 1179A* (NYB,UP); middle Ga., May 6, 1846, *ex Herb. Porter* (ANSP); dry sandhills 3 mi. east of Butler, Taylor Co., April 30, 1938, *Pyron & McVaugh 2799* (MBG); dry roadside 1.25 mi. north of Cleveland, White Co., May 14, 1938, *Pyron & McVaugh 2883* (MBG); Ocmulgee River Swamp below Macon, May 18–24, 1895, *Small* (NYB).

FLORIDA: no definite locality, coll. of 1846, *Chapman* (MBG); Quincy, *Chapman* (MBG); Gadsden Co., coll. of 1889, *Chapman* (MBG,USN); no definite locality, *Chapman* (NYB,UW); "in pinetis, prope Quincy," May 1843, *Rugel* (NYB); pinelands near Wewahitchka, May 7, 1926, *Small, Mosier & Matthaus* (NYB); field, Quincy, April 19, 1930, *Tisdale & West* (MBG).

23. B. albescens Small, Fl. Southeast. U. S., ed. 1, 600, 1331. 1903, and ed. 2, 600. 1913; Small, Man. Southeast. Fl. 677. 1933.

Plant 1 m. or less high, slightly pubescent throughout, frequently glabrate in age; stem slender, firm, lemon through deep yellow to tan in age, glaucous, subdichotomously branched, inner branches ascending, outer sometimes widely spreading; leaves petiolate, petioles slender, 0.5–1.8 cm. (average 1.2–1.5 cm.) long, pubescent; leaflets elliptic to obovate, sometimes slightly cuneate, rounded and slightly retuse at the apex, or acute and finely mucronate, 3.5–6 cm. long, 1–1.5 cm. broad, pubescent on lower surface especially along the midrib, usually glabrous above; stipules minute, deltoid, subulate to setaceous, caducous, or lanceolate, 5 mm. long, persistent; raceme 1.5–4 dm. (average 2.5 dm.) long, flowers subverticillate; floral bracts oblanceolate, 5–7 mm. long, ciliate, caducous; pedicels rarely longer than the calyx, 5–6 mm. long; calyx-tube 5–6 mm. deep, upper lip entire or slightly emarginate, lobes of the lower lip deltoid 1.5–2 mm. long; corolla white, standard not conspicuously reflexed, 1.3–1.5 cm. high, 1.5–1.8 cm. wide, wings and keel usually more than 1.5 cm. high, exceeding the standard by about 2 mm.; mature pod cylindical, inflated, 3.5 cm. long, 1 cm. broad, yellow-brown, reticulate, short-stipitate, stipe barely exceeding the calyx.

Hybridizes with *B. perfoliata* in Georgia.

Distribution: sandy pine woods, North Carolina and Tennessee, south to Georgia.

CITATION OF SPECIMENS:

NORTH CAROLINA: no definite locality, *Curtis* (NYB); roadside, Mayodan, June 3, 1928, *Schallert 8456* (DU); Flat Rock, coll. of 1861, *ex Herb. Gibbes* (NYB).

SOUTH CAROLINA: Oconee Co., May 27, 1897, *Anderson* (UM); no definite locality, *Backman* (ANSP); Columbia, May 16, 1912, *Bartram* (NYB); sandy barrens, S. Williamsburg Co., May 21, 1931, *Bright 2953* (GH); pine barrens, Summerville, May 1892, *Brownfield 643* (UW); "in umbrosis humidis," *Elliott* (CM); open pine woods, Summerville, May 22, 1855, *ex Herb. Hexamer & Maier* (GH); sandy hillside near Black Creek between Hartsville and Dovesville, about 5 mi. from Hartsville, June 7, 1921, *Norton* (USN); Summerville, April 29–May 10, 1918, *Perkins* (GH); Santee Canal, May, *Ravenel* (GH,CM); Batesburg, May 22, 1911, *McGregor 656* (USN); Summerville, *Taylor* (USN); pine woods, Summerville, June 1891, *Taylor* (UM); Seneca, Oconee Co., May 1879, *Trelease* (MBG).

GEORGIA: pine barren, Thomson, McDuffie Co., June 15, 1911, *Bartlett 2651* (KA); no definite locality, *Boykin* (ANSP); wooded hillsides in good soil, Augusta, May 15, 1900, *Cuthbert* (NYB); no definite locality, *LeConte* (NYB); Macon, *Loomis* (NYB); near Butler, Taylor Co., *Neisler* (NYB).

TENNESSEE: Polk Co., May 15, 1892, *Ruth* (OU); open woods, Knoxville, May 1897, *Ruth 2217* (NYB,TYPE); thickets, Thompson's, E. Tenn., May 1897, *Ruth* (OU); woodlands, Hiawassee Valley, May 1898, *Ruth* (MBG,NYB,ND).

24. B. pendula Larisey, sp. nov.[29]

Height unknown; plant glabrous, somewhat glaucous throughout; stem firm, slender, subdichotomously branched, branches strongly geniculate, spreading, declined; leaves petiolate, petioles 0.8–1.3 cm. long; leaflets elliptic, frequently oblanceolate when young, sometimes slightly cuneate, 4–6 cm. long, 1–2 cm. wide, acute, rarely rounded at apex except occasionally in age, never retuse, margins revolute, texture firm, primary vein deeply impressed, secondary veins regularly placed, nearly parallel, area bordering them usually remaining conspicuously pale; stipules subulate to setaceous, seldom ex-

[29]Herba omnino glabra sat glauca altitudine ignota. Caulis graciliusculus firmus subdichotome ramosus; ramis valde geniculatis patulis. Folia petiolata, petiolis 8–13 mm. longis; foliolis ellipticis vel immaturitate saepe oblanceolatis apice acutis raro rotundatis haud retusis basi cuneatis 4–6 cm. longis 1–2 cm. latis firmiter membranaceis margine post exsiccationem revolutis, nervo medio profunde impresso venis secundariis regulariter parallelis parenchymate prope nervum venosque post exsiccationem pallidissimo haud nigrescente, stipulis subulatis vel setaceis ca. 3 mm. longis saepissime caducis. Racemi numerosi erecti compacti folia vix superantes 1.5–2.5 cm. longi, bracteis caducis, pedicellis 4–7 mm. longis. Flores subverticillati, calycis tubo 6–8 mm. longo, labro superiore ovato-rotundato vel truncato vel vix emarginato tubum ca. dimidio aequante, labri inferioris lobis deltoideis 2–3 mm. longis, corollae albidae (?) vexillo 1.5 cm. longo 1.2 cm. lato, alis carinaque 1.7–2.0 cm. longis. Legumen pendulum breviter stipitatum oblongoideum valde inflatum 4.0–4.5 cm. longum 1.5–2.0 cm. latum abrupte breviterque sed anguste rostratum (rostro ca. 5 mm. longo) nigro-pruinosum firmum sed tenue et fragile indistincte reticulatum, stipite calycem vix superante.

ceeding 3 mm. in length, mostly caducous; racemes numerous, erect, barely exceeding the foliage, compact, 1.5–2.5 dm. long; flowers subverticillate, floral bracts caducous; pedicels 4–7 mm. long; calyx-tube 6–8 mm. deep, upper lip ovate, rounded to slightly truncate or barely emarginate, one-half the length of the tube, lobes of the lower lip deltoid, 2–3 mm. long; corolla white (?), standard 1.5 cm. high, 1.2 cm. broad, wings and keel 1.7–2 cm. long; mature pod pendulous, short-stipitate, stipe barely exceeding the calyx, body oblongoid, much inflated, black, pruinose, firm but thin and brittle, lightly reticulate, 4–4.5 cm. long, 1.5–2 cm. broad, abruptly short- but slender-beaked, beak 5 mm. long.

Distribution: dry open pine woods and upland sand ridges, lower South Carolina, Georgia and upper Florida.

Citation of Specimens:

South Carolina: Bluffton, June 1879, *Mellichamp* (GH); Bluffton, Beaufort Co., Aug. 1879, *Mellichamp* (NYB); Santee River bottom west of St. Paul, Clarendon Co., May 11, 1917, *Stone 616* (ANSP); Hardeeville, April 1894, *Williamson* (ANSP).

Georgia: dry open woods bordering the Flint River near Bainbridge, June 19, 1901, *Curtiss 6810* (MBG,TYPE, USN,GH,NYB,UN,UM,KA,COTYPES); rare on drier upland sand ridges, cut-over pine woods and pastures, Tift Co., May 15, 1935, *Stephens* (MBG); shaded roadside south of Ways Station, Route 17, Bryan Co., April 18, 1935, *Tees* (ANSP); Savannah, Mar. 15, *Williamson* (FM).

Florida: E. Fla., *Garber* (MBG); Rosewood, June 1876, *Garber* (ANSP); in low woods, Washington Co., May 22, 1885, *Small* (NYB).

25. B. pendula Larisey var. **obovata** Larisey, var. nov.[30]

As the species except: leaflets shortly obovate, rounded and occasionally slightly retuse at the apex, 2–3.5 cm. long, 1–1.5 cm. broad; petioles not usually exceeding 5 mm., though sometimes 1 cm. long; terminal raceme exceeding the foliage 1–1.5 dm.; mature pod not known.

Distribution: middle South Carolina.

Citation of Specimens:

South Carolina: Columbia, Richland Co., May 16, 1912, *Bartram* (ANSP); along roadside about 15–20 mi. north of Columbia, May 6, 1937, *Coker* (UNC,TYPE, NYB,COTYPE); Newberry Road 5 mi. from Columbia, May 1936, *Philson* (DU).

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[30]Ab specie differt foliolis breviter obovatis apice rotundatis saepe paululo retusis 2.0–3.5 cm. longis 1.0–1.5 cm. latis, petiolis plerumque 5 mm. longis, rarissime usque ad 1 cm. longis; racemo terminali folia superante 1.0–1.5 dm. longo; legumine maturo ignoto.

26. B. pendula Larisey var. **macrophylla** Larisey, var. nov.[31]
As the species except: stems stouter, branches longer, leaflets somewhat more delicate, broadly elliptic to obovate, only rarely cuneate, obtuse or rounded at apex, frequently retuse, 4–6 cm. long, 2–2.5 cm. broad.

Distribution: middle and lower Georgia; localized in Kentucky near Paducah.

CITATION OF SPECIMENS:

GEORGIA: Marshallville, June 8, 1895, *Earle 3120* (NYB); below Augusta, April 1847, *ex Herb. Porter* (ANSP); Experiment, June 2, 1899, *Riegel 29* (KA); along Flint River at Albany, Dougherty Co., May 24–28, 1895, *Small* (FM,NYB).

KENTUCKY: Tennessee-Cumberland River region, Paducah, McCracken Co., May 30–June 20, 1909, *Eggleston 4495* (NYB); open ground along small streams near Paducah, McCracken Co., June 17, 1920, *Palmer 17935* (MBG,TYPE).

27. B. leucantha Torr. & Gray, Fl. N. Am. **1**: 585. 1840; Britton & Brown, Illust. Fl. North. U. S., ed. 1, **2**: 267, *fig. 2054.* 1897, and ed. 2, **2**: 346, *fig. 2458.* 1913, in part; Small, Fl. Southeast. U. S., ed. 1, 600. 1903, and ed. 2, 600. 1913, in part; Gray, New Man. Bot., ed. 7, 506. 1908, in part; Rydb. Fl. Prairies & Plains Central N. Am. 455. 1932, in part; Small, Man. Southeast. Fl. 678. 1933, in part.

Podalyria alba Sims in Curt. Bot. Mag. **29**: *pl. 1177.* 1809, not *B. alba* R. Br., not *Sophora alba* L.

Plant 1.5–2 m. high, glabrous throughout, glaucous, blackening in drying; stem solitary, stout, succulent, heavily ribbed, widely but simply branched, branches ascending, usually straight but occasionally slightly geniculate toward the ends; leaves deep green, blackening early, petiolate, petioles 5–10 mm. long, or upper leaves often subsessile, leaflets cuneate-obovate to nearly elliptic or oblanceolate, 2.5–6.5 cm. long, 1.5–3 cm. broad, obtuse, retuse, or mucronate at the apex, undulate, sometimes revolute; stipules lanceolate, usually about the length of the petioles though sometimes less, mostly caducous; racemes few, stout, erect, flexuous, central raceme 2–6 dm. long, lateral ones usually not exceeding 4 dm.; flowers numerous,

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[31]Ab specie differt caulibus crassioribus, ramulis longioribus; foliolis paulo delicatioribus late ellipticis vel obovatis raro cuneatis apice obtusis vel rotundatis saepe retusis 4–6 cm. longis 2.0–2.5 cm. latis.

subverticillate, usually horizontal or occasionally slightly ascending, pedicels 3–10 mm. long; floral bracts ovate-lanceolate, 8–10 mm. long, usually caducous; calyx-tube 7–9 mm. long, almost as broad, densely white-pubescent within, upper lip entire or slightly emarginate, lobes of the lower lip ovate-deltoid, one-half to one-third the length of the tube; corolla white, standard splotched with purple, 1.3–1.5 cm. high, 1.5–1.8 cm. broad, wings and keel 2–2.5 cm. long; mature pod firm, black, glaucous, ovoid to oblong, 2.5–4 cm. long, 1–2 cm. broad, slender-stipitate, stipe 2–3 times as long as the calyx, abruptly short-beaked.

Hybridizes with *B. tinctoria* var. *crebra* in Indiana, *B. sphaerocarpa* in Oklahoma, and *B. viridis* in Louisiana and Texas.

Distribution: open prairies, woods, and waste fields, Michigan to Minnesota, southwest to Mississippi, Louisiana and Texas.

Citation of Specimens:

Mississippi: low woods 10 mi. north of Bay St. Louis, April 30, 1926, *Small, Mosier & Matthaus* (NYB).

Louisiana: prairie, RR. right-of-way between Scott and Duson, Lafayette Parish, April 19, 1936, *Anderson & Hubricht* (MBG); vicinity of Covington, Fairview, May 8, 1920, *Arsène 11851* (USN); pine flat woods west of Covington, April 22, 1933, *Brown 3967* (LU); pine flat woods 5 mi. east of Hammond, July 15, 1933, *Brown 4088* (LU); Covington, May 1900, *Cocks* (LU); pine barrens, Covington, April 2, 1902, *Cocks 1626* (NYB,TU); pine barrens, Pineville, April (2), 10, 1911, *Cocks* (NYB,LU,TU); Alexandria, *Hale* (NYB); plains, Abbeville, May 28, 1882, *Langlois* (NYB); Cat Island (Miss. delta & adjacent island), Aug. 26, 1900, *Lloyd & Tracy 251* (NYB); open upland woods, Natchitoches, April 25, 1915, *Palmer 7370* (MBG); dry open ground, Creston, Natchitoches Parish, April 14, 1916, *Palmer 9427* (MBG,USN); hills near Bogalusa, May 2, 1926, *Small, Mosier & Matthaus* (NYB); silt loam, open prairie, Holloway Prairie, Rapides Parish, July 10, 1935, *Smith 115* (LU).

Ohio: Paxton Twp., Ross Co., Nov. 2, 1930, *Bartley & Pontius* (OU); opening in pin- and white-oak swamp forest, Five-Mile, Brown Co., Nov. 3, 1932, *Braun* (LB); Georgesville, Franklin Co., July 2, 1900, *Coberly* (OU); West Union, Tiffin Twp., Adams Co., Sept. 13, 1933, *Dodd* (OU); Defiance Co., June 18, 1897, *Fullmer* (OU); near South Charleston, Clark Co., June 21, 1930, *Gordon & Chapman* (OU); upper Sandusky, Wyandot Co., Sept. 18, 1930, *Hicks* (OU); Pront's, Erie Co., June 9, 1895, *Mosely* (GH); Oxford, Erie Co., July 8, 1895, *Mosely* (USN,OU); Miami, *Sartwell* (GH); Madison Co., July 12, 1920, *Taylor* (OU); Dunn's Prairie, Madison Co., Sept. 1, 1928, *Thomas* (OU).

Michigan: roadside, 2 or 3 mi. northeast of Schoolcraft, Kalamazoo Co., June 23, 1937, *Anderson & Peck* (MBG); roadside south of Bronson, Branch Co., July 6, 1929, *Brown 2603* (WU); near Parma, Jackson Co., July 8, 1896, *Camp & Camp* (UM,UW).

INDIANA: clay hills near lakes in Jackson Twp., Wells Co., July 25, 1897, *Deam* (IU); high bank on east side of lakes in Jackson Twp., Wells Co., June 26, 1904, *Deam* (USN); in prairie condition near Clear Lake, Steuben Co., July 4, 1904, *Deam* (IU); on wooded sand dune near Hammond, Lake Co., Aug. 5, 1906, *Deam 1428* (IU); wooded sand dunes between Pine and Gary, Lake Co., July 28, 1907, *Deam 2344* (IU); in open wooded pasture about 4 mi. north of Goshen, Elkhart Co., June 23, 1910, *Deam 6758* (CD); rather dry woods about 2 mi. west of Hovey Lake, Posey Co., May 23, 1911, *Deam 8299* (IU); not frequent, in dry soil, along the Lake Erie RR. about 2 mi. north of Rochester, Fulton Co., June 25, 1911, *Deam 8902* (CD); not frequent, in open sandy woods about 2 mi. south of Culver, Marshall Co., July 2, 1911, *Deam 9064* (IU); in sandy soil on the exposed bank of Fishtrap Lake near Laporte, Laporte Co., Aug. 13, 1911, *Deam 9609* (IU); in prairie habitat along the right-of-way, Lake Erie RR. west of Goldsmith, Tipton Co., July 9, 1913, *Mrs. Deam 13,636* (IU); roadside 4½ mi. southwest of Hanover, Jefferson Co., June 21, 1915, *Deam 16,256* (CD); open white oak ridge about ½ mi. south of Lake Galacia about 5 mi. northeast of Fairmount, Grant Co., July 1, 1916, *Deam 20,625* (CD); in an open sandy black- and white-oak woods 1½ mi. east of Mongo, Lagrange Co., July 9, 1916, *Deam 20,699* (CD); rocky bar of Wabash River 3 mi. west of Huntington, Huntington Co., July 23, 1916, *Deam 20,766* (IU); in white oak woods bordering the east side of New Lake, Whitley Co., Sept. 12, 1916, *Deam 21,783* (IU); in hard clay soil along roadside through the "flats" 1 mi. north of Midway, Spencer Co., June 9, 1918, *Deam 25,265* (IU); right-of-way, Vandalia RR. near Haeckland about 7 or 8 mi. northeast of Terre Haute, Vigo Co., July 5, 1918, *Deam 25,787* (IU); roadside along Pine Creek about 1½ mi. south of Rainsville, Warren Co., July 8, 1919, *Deam 25,877* (IU); right-of-way of the Penn. RR., 2 mi. east of Burnettville, July 9, 1918, *Deam 25,905* (CD); in sterile soil on the crest of the wooded Van Buren ridge about 7 mi. east of Cannelton, July 22, 1919, *Deam 28,464* (IU); sandy roadside 8 mi. northeast of South Bend, St. Joseph Co., July 8, 1920, *Deam 31,386* (IU); dry hard clay roadside 1 mi. northeast of Crisman, Porter Co., July 10, 1920, *Deam 31,568* (IU); wooded sand hill about ½ mi. southwest of Schneider, Lake Co., July 12, 1920, *Deam 31,648* (IU); black oak woods 4 mi. southwest of Lake Village, July 13, 1920, *Deam 31,682* (IU); black oak woods 3 mi. west of Gifford, Jasper Co., July 14, 1920, *Deam 31,747* (IU); pin- and black-oak woods about 5¼ mi. southeast of North Judson, Starke Co., July 14, 1920, *Deam 31,833* (IU); right-of-way of the Penn. RR. about 3 mi. east of Monticello, White Co., Aug. 4, 1923, *Deam 39,347* (IU); in the old lake bottom of the east side of Bear Lake about 1½ mi. southwest of Wolf Lake, Noble Co., June 25, 1929, *Deam 47,035* (IU); roadside 1 mi. northeast of Otwell, Pike Co., Aug. 12, 1932, *Deam 52,673* (IU); open place in H. H. Peele woods, 1 mi. southwest of Knox, Starke Co., June 24, 1938; *Deam 58,992* (MBG); Lake Maxinkuchee, July 17, 1899, *Evermann 754* (USN); Hanover, July 1887, *Kearney* (OU); common in pasture, Sleek's farm ¾ mi. east of Yockey, Lawrence Co., June 25, 1933, *Kriebel 708* (CD); open sandy woods, East Chicago, July 8, 1903, *Lansing 2586* (GH); along beach, Michigan City, July 8, 1903, *Mell 126* (USN); Chain Lakes, Oct. 10, 1912, *Nieuwland 10372* (USN); Knox, June 1926, *Rhoades* (UW); clay soil, old field west of Buttermilk Creek, Sullivan Co., July 1, 1928, *Steiner 5608 & 5609* (IU); sandy woods, Clarke, July 11, 1895, *Umbach 641* (UW); dry sands, Clarke, June 15, 1895, *Umbach* (UM); woods, Clarke, June 30, 1897, *Umbach* (MBG); wood, Clarke, July 9, 1897, *Umbach* (GH); woods, Miller's, June 23, 1898, *Umbach 7879* (UW); dunes, Aetna, July 7, 1900, *Umbach 11185* (UW); swales, Pine, June 16, 1906, *Umbach 1056 (22471)* (UW); swales, Clarke, June 21, 1909, *Umbach 3500 (31509)* (UW); low meadow, Miller's, June 29, 1909, *Umbach 3599 (31508)* (UW); ½ mi. west of Fountain Park, roadside, Jasper Co., 1923, *Welch 5818* (IU).

TENNESSEE: sandy fields, Henderson, May 1893, *Bain 401* (NYB).

WISCONSIN: Galesville, Trempealeau Co., July 9, 1932, *Anthony* (UW); roadside, Montfort, Grant Co., June 28, 1929, *Breakey* (UW); open field, Hinsdale, Cook Co., July 28, 1926, *Churchill* (GH); Baraboo, July 1885, *Curtis* (UW); Racine, July 9, 1880, *Davis* (UW); Hollandale, Iowa Co., Aug. 14, 1927, *Davis* (UW); Lynxville, Sept. 1, 1915, *Denniston* (UW); Iron Dell north of Mirror Lake, Sauk Co., July 13, 1903, *Eggert* (MBG); Lake Denoon, Muskego, Waukesha Co., July 11, 1928, *Ehrlers* (UW); sand plain, north of La Crosse, La Crosse Co., Aug. 31, 1927, *Fassett 4367* (UW); sandy roadside 2 mi. northwest of Pepin, Pepin Co., Aug. 7, 1934, *Fassett 17782* (UW); roadside, prairie relic, New Diggings, Lafayette Co., Aug. 17, 1934, *Fassett 16664* (UW); roadside & pasture, (T.8N.,R.5W.), Eastman, Crawford Co., Aug. 12, 1934, *Fassett 16648* (UW); RR., Liberty, Grant Co., Aug. 15, 1934, *Fassett 17786* (UW); sandy woods near White River between Berlin & Princeton, Green Lake Co., Sept. 12, 1934, *Fassett 16536* (UW); sandy roadside 5 mi. north of Peysippi, Waushara Co., Sept. 14, 1934, *Fassett 16538* (UW); roadside, Sprague, Juneau Co., Sept. 17, 1934, *Fassett 16534* (UW); sandy roadside, Lemonweir, 5 mi. southeast of Mauston, Sept. 17, 1934, *Fassett 16535* (UW); sandy roadside near Port Hope, about 8 mi. north of Portage, Marquette Co., Sept., *Fassett 16539* (UW); 3 mi. north of Cassville, Sept. 28, 1934, Grant Co., *Fassett 17783* (UW); sandy roadside near Silver Lake, Wild Rose, Waushara Co., June 30, 1935, *Fassett 17789* (UW); shore of Lake St. Croix near Pierce Co. line, St. Croix Co., Aug. 21, 1935, *Fassett 17772* (UW); Wisconsin River bottoms east of Necedah, Adams Co., Oct. 7, 1934, *Fassett & Bushnell 16573* (UW); between Camp Douglas and Tomah, Oakdale, Monroe Co., Oct. 7, 1934, *Fassett & Bushnell 16730* (UW); sandy soil, mouth of Beef River, Alma, Buffalo Co., Aug. 13, 1926, *Fassett & Hotchkiss 3099* (GH,UW); roadside, Winchester, Winnebago Co., Oct. 26, 1935, *Fassett & McGraw 17776* (UW); roadside east of Lancaster, Grant Co., May 31, 1930, *Fernholz & Wadmond* (UW); Madison, *Hale* (UW); farm land through woods 2 mi. east and 16 mi. south of Babcock, Wood Co., June 21, 1936, *Hamerstrom* (UW); prairies and opening, Milwaukee Co., July 1882, *Hasse* (NYB); in an uncared-for, blue-grass yard on northern bluff of Lake Wingra, Madison, July 8, 1907, *Heddle 544* (UW); open, rocky woods on summit of slope of the west mound near Blue Mounds, Iowa Co., July 1, 1919, *Heddle 2719* (UW); Winnebago Co., June, *Kellerman* (UW); rocky bank at Jim Falls, Chippewa Co., July 8, 1928, *Kunz 8* (UW); Milwaukee, *Lapham* (UW); Camp Douglas, July 14, 1890, *Mearns 224* (USN); Beloit, July 3, 1895, *Olds 32* (UW); rocky banks of Chippewa River, north of Chippewa Falls, July 9, 1915, *Rosendahl & Butters 3061* (UM); Poynette, July 8, 1886, *Russell* (UW); Madison, June 14, 1885, *Smith* (UW); Janesville, June 25, 1889, *Skavlem* (UW); Black River Falls, Jackson, June 27, 1922, *Smith 6804* (UW); Tuffa Falls, Grant Co., July 31, 1922, *Smith 7835* (UW); sandy soil near Buffalo Lake, Montello, Marquette Co., Sept. 18, 1929, *Uhler & Warren* (UW); Blue Mounds, June 19, 1886, *Williamson* (UW).

Illinois: Riverside, June 8, 1871, *Babcock* (NYB); prairies, Holcomb, July 1, 1907, *Beck 26908* (UW); prairies, Riverside, Cook Co., May 22, 1912, *Braun* (LB); old fields, Auburn, Aug. 1882, *Bigler* (GH); dry prairie, Akron Twp., Peoria Co., *Chase 4143* (UW); dry prairie northwest of Princeville, June 30 and July 15, 1898, *Chase 107* (NM); open field, Hinsdale, Cook Co., July 28, 1926, *Churchill* (MBG); Decatur, June 22, 1899, *Clokey* (MBG); prairie north of Prairie du Pont, July 2, 1878, *Eggert* (MBG); wet prairies, St. Clair Co., July 2, 1878, *Eggert* (GH); Bluff Lake, July 27, 1878, *Eggert* (MBG,UT); gravelly banks of Desplains River, Leyden Twp., Cook Co., June 17, 1905, *Gates* (USN); in prairie along roadside, Carthage, Hancock Co., Sept. 22, 1917, *Gates 10861* (MBG); dry upland woods, Mohamet, June 1902, *Gleason* (GH); Ottawa, *Huett* (GH); Quercus Lake, Clinton Co., May 20, 1917, *Ledman* (MBG); prairie west of Melrose, June 15, 1894, *Moffatt 645* (UW); prairies near Oquawka, Aug., *Patterson* (MBG); prairie, Bloomington, July 1886, *Robinson* (GH); rich prairie soil in sunny situations, Hendrix, Aug. 31, 1904, *Robinson* (GH); Bogota, July 6, 1926, *Schallert* (DU); Indian Creek region, vicinity of Concord, Morgan Co., Aug. 20, 1910, *Steele* (USN); fields, Palos Park, June 27, 1900, *Umbach 11501* (UW); fields, Beach, July 3, 1909, *Umbach 3717 (31510)* (UW); Jubilee, 1888, *Van Rensselaer* (GH); Ringwood, *Vasey 1182* (MBG); Chicago, Jan. 1888, *Williamson* (ANSP).

Minnesota: Rochester, June 22, 1904, *Amslie* (UM); Zumbrota, Goodhue Co., June 1893, *Ballard* (USN,GH,UM,UW); Winona, July 1912, *Freiberg* (MBG); Houston Co., Aug. 1912, *Freiberg* (MBG); sand prairie about 2 mi. north of Weaver, Wabasha Co., Sept. 21, 1930, *Hotchkiss & Jones 4159* (USN); Washington P.O., July 16, 1875, *Leonard* (UM); near Lake City, June 30, 1886, *Manning* (UM); White Rock, July 1881, *Sandberg* (UM); thickets, Hennepin, July 1890, *Sandberg* (UM); alluvial soil, Hennepin, July 1890, *Sandberg* (UM); White Bear Lake, July 16, 1888, *Schuette* (NYB); Minneapolis, July 7, 1884, *Roberts* (UM); Spring Grove, June 8, 1902, *Rosendahl 401* (UM).

Iowa: rich soil, Decatur Co., July 21, 1904, *Anderson* (MBG); Black Hawk Co., *Burk* (MBG); Vinton, *Davis* (UW); clay terrace, (Sect. 5T.95N.,R.3W.), Marquette, Clayton Co., *Fassett 4365* (UW); high ground, Fayette Co., June 1893, *Fink 578* (USN); common in fields, Decatur Co., June 7, 1896, *Fitzpatrick & Fitzpatrick* (MBG,GH); woods and pastures, Bentonsport, June 1920, *Graves 1704* (MBG); Ames, *Hitchcock* (MBG); Ames, July 10, 1907, *Jeffs* (UO); Grinnell, Aug. 9, 1892, *A. J. Jones* (MBG); Grinnell, June 1877, *M. E. Jones* (USN, NYB); Des Moines, July 1895, *Mosier* (USN); open sunny hillsides, McGregor, Aug. 21, 1925, *Pammel 676* (MBG,GH); Polk Co., July 6, 1927, *Pammel* (UM); common, Iowa drift sheet, Grundy Center, June 23, 1925, *Pammel & Zimmerman 327* (GH); Fayette, *Parker* (UM).

Missouri: dry field, Leffingwell Ave., Kirkwood, July 11, 1936, *Ammerman* (MBG); Greene Co., July 29, 1893, *Blankinship* (GH); Jackson Co., July 6, 1892, *Bush* (MBG); common, Montier, May 15, 1894, *Bush 87* (MBG); common, Little Blue, Jackson Co., May 24, 1896, *Bush 311* (MBG); common in woods, Swan, June 6, 1899, *Bush 74* (MBG); prairies, Converse, July 12, 1930, *Bush 11854* (MBG); barrens, Eagle Rock, May 9, 1936, *Bush 15387* (MBG); Munger, Iron Co., May 29, 1937, *Chandler 2685* (MBG); roadsides, Whiteside, July 26, 1914, *Davis 3773* (MBG); meadows near Oakwood, Ralls Co., July 16, 1915, *Davis 609* (MBG); wet prairies, Whiteside, Sept. 17, 1916, *Davis 1714* (MBG); roadside, Whiteside, Lincoln Co., Sept. 17, 1916, *Davis* (UT); waste fields, Eolia, Pike Co., July 29, 1918, *Davis 3151* (MBG); Springfield, July 31, 1892, *Dewart 101* (MBG); Graniteville, May 27, 1916, *Drushel* (MBG); dry hills north of Keren, St. Francois Co., July 3, 1892, *Eggert* (MBG); prairies, St. Louis, Aug. 1845, *Engelmann* (MBG); meadows, St. Louis, June 29, 1860, *Engelmann* (MBG); Bridgeton, July 16, 1859, *Fritchy* (MBG); St. Louis, July 21, 1894, *Glatfelter* (MBG); banks of Stout Creek, the Shut-In, Iron Co., May 25, 1918, *Greenman 3891* (MBG); Lake Killarney, Iron Co., May 8, 1925, *Greenman 4786* (MBG); St. Francois River near Silver Mine, Madison Co., May 20, 1927, *Greenman, Kobuski & Larsen* (MBG); Allenton, July 17, 1884, *Kellogg* (MBG); Jerome, May 28, 1914, *Kellogg 103* (MBG); Rolla, Phelps Co., May 20, 1928, *Kellogg 1799* (MBG); along RR., Eolia, Pike Co., July 17, 1930, *Kellogg 15217* (MBG); hillsides and RR. embankment 1 mi. south of Cedar Gap, Ozark Mtns., May 22–June 3, 1911, *Lansing 2986* (USN,GH); sandy banks of St. Francois River above concrete bridge at Silver Mine, Iron Co., May 9, 1936, *Larisey 1 & 2* (MBG); Allenton, May 10, 1896, *Letterman* (MBG); along RR. tracks on Highway 66, 3 mi. east of city limits of Cuba, Crawford Co., May 29, 1937, *Lodewyks 368* (MBG); Peruque, July 20, 1919, *McAtee 3013* (USN); common in low prairies and woods, Adams, Jackson Co., June 13, 1897, *Mackenzie* (MBG,UM); frequent on moist prairies, Webb City, Jasper Co., July 10, 1909, *Palmer 2464* (MBG); meadows and roadsides, black alluvial soil, Mississippi River bottoms 10 mi. south of Alexandria, Clark Co., June 26, 1933, *Palmer & Steyermark 40629* (MBG); St. Louis, 1843, *Riehl 421* (NYB); wet boggy ground, Buzzard Mtn., Iron Co., Aug. 1897, *Russell* (MBG); St. Louis Co., west of St. Louis, Sept. 7, 1905, *Shannon 201* (MBG); open field, vicinity of Strafford, Greene Co., Aug. 27, 1912, *Standley 9454* (USN); on low alluvial flood plain near Missouri River, 12 mi. northeast of St. Charles near Portage des Sioux, St. Charles Co., June 1, 1929, *Steyermark 1353* (MBG); on sand bars of Little St. Francis River near Silver Mine, Madison Co., Nov. 9, 1930, *Steyermark 1471* (MBG); rocky gravel of creek bed along Warm Branch of Spring River about 5 mi. north of Koshkonong, Oregon Co., Aug. 9, 1934, *Steyermark 14379* (MBG,USN); low woods along Mud Creek, T.26N.,R.7E., Sect.20, 2 mi. northwest of Rombauer, Butler Co., June 30, 1936, *Steyermark 11293* (MBG); gravel bar along headwaters of Meramec River, T.33N.,R.4W., Sect.14, 2 mi. southeast of Max, Dent Co., Aug. 10, 1936, *Steyermark 12825* (MBG); Reservoir, Joplin, Jasper Co., Oct. 7, 1897, *Trelease 198* (MBG); Lake Killarney, Iron Co., May 8, 1925, *Woodson 259* (MBG); Kirkwood, July 18, 1926, *Woodson 740* (MBG).

Arkansas: along RR. 4 mi. northeast of Texarkana, Miller Co., May 20, 1938, *Cutler* (MBG); sandy prairies, Fayetteville, July, *Harvey 16* (UM); prairies, northwest Arkansas, July, *Harvey 16* (GH); Stuttgart, May 12, 1910, *Howell 644* (USN); on roadside, 6 mi. west of Mount Ida on Highway 270, Montgomery Co., April 27, 1935, *Lodewyks 176* (MBG); no definite locality, *Pitcher* (NYB); Benton Co., 1899, *Plank* (NYB); dry woods, Winslow, May 22, 1920, *Wheeler* (NYB).

Nebraska: Saline Co., June 28, 1873, *Aughey* (UN); Ames, Story Co., June 1869, *Bessey* (UN); Wild Cat Cave near Fort Dodge, Webster Co., Sept. 24, 1904, *Churchill 2054* (UN); rare, rich bottoms of Platte, June 7, *Hayden* (MBG); river bottoms, Nebraska City, May 31, 1889, *Lownes* (UN); scattered in low prairie near Ashland, Saunders Co., June 20, 1934, *Morrison 1093* (MBG,UN); Lincoln, Lancaster Co., June 1906, *Petersen* (UN); Crabbe's Mill road, Lincoln, Lancaster Co., June 27, 1887, *Smith* (UN); Salt Creek near Asylum, Lincoln, Lancaster Co., July 1887, *Smith* (UN); low prairie northeast of Havelock, July 14, 1928, *Steiger* (UN); Lincoln, July 1888, *Webber* (MBG); prairies, Lincoln, Aug. 1889, *Webber 344* (GH); roadside prairie, Peru, June 12, 1933, *Winter 3* (USN).

KANSAS: near Randolph, July 1886, *Cleburne* (UN); Marshall Co., July 25, 1897, *Clothier & Whitford* (KA); Brown Co., July 29, 1897, *Clothier & Whitford* (KA); Doniphan Co., July 31, 1897, *Clothier & Whitford* (KA); Atchison Co., Aug. 2, 1897, *Clothier & Whitford* (KA); Linn Co., Aug. 9, 1897, *Clothier & Whitford* (KA); Bourbon Co., Aug. 11, 1897, *Clothier & Whitford* (KA); Crawford Co., Aug. 12, 1897, *Clothier & Whitford* (KA); Labette Co., Aug. 18, 1897, *Clothier & Whitford* (KA); Montgomery Co., Aug. 19, 1897, *Clothier & Whitford* (KA); Elk Co., Aug. 20 and 21, 1897, *Clothier & Whitford* (KA); Woodson Co., Aug. 29, 1897, *Clothier & Whitford* (KA); Coffey Co., Aug. 31, 1897, *Clothier & Whitford* (KA); prairie, Ellis Co., July 26, 1882, *Deane* (GH); prairie, Brown Co., Sept. 1925, *Garner* (KA); Allen Co., July 1890, *Hitchcock* (KA); Cherokee, Crawford Co., Aug. 1892, *Hitchcock* (KA); Eureka, Greenwood Co., Aug. 1892, *Hitchcock* (KA); Neosha Co., July 1896, *Hitchcock* (KA); Olathe, Johnson Co., July 7, 1887, *Kellerman* (MBG,KA); Columbus, Cherokee Co., July 13, 1887, *Kellerman* (KA); Burlingame, Osage Co., July 21, 1887, *Kellerman* (KA); dry prairie soil northeast of Keene, Wabaunsee Co., June 16, 1926, *Maus 113* (KA); open prairie north of Auburn, Shawnee Co., July 7, 1927, *Maus 848* (KA); near Belvue, Pottawatomie Co., July 29, 1896, *Nagle* (KA); wet soil, Pottawatomie Co., 1895, *Norton 997* (MBG,GH,KA,NM); Wabaunsee Co., July 14, 1893, *Carleton* (KA); near St. Mary's, Pottawatomie Co., July 4, 1895, *Norton & Clothier* (KA); near St. Mary's in Jackson Co., July 4, 1895, *Norton & Clothier* (KA); Topeka, July 16, 1879, *Popenoe* (KA); schoolhouse hill and town reservoir, Pleasanton, Linn Co., June 19, 1929, *Rydberg & Imler 65* (MBG).

OKLAHOMA: open woods north of Tecumseh, June 6, 1932, *Barkley 232* (UO); without definite locality, coll. of 1877, *Butler* (MBG); common on prairies, Sapulpa, July 22, 1894, *Bush 60* (MBG); open prairies, Wilburton, June 12, 1930, *Clark* (UO); roadside, high hill, Talihina, Le Flore Co., May 17, 1936, *Demaree 12702* (NYB); black sticky soil on gentle slope 3 mi. north of Sapulpa, Creek Co., June 13, 1931, *Fox 27* (UT); E. Latimer Co., May 5, 1935, *Goodman 2557* (GH); along roadside east of Bokchite, Cleveland Co., June 19, 1919, *Jeffs* (UO); unbroken moist prairie, T.12N., R.20E., Sect. 20, Muskogee Co., May 22, 1927, *Little 614* (UO); T.13N., R.18E., Sect. 24, Muskogee Co., June 12, 1927, *Little 1251* (UO); Shannon Ranch Spring, McCurtain Co., T.3S, R.24E., Sect. 28, June 7, 1930, *Little & Olmsted* (UO); prairie meadow 2 mi. west of Dawson, July 8, 1928, *Myers 118* (UO); common on prairie, 3 mi. east of Adel, July 12, 1905, *Van Vleet* (UO); roadside 3 mi. east of Miami, *Whaley 115* (UO).

TEXAS: along RR. 2 mi. east of Pine Island, Jefferson Co., April 20, 1936, *Anderson & Hubricht* (MBG); seen at edge of timbered rolling land, Orange, April 17, 1899, *Bray 54* (UT); Jacksonville, Cherokee Co., April 30, 1903, *Biltmore Herb.* (UM); near Turning Basin, Harris Co., April 14, 1934, *Cory 8120* (GH); dry prairies north of Polk, Bowie Co., June 13, 1898, *Eggert* (MBG); Dalby, May 1896, *Milligan* (MBG); along RR. between Grand Saline and Silver Lake, May 22, 1900, *Reverchon 1935* (MBG); low prairies, Silver Lake, May 22, 1900, *Reverchon 1935* (USN); San Jacinto, Harris Co., July 4, 1923, *Tharp 2316*

(USN,UT); Clyde, July 3, 1927, *Tharp 4739* (USN); Nacogdoches-Alto, June 15, 1931, *Whitehouse* (UT).

28. B. leucantha Torr. & Gray var. **divaricata** Larisey, var. nov.[32]

As the species except: less than 1 m. tall, darkening but apparently not blackening; stem slender, firm, scarcely ribbed, branches subdichotomous, divaricate, lateral ones drooping; petioles usually less than 5 mm. long, leaflets narrowly obovate to oblanceolate, mucronate, 2.5–3 cm. long; stipules setaceous, less than 3 mm. long, usually caducous; racemes slender, few-flowered, less than 2 dm. long; mature pod elliptic-oblongoid, firm, rugose, 2–2.5 cm. long, 0.8–1.5 cm. broad.

Distribution: prairies, southwestern Louisiana.

CITATION OF SPECIMENS:

LOUISIANA: prairie west of Crowley, Acadia Parish, July 16, 1935, *Brown 5308* (LU); prairies, Opelousas, June, *Langlois* (UW,TYPE).

29. B. leucantha Torr. & Gray var. **pauciflora** Larisey, var. nov.[33]

As the species except: less than 1 m. tall; stem slender, firm, lightly ribbed, branches subdichotomous, spreading-ascending; petioles not exceeding 5 mm. in length, leaflets obovate to oblanceolate, retuse, not more than 4 cm. long; stipules lanceolate to setaceous, 3–4 mm. long, usually persistent; racemes slender, few-flowered, less than 2 dm. long; mature pod ovoid to subglobose, inequilateral, firm but extremely brittle, 1.5–2 cm. broad, 2 cm. long.

Distribution: prairies, south-central Louisiana.

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[32] Ab specie differt caulibus vix 1 m. altis postremo fuscis sed vix nigrescentibus, ramis gracilibus firmis vix striatis, ramulis subdichotomis divaricatis, lateralibus patulis; petiolis plerumque 5 mm. vel minus longis, foliolis anguste obovatis vel oblanceolatis 2.5–3.0 cm. longis, mucronatis, stipulis setaceis vix 3 mm. longis plerumque caducis; racemis gracilibus paucifloris vix 2 dm. longis; legumine maturo subcylindrico firmo rugoso 2.0–2.5 cm. longo 0.8–1.5 cm. lato.

[33] Ab specie differt caulibus vix 1 m. altis gracilibus firmis leviter striatis, ramis subdichotomis patulo-ascendentibus; petiolis circiter 5 mm. longis, foliolis obovatis vel oblanceolatis retusis 4 cm. longis vel brevioribus, stipulis lanceolatis vel setaceis 3–4 mm. longis plerumque persistentibus; racemis gracilibus paucifloris vix 2 dm. longis; legumine ovoideo vel subgloboso inaequilaterale firmo sed fragilissimo 2 cm. longo, 1.5–2.0 cm. lato.

CITATION OF SPECIMENS:

LOUISIANA: common in prairies, Attakapas, "West La.," May 27, 1883, *Langlois 10* (NYB,TYPE); common, Attakapas, June 3, 1890, *Langlois 171* (UM).

30. B. psammophila Larisey, sp. nov.[34]

Plant usually more than 1 m. high, sometimes less, glabrous throughout; stem stout, fairly firm, heavily ribbed, blackening early, glaucous, simply branched, branches arising alternately from the primary stem, secondary and subsequent branches ascending, only rarely geniculate; leaves bright green, usually not blackening, petiolate, petioles 0.8–1.2 cm. long; leaflets broadly elliptic to obovate, occasionally oblanceolate, rarely cuneate, 4–6.5 cm. long, 2–3 cm. broad, delicate, finely reticulate, apex obtuse, rounded, or broadly acute, seldom retuse; stipules lanceolate, 0.8–1.2 cm. long, usually persistent, sometimes caducous; racemes terminal, erect, only rarely flexuous, compact, exceeding the foliage, 1–3.5 dm. long, flowers subverticillate; bracts lanceolate, 7–8 mm. long, usually caducous; pedicels 4–6 mm. long, slender; calyx black, glaucous, 0.9–1 cm. deep, upper lip entire, ovate, truncate, not usually emarginate, lobes of the lower lip deltoid to ovate, 3–3.5 mm. long; corolla white (?), standard 1.5–1.7 cm. high, 1.4–1.5 cm. wide, wings and keel 1.8–2.2 cm. long; pod black, glaucous, strongly reticulated, much inflated, oblong to subglobose, tapering gradually into a long stipe, 0.7–1.1 cm. in length, body

[34] Herba 1 m. plus minusve alta, omnino glabra. Caules crassiusculi sat firmi valde striati cito nigrescentes glauci haud dichotomi, ramis alternatis ascendentibus haud vel raro geniculatis. Folia viridia raro nigrescentia, foliolis late ellipticis vel obovatis vel oblanceolatis 4.0–6.5 cm. longis, 2–3 cm. latis delicate membranaceis reticulato-venosis, apice obtusis vel rotundatis vel acutis raro retusis basi cuneatis, petiolis 0.8–1.2 cm. longis, stipulis lanceolatis 0.8–1.2 cm. longis fere persistentibus. Racemi terminales erecti raro flexuosi compacti folia superantes 1.0–3.5 dm. longi, bracteis lanceolatis 7–8 mm. longis saepe caducis, pedicellis 4–6 mm. longis graciliusculis subverticillatis. Calycis tubum 0.9–1.0 cm. longum nigrum pruinosum, labro superiore integro ovato truncato raro emarginato, labri inferiori lobis deltoideis vel ovatis 3.0–3.5 mm. longis. Corolla albida (?), vexillo 1.5–1.7 cm. longo, 1.4–1.5 cm. lato, alis carinaque 1.8–2.2 cm. longis. Legumen oblongoideum vel subglobosum 3.5–4.0 cm. longum, 2.5–3.0 cm. latum apice abrupte breviterque sed anguste rostratum basi in stipitem angustum 0.7–1.1 cm. longum gradatim productum nigrum pruinosum conspicue reticulatum valde inflatum tenue in rugas profundas corruens.

3.5–4 cm. long, 2.5–3 cm. broad, abruptly short- and slender-beaked, pericarp thin, collapsing into deep folds.

Distribution: sandy pine lands, central Georgia south to northern Florida.

CITATIONS OF SPECIMENS:

GEORGIA: rich woodland, Augusta, April 24–May 26, 1900, *Cuthbert 180* (NYB); lowland woods between Montezuma and Oglethorpe, Macon Co., April 1, 1937, *Oosting 74* (DU); 9 mi. southeast of Valdosta, Lowndes Co., Mar. 19, 1938, *Pyron & McVaugh 2153* (MBG); dry roadside embankment, Ochlockonee River 5 mi. west of Thomasville, Thomas Co., Mar. 20, 1938, *Pyron & McVaugh 2206* (MBG); moist alluvial soil in woods 1 mi. north of River Junction, Florida (?), Decatur Co., Mar. 21, 1938, *Pyron & McVaugh 2249* (MBG); sandy ridge 8 mi. from Valdosta, April 19, 1933, *Totten* (UNC).

FLORIDA: moist soil, Westville, Holmes Co., April 18, 1899, *Biltmore Herb. 1597* (NYB); pine woods, Tallahassee, April 8, 1902, *Biltmore Herb. H/6046* (GH,TYPE, USN,NYB); high pineland 1 mi. south of Belleview, April 18, 1930, *Blanton 6387* (MBG); no definite locality, *Chapman* (NYB); Chattahoochee, *Chapman, Herb. No.792965* (MBG); Tologie Creek, Gadsden Co., 1889, *Chapman* (USN); open sandy woods, Alachua Co., March, *Curtiss 697* (UN,ANSP); in dry sandy field, Greenville, Madison Co., May 1, 1930, *Moldenke 1107* (MBG,NYB,DU); in pinelands 3 mi. west of Gainesville, Mar. 31, 1925, *O'Neill 619* (MBG); flat sandy prairies 5 mi. west of Tallahassee, Leon Co., April 11, 1931, *Palmer 38521* (MBG); Leon Co., Mar. 22, 1904, *Rehn* (ANSP); "ad rivulos, prope Tallahassee," April 1843, *Rugel* (MBG,NYB); hammock along Suwannee River near Withlacoochee Bridge, April 21, 1924, *Small, DeWinkeler, Mosier 11181* (NYB).

31. B. villosa (Walt.) Nutt. Gen. N. Am. Pl. **1**: 281. 1818; Ell. Sketch Bot. S. Car. & Ga. **1**: 468. 1821; DC. Prodr. **2**: 100. 1825; Torr. & Gray, Fl. N. Am. **1**: 384. 1840; Chapman, Fl. South. U. S., ed. 1, 111. 1860, ed. 2, 111. 1889, and ed. 3, 111. 1897; Britton & Brown, Illust. Fl. North. U. S., ed. 1, **2**: 266, *fig. 2051.* 1897, in part, and ed. 2, **2**: 345, *fig. 2455.* 1913, in part; Small, Fl. Southeast. U. S., ed. 1, 599. 1903, and ed. 2, 599. 1913; Gray, New Man. Bot., ed. 7, 506. 1908, in part; Small, Man. Southeast. Fl. 677. 1933.

Sophora villosa Walt. Fl. Car. 134. 1788.

Podalyria villosa Michx. Fl. Bor. Am. **1**: 264. 1803; Pursh, Fl. Am. Sept. **1**: 307. 1814, and ed. 2, 1816.

Lasinia cinerea Raf. New Fl. N. Am. **2**: 50. 1836 [1837].

Lasinia fulva Raf. New Fl. N. Am. **2**: 49. 1836 [1837].

Plant less than 1 m. high, tawny-pubescent throughout, villous when young, blackening; stem stout, heavily ribbed, slightly twisted, with spreading-drooping, strongly geniculate branches; leaves short-petiolate, petioles stout, channelled, usually less than 5 mm. long; leaflets coriaceous, strongly reticulate, lustrous and glabrous above, elliptic to rhombic-elliptic, or individually oblanceolate or obovate, cuneate, tapering gradually toward base into a slender petiole, apex obtuse or broadly acute, rarely notched, usually apiculate, 6–9 cm. long, 2–3.5 cm. broad; stipules ovate to lanceolate, firm, reticulate, 5–10 mm. long, usually persistent, sometimes caducous; racemes terminal, erect or flexuous, 2–4 dm. long; floral bracts lanceolate, 7–9 mm. long, usually caducous, occasionally persistent; pedicels stout, 5–7 mm. long; calyx-tube 8–10 mm. deep, strongly reticulate, upper lip broadly truncate, slightly depressed, or occasionally emarginate, lobes of the lower lip deltoid to ovate, 3–4 mm. long; corolla yellow, standard 1.7–1.9 cm. high, 2 cm. wide, wings and keel 2–2.4 cm. long; ovary densely villous, mature pod somewhat ligneous, inflated, lustrous, sparsely pubescent, ellipsoid, 2.5–3 cm. long, 1.3 cm. broad, narrowing gradually into a slender beak.

Distribution: sandy woods and hills, coastal plain of Virginia, south to South Carolina.

CITATION OF SPECIMENS:

VIRGINIA: Franklin, coll. of 1867, *Canby* (GH).

NORTH CAROLINA: sandy woods, Wilmington, May 9, 1928, *Anderson* (MBG); sandy soil, White Hall, Bladen Co., June 19, 1897, *Biltmore Herb. 1262* (USN, NYB,UM); sandy soil, Fayetteville, June 12, 1902, *Biltmore Herb. 1262d* (NYB); dry sandy soil, Leland, Brunswick Co., May 10, 1931, *Blomquist 3895* (DU); in sand barrens near Raleigh, Wake Co., May 19, 1930, *Bright 2594* (CD); near Wilmington, May 1867, *Canby* (NYB,ANSP,FM); Weldon, July 1, 1878, *ex Herb. Canby* (GH,FM); no definite locality, *Herb. Chapman* (NYB); sand hills "across Lake," May 22, 1909, *Coker* (NYB); no definite locality, *Curtis* (MBG,NYB,WU); Wilmington, *Curtis* (GH); open sandy and peaty barrens about 4 mi. east of Bolivia, Brunswick Co., April 16, 1933, *Fogg 5490* (GH); on pocasin-savanna, Chowan Terrace at Angola Bay, Wilmington, New Hanover Co., April 16, 1938, *Moldenke (Friend) 10432* (NYB); Southern Pines, May 5, 1927, *Harriott* (ANSP); Statesville, *Hyams* (MBG,FM,UM); Bingham, June 1877, *Hyams* (USN); Burgaw, May 1880, *Hyams* (NYB,KA); Wilmington, Aug. 1880, *Hyams* (OU); Magnolia, Duplin Co., April 30, 1933, *Mathews* (DU); dry sandy pine woods west of Leland, Brunswick Co., May 15, 1930, *Moldenke 1236* (MBG,USN, NYB,DU); no definite locality, Aug. 2, *Nuttall* (ANSP); sandy area near White Lake, Bladen Co., May 12, 1934, *Oosting 34111* (DU); sandy turkey oak area, Sampson Co., May 12, 1934, *Oosting 34145* (DU); dry sandy soil, open scrub land

1½ mi. southeast of Kinston, Lenoir Co., July 9, 1922, *Randolph & Randolph 565* (GH); low pine land, Nakina, May 1, 1929, *Schallert* (DU); Burgaw, July 1879, *Spence* (OU); dry sandy bank 3 mi. west of Sims, Wilson Co., June 25, 1927, *Wiegand & Manning 1493* (GH); sandy field 1 mi. south of Hoffman, Richmond Co., July 1, 1927, *Wiegand & Manning 1494* (GH); Hamlet, May 20, 1895, *Williamson* (NYB,ANSP).

SOUTH CAROLINA: Poston, April 21, 1924, *Benke 3800-1* (FM); Camden, May 8, 1857, *Gibbes* (NYB); South Pines in eastern S. Car., 1889, *McCarthy* (USN); South Pines, Aug. 1889, *McCarthy 9920* (WU); sand hills, Highland Farms, Hartsville, July 17, 1920, *Norton* (USN); Cherow, *Wallace* (CM).

32. B. tinctoria (L.) Vent. Dec. Gen. Nov. 9. 1808; R. Br. in Ait. Hort. Kew, ed. 2, **3**: 6. 1811; Ell. Sketch Bot. S. Car. & Ga. **1**: 467. 1821; DC. Prodr. **2**: 100. 1825; Torr. & Gray, Fl. N. Am. **1**: 386. 1840; Chapman, Fl. South. U. S., ed. 1, 111. 1860, ed. 2, 111. 1889, and ed. 3, 121. 1897; Britton & Brown, Illust. Fl. North. U. S., ed. 1, **2**: 266, *fig. 2050*. 1897, in part, and ed. 2, **2**: 345, *fig. 2454*. 1913, in part; Small, Fl. Southeast. U. S., ed. 1, 598. 1903, and ed. 2, 598. 1913; Gray, New Man. Bot., ed. 7, 506. 1908; Rydb. Fl. Prairies & Plains Central N. Am. 455. 1932; Small, Man. Southeast. Fl. 676. 1933.

B. Gibbesii Small, Fl. Southeast. U. S., ed. 1, 600, 1331. 1903, and ed. 2, 599. 1913; Small, Man. Southeast. Fl. 676. 1933.

B. tinctoria (L.) Vent. var. *Gibbesii* (Small) Fern. in Rhodora **38**: 424. 1936.

Sophora tinctoria L. Sp. Pl. **1**: 373. 1753; Walt. Fl. Car. 134. 1788.

Podalyria tinctoria Willd. in L. Sp. Pl., ed. 4, **2**: 503. 1799; Michx. Fl. Bor. Am. **1**: 265. 1803; Curt. Bot. Mag. **27**: *pl. 1099*. 1808; Pursh, Fl. Am. Sept. **1**: 308. 1814, and ed. 2, 308. 1816.

Plant 1 m. or less high, virtually glabrous, occasionally slightly pubescent in parts, blackening in drying; stem slender, firm, widely branched, branches arising alternately from a single primary stem, ascending; leaves subsessile to short-petiolate, petioles 2–3 mm. long, leaflets obovate, strongly cuneate, 1–1.5 cm. long, 0.6–1 cm. broad, rounded or obtuse at the apex, slightly retuse, lower surface delicately nerved; stipules minute, setaceous, deciduous; racemes numerous, terminating the branches, 0.7–1 dm. long; floral bracts lanceolate-setaceous, minute, deciduous; pedicels 4–5 mm. long; calyx-tube 3–4 mm. long, upper lip entire or slightly emarginate, lobes of the lower lip deltoid-acuminate, 1–1.5 mm. long; corolla yellow, standard 1 cm. high, 0.8–1 cm. broad, wings and keel 1.2–1.3 cm. long; mature pods subglobose to ovoid, strongly rounded at base and summit, contracted along the sutures, 0.7–0.9 cm. long, 0.6–0.8 cm. broad, black, glaucous, rugose to reticulate, slender-beaked, long-stipitate, stipe 3 times the length of the calyx.

Distribution: sandy ground and dry open woods, Massachusetts to Minnesota, southeast to South Carolina and Georgia.

Citation of Specimens:

Massachusetts: Nantucket, July 1887, *Allen* (UW); near Boston, coll. of 1816, *Boott* (USN); Martha's Vineyard, July 16 & Aug. 18, 1892, *Curtiss* (UM); common near lagoon, Martha's Vineyard, *Drushel 6267* (MBG); Beverly, Sept. 10, 1856, *Engelmann* (MBG); sterile hillside, Lunenburg, Worcester Co., July 12, 1930, *Fassett 10610* (UW); Reading, July 24, 1882, *Manning* (NYB); along Edgarton Road, West Tisbury, Martha's Vineyard, Sept. 5, 1916, *Seymour 1237* (NYB); Nantucket, July 23, 1890, *Wislizenus 922* (MBG).

Connecticut: Bates' Farm, North Haven, Oct. 4, 1913, *Bates 5847* (UN).

New York: prairie, Hempstead Plains near Central Park, Cold Spring Harbor, Long Island, Aug. 6, 1934, *Cain 7433* (IU); Babylon, southern Long Island, July 4–5, 1898, *Clute 134* (NYB); Long Island, Aug. 13, 1891, *Schrenk* (MBG).

New Jersey: dry open sandy places along Maurice River south of Millville, Cumberland Co., July 1, 1926, *Adams 354* (CD); vacant lot near Roosevelt School, Westfield, July 18, 1927, *Drushel 3302* (MBG); Spotswood, July 27, 1930, *Drushel 6957* (MBG); pine barrens, Sept. 16, 1879, *Engelmann* (MBG); Cape May Co., Aug. 5, 1931, *Keefe* (UW); sandy soil, East Orange, July 8, 1914, *Lighthipe* (MBG); dry sandy pine woods, Atsion, Burlington Co., June 22, 1922, *Long 26855* (GH); sand-hills, South Amboy, Middlesex Co., July 30, 1905, *Mackenzie 1558* (MBG); Peapack, *Perry* (MBG); woods, Elmer, Salem Co., July 4, 1874, *Redfield 1186* (MBG).

Pennsylvania: Tuscarora, Aug. 1824, *ex Bernhardi Herb.* (MBG); York Co., Sept. 1899, *ex Glatfelter Herb.* (MBG); Philadelphia, 1843, *Lea* (MBG).

Delaware: Sussex Co., July 13, 1878, *Canby* (GH).

Maryland: woods and fields, Mtn. Lake Park, July 25, 1906, *Braun* (LB); Black Ridge, near Swanton, Garrett Co., June 27, 1931, *Core* (NYB).

District of Columbia: sandy soil, Brookland, Aug. 28, 1908, *Holm* (MBG); north of Brookland, Aug. 7, 1911, *Nieuwland* (MBG); dry hillsides near Rock Creek Park, Washington, Sept. 17, 1930, *Steyermark 993* (MBG).

Virginia: dry open woods, Clarendon, July 6 & Aug. 12, 1929, *Blake 10857* (UT); Norfolk Co., June 27, 1872, *Curtiss* (MBG); clay field near Lynnhaven, Princess Anne Co., June 17, 1935, *Fernald, Griscom & Long 4658* (GH); dry clearing bordering pine woods south of Kendall Grove, Northampton Co., Oct. 13, 15, 1935, *Fernald, Long, Fogg 5319* (GH); argillaceous and siliceous boggy depression north of Gary Church, Prince George Co., June 25, 1936, *Fernald, Long & Smart 5804* (MBG,GH); on Round Top Mtn., west of Seven Mile Ford, Smyth Co., July 2, 1892, *Small* (MBG).

North Carolina: Salem, July 1896, *ex Herb. Ashe* (MBG); dry woodland, Biltmore, Aug. 16, 1897, *ex Biltmore Herb. 137a* (NYB); dry woods, Waynesville, Haywood Co., July 18, 1930, *Blomquist 3894* (DU); dry open ground, Durham Co., Aug. 5, 1932, *Blomquist 3893* (DU); Weldon, July 1, 1878, *Canby* (GH); old field, dry soil, near Bear Creek, Chatham Co., June 14, 1935, *Correll 691* (GH); no definite locality, coll. of 1848, *Curtis mis.* (MBG); open pastures, Mt. Mitchell Station, McDowell Co., July 27, 1917, *Davis 7805* (MBG); dry woods, Flat Rock, Henderson Co., June 26, 1920, *Davis* (UM); Saluda, Polk Co., June 29, 1920, *Davis* (MBG); Mt. Mitchell, Aug. 19, 1925, *Kraus* (UW); east of Durham, Wake Co., July 1932, *Lynn* (DU); in dry soil, woods on old town road north of Winston-Salem, May 12, 1911, *Schallert 859* (DU); Grandfather Mtn. Forest, Aug. 12, 1890, *Sudworth 131* (USN); mtns. of western N. Car., coll. of 1926, *Trentham* (DU); sandy bank by roadside 4 mi. west of Raleigh, Wake Co., coll. of 1927, *Wiegand & Manning 1491* (GH).

South Carolina: Society Hill, July 1, 1878, *Canby* (GH); sandy woods north of Graniteville, Aiken Co., Aug. 6, 1898, *Eggert* (MBG); sandy ground north of King Station, Aiken Co., May 24, 1899, *Eggert* (MBG); no definite locality, *ex Herb. Ell.* (CM); Caesar's Head, Aug. 7, 1912, *Gailliard & Bragg 3672 & 3673* (CM); Abbeville, *Hexamer & Maier* (GH); no definite locality, coll. of 1834, *Gibbes* (NYB,cotype of *B. Gibbesii* Small); Charleston, July 10, 1861, *Manigault* (NYB,type of *B. Gibbesii* Small); Seneca, June 1888, *McCarthy* (USN); Steadman's Pond, vicinity of Batesburg, Lexington Co., May 30, 1913, *McGregor 162* (USN); dry open woods near Clementia Tourist Camp, 14 mi. south of Charleston, Charleston Co., May 14, 1930, *Moldenke 1220* (MBG,DU); Aiken, Aug., *Ravenel* (NYB); Santee Canal, *Ravenel* (CM); Aiken, June 1869, *Ravenel* (USN); Cooper River, May 1848, *Wallace* (CM).

Georgia: sandy ground north of Tucker, Richmond Co., May 22, 1899, *Eggert* (MBG); dry pine woods near Belair, Richmond Co., June 10, 1902, *Harper 1315* (USN,GH); Tallulah Falls, June 14, 1911, *Reade E3390* (UG); open woodland, Athens Y Camp, Tallulah Falls, July 14, 1929, *Reade E3371* (UG); Blue Ridge Mtns., Fannin Co., July 22, 1909, *Smith 2465 & 2544* (UW).

Florida: "in pinetis, prope Quincy," May 1843, *Rugel* (MBG).

Ohio: Parma, July 1897, *Ashcroft* (MBG,UM); Sheffield, Lorain Co., Aug. 12, 1895, *Dick* (USN,OU); Turkey Creek road near base of Divide, Sciota Co., July 16, 1927, *Harper* (OU); Oak Harbor, Aug. 1927, *Moore* (UO).

West Virginia: Rhododendron Nursery near White Sulphur Springs, Greenbriar Co., July 24, 1930, *Berkley 1240* (MBG); near Bucklin, Upshur Co., July 16, 1894, *Pollock* (MBG,KA).

Indiana: Gary, Lake Co., July 5, 1930, *Standley 57413* (CD); on sandy road, 2–3 mi. northeast of Tefft, Jasper Co., July 10, 1924, *Welch 5211* (IU).

Minnesota: Lake City, July 24, 1882, *Sandberg* (UM).

33. B. tinctoria (L.) Vent. var. **crebra** Fern. in Rhodora **39**: 415. 1937.

As the species except: plant larger and coarser in general habit; leaflets 2–4 times as large, 1.5–4 cm. long, 0.8–1.8 cm. broad; flowers 1.3–1.6 cm. long; pods ovoid to elliptic, attenuate at base and apex, 0.8–1.5 cm. long.

Hybridizes with *B. alba* in Virginia, and with *B. leucantha* in Indiana.

Distribution: dry woods, Maine to Minnesota, south to North Carolina and Tennessee.

CITATION OF SPECIMENS:

MAINE: dry woods, mixed hardwood, Alfred, Shaker Hill, York Co., July 23, 1936, *Steinmetz* (GH).

VERMONT: shade of oaks, Pownal, Bennington Co., Aug. 13, 1902, *Blanchard* (GH); Pownal, rare in S. Vt., July 29, 1898, *Eggleston & Churchill* (MBG).

MASSACHUSETTS: Wellesley, Sept. 4, 1915, *Anderson 2401* (IU); Springfield, Hampden Co., July 27, 1903, *Burnham* (GH); scarce, moist shady road, Sheffield, Berkshire Co., Aug. 8, 1920, *Churchill* (MBG,GH); New Bedford, *Greene* (UW); near Hyannisport, Cape Cod, Sept. 5, 1898, *Greenman 458* (MBG,GH); Milton, Aug. 6, 1899, *Greenman 2279* (MBG); Canton, Aug. 8, 1887, *Kennedy* (GH); Springfield, July 10, 1928, *Lyman* (UW); Newton, Oct 5, 1889, *Pound* (UN); Beverly, July 5, 1895, *Rich* (UN); dry woods, Lincoln, Aug. 15, 1896, *Rich* (GH); along Edgarton Road west of Tisbury, Martha's Vineyard, Sept. 5, 1916, *Seymour* (GH); open spots in deciduous woods, Wilbraham Mt., Wilbraham, Hampden Co., July 26, 1927, *Seymour 679* (GH,TYPE, MBG); Hyde Park, July 1891, *Tower* (NM).

RHODE ISLAND: fields east of cut swamp, Providence, Aug. 11, 1893, *Collins* (GH); Providence, *Olney* (GH).

CONNECTICUT: New Haven, July 7, 1879, *Allen* (GH); common, sandy woods, Southington, Sept. 10, 1897, *Bissell 514(42)* (MBG); dry field, Stratford, July 22, 1898, *Eames 1* (GH).

NEW YORK: dry thickets south of sand dunes by Lake Ontario, Selkirk, Oswego Co., Aug. 23, 1922, *Fernald, Wiegand, Eames 14356* (GH); New Dorp, Long Island, Sept. 30, 1894, *Kearney* (OU); Shrub Oak, July 31, 1887, *Martens* (GH); Canarsie, Brooklyn, July 7, 1936, *Monachino 84* (GH,UT).

NEW JERSEY: sandy roadside bank, margins of damp woods 0.75 mi. northwest of Shiloh, Cumberland Co., July 24, 1927, *Adams 863* (MBG); Califon, Hunterdon Co., July 12, 1902, *Fisher* (UW); dry pine woods, Cape May Point, July 8, 1922, *Fogg 162* (GH); in sand along ocean front, Cape May, Aug. 17, 1917, *Gershey 356* (GH); Orange, Aug. 5, 1914, *Lighthipe* (UT); vicinity of Clifton, Passaic Co., July 19, 1891, *Nash* (KA); Franklin, July 1879, *Rusby 692* (UM); Summit, Aug. 3, 1907, *Rydberg 8000* (NYB); in dry ground, Pleasantville, July 10, 1923, *Tidestrom 11399* (GH).

PENNSYLVANIA: sandy ground, Grove City, Mercer Co., July 18, 1900, *Barbour 4* (KA); Mount Gretna, July 19, 1889, *Fritchy* (MBG); Lancaster Co., June 8, 1883, *Galen* (MBG); Loganville, Oct. 1, 1892, *ex Herb. Glatfelter* (MBG); Philadelphia, 1889, *Greenman 970* (GH); no definite locality, 1844, *Lea* (MBG); woods, lower Merson, July 2, 1871, *Redfield* (MBG); Smithville Swamp, Lancaster Co., July 23, 1889, *Small* (MBG); Lancaster, July 8, 1874, *Stevens* (MBG).

DELAWARE: dry woods, Greenbank, July 24, 1883, *Cummins* (MBG,GH); in woods west of Wilmington, Aug. 1, 1923, *Tidestrom 11514* (GH).

MARYLAND: Elk Neck, Cecil Co., June 18, 1923, *Abbott* (GH); Deep Creek Lake region, Garrett Co., Aug. 5, 1937, *Bright 15565* (UT); among pines, Armiger, July 8, 1924, *Tidestrom 12254* (GH).

DISTRICT OF COLUMBIA: woods, July 4, 1890, *ex Herb. Blanchard* (UM); Washington, July 16, 1891, *Blanchard* (MBG); woods near Eckington, July 15, 1893, *Boettcher 137* (MBG); coll. of 1881, *Canby* (UN); rocky woods south of Chevy Chase, July 18, 1904, *Chase 2492* (UM); frequent in woods near Washington, July 1, 1880, *Holm* (GH); sand hills near Terra Cotta, July 1910, *Holm* (MBG); in sandy soil, Brookland, May 1911, *Holm* (MBG); near West Gate, Soldiers' Home, June 25, 1897, *Kearney* (OU); July 7, 1843, *McCarthy & Schuette* (UM); dry thickets and woods, July 25, 1896, *Steele* (MBG,DU,UM); Oxen Hill, June 16, 1895, *Topping* (UM); coll. of 1875, *Vasey* (OU).

VIRGINIA: dry soil, Clifton Forge, June 29, 1903, *Biltmore Herb. 137b* (OU); Arlington, June 21, 1890, *Blanchard* (MBG); dry mixed woods, Little Neck, Princess Anne Co., Aug. 8 & 9, *Fernald & Long 3972* (GH); dry clearing bordering pine woods south of Kendall Grove, Northampton Co., Oct. 13–14, 1935, *Fernald, Long & Fogg* (GH); dry pasture, Elkins, Randolph Co., Sept. 22, 1904, *Greenman 185* (GH); in open stand of *Pinus Taeda* 3.5 mi. north of Accomac, Accomac Co., June 29, 1928, *Jones* (MBG); Round Top Mtn., west of Seven Mile Ford, Smyth Co., July 2, 1892, *Small* (NYB); vicinity of Stony Mtn., near Luray, Aug. 20, 1901, *Steele & Steele 42* (UM).

NORTH CAROLINA: rocky woods, Balsam, July 19, 1911, *Braun* (LB); face of mountain above Tuckaseegee Falls, Jackson Co., July 4, 1934, *Clabaugh 56* (DU); Flat Rock, Henderson Co., June 26, 1920, *Davis* (MBG,UT); Saluda, Polk Co., June 27, 28, 29, 1920, *Davis* (MBG,UM,UT); Saluda, July 30, 1912, *Davis 1493* (MBG); Asheville, June 1925, *Kraus* (UW); Sapphire, July 20, 1901, *Magee* (GH); open woods 9 mi. west of Hayesville, Trout Cove Creek, Clay Co., July 8, 1934, *Oosting 34584* (DU); dry shaley slope, Nantahala Gorge, road to Robbinsville, July 8, 1934, *Oosting 34631* (DU); dry sterile soil, edge of woods, 2 mi. southeast of Granite Falls, Caldwell Co., July 30, 1922, *Randolph & Randolph 1067* (GH).

ONTARIO: sandy swamps near Leamington, western Ontario, June 1, 1882, *Macoun 564* (NYB); sandy woods, Windsor, Sept. 16, 1884, *Macoun* (GH); Sandwich, July 25, 1901, *Macoun 34197* (GH).

OHIO: common in copses near Toledo, Lucas Co., June 1898, *Burglehaus* (OU); abundant locally, Stanhope Gorge, Williamsfield Twp., Ashtabula Co., Sept. 4, 1928, *Hicks* (OU); Niles, Trumbull Co., July 31, 1891, *Ingraham* (OU); Bowling Green, Wood Co., Sept. 2, 1901, *Kellerman* (OU); Collmer, Cuyahoga Co., July 18, 1895, *Stair* (OU); Neopolis, Lucas Co., Aug. 16, 1897, *Schultz* (OU); Brady's Lake, Portage Co., July 12, 1902, *Webb 534* (GH); Painesville, Lake Co., July 1892, *Warner* (OU).

WEST VIRGINIA: open woods, Buckhannon, Upshur Co., July 11, 1890, *Millspaugh 399* (NYB); Upshur Co., July 9, 1896, *Pollock* (MBG,KA).

MICHIGAN: north of Wayne, Wayne Co., Aug. 11, 1929, *Brown 2744* (UW); dry soil, Jackson Co., July 17, 1894, *Camp & Camp 642* (UM,UW); St. Clair-Algonac, St. Clair Co., July 11, 1894, *Dodge* (UT); near Port Huron, St. Clair Co., July 27, 1894, *Dodge 6468* (UM,UW); Arboretum, Ann Arbor, Washtenaw Co., Aug. 14, 1915, *La Rue* (KA).

INDIANA: prairie 0.5 mi. north of Clear Lake, Steuben Co., July 24, 1904, *Deam* (MBG,CD); flat woods on southeast border of Bass Lake, Starke Co., Aug. 20, 1915, *Deam 17,971* (GH,UM,CD); in clearing on high gravelly bank on east side of tamarack bog 5 mi. east of La Grange, La Grange Co., July 12, 1923, *Deam 39,066* (CD); moist roadside 1 mi. west and 3 mi. south of Tefft, Jasper Co., July 20, 1930, *Deam 49,180* (CD); low open place in H. H. Peele woods 1 mi. southwest of Knox, Starke Co., June 24, 1938, *Deam 58,993* (MBG); open sandy low woods 3 mi. south and 1 mi. west of Knox, Starke Co., June 24, 1938, *Deam 58,-996* (MBG); sandy bank of freshly dug ditch 5 mi. north of Medaryville, Pulaski Co., Sept. 5, 1931, *Potzger 2069* (IU).

KENTUCKY: Pine Mtn., Harlan Co., Aug. 1893, *Kearney 76* (GH,NYB,UM).

TENNESSEE: dry woods, Cades Cove Mtn., July 29, 1897, *Ruth 306* (GH).

MINNESOTA: Madison, July 1886, *ex Herb. L. Braun* (LB).

34. B. tinctoria (L.) Vent. var. **projecta** Fern. in Rhodora **39**: 415. 1937.

As var. *crebra* Fern. except: leaves oblanceolate; racemes 3–4.5 dm. long.

Distribution: mountains, Pennsylvania to Virginia.

CITATION OF SPECIMENS:

PENNSYLVANIA: laurel woods, hill top, Warrior's Mark, Huntingdon Co., June 27, 1924, *Wiegand* (GH).

VIRGINIA: common in opening southwest of Skyland, Shenandoah Nat. Park, May 31, 1936, *Camp 1281* (NYB); abundant, open slopes, rocky spurs and coves between Pass Mtn. and Oventop Mtn., Shenandoah Nat. Park, June 3, 1936, *Camp 1340* (NYB); dry woods, Hot Springs, Bath Co., July 1, 1917, *Hunnewell 4694* (GH,TYPE).

35. × **B. Deamii** Larisey, hyb. nov.[35]

= *B. tinctoria* var. *crebra* × *leucantha*.

Plant at least 1 m. high, usually glabrous throughout, occasionally sparsely pubescent in parts, blackening in drying; stem somewhat stout, relatively firm, ribbed, glaucous, erect or geniculate, widely but simply branched, branches ascending; upper leaves subsessile to short-petiolate, petioles of the lower leaves 5–8 mm. long; leaflets broadly obovate, rarely oblanceolate, cuneate, apex rounded, obtuse, finely apiculate or slightly retuse, 2.8–4.5 cm. long, 0.8–2.5 cm. broad, delicate, lightly reticulate, lower surface frequently pubescent toward the base, especially along the midvein; stipules lanceolate-setaceous,

[35] Inter *tinctoriam* var. *crebram* et *leucantham* media; herba usque ad 1 m. alta; foliolae late obovatae raro oblanceolatae cuneatae apice rotundae vel obtusae anguste apiculatae vel paulo retusae; corolla fulva, vexillo purpureo-maculato.

less than 5 mm. long, usually caducous; terminal racemes about 3 dm. long, lateral 1–2 dm. long, both loose, erect or somewhat flexuous; floral bracts ovate-lanceolate, 5–6 mm. long, usually caducous; pedicels slender, 4–7 mm. long; calyx-tube 6–7 mm. deep, upper lip entire, truncate, or slightly emarginate, lobes of the lower lip deltoid-ovate, 1–1.5 mm. long; corolla yellow, standard splotched with purple, 1.5–1.7 cm. high, 1–1.2 cm. broad, wings and keel 1.7–1.9 mm. long; mature pod oblongoid to subcylindrical, 1.7–2 cm. long, 0.7–0.9 cm. broad, very firm, rugose, black, pruinose, long-stipitate, short-beaked.

This hybrid is named in honor of Mr. Charles C. Deam in appreciation of his efforts to obtain material of the three entities involved; through his interest in the problem much information not otherwise available has aided in the study of this complex.

Distribution: sandy oak woods, northwestern Indiana.

Citation of Specimens:

Indiana: rare in black sandy soil along roadside through pin- and black-oak land about 3 mi. northwest of Knox, Starke Co., June 9, 1923, *Deam 38,811* (ANSP); in an open, sandy, low wood at southeast corner of crossroads 3 mi. north and 1 mi. west of Knox, Starke Co., June 24, 1938, *Deam 58,994, 58,995,* (MBG, type); open woods at crossroads 3 mi. north, 1 mi. west of Knox, Starke Co., June 24, 1938, *Deam* (MBG); H. H. Peele woods 1 mi. southwest of Knox, Starke Co., June 24, 1938, *Deam* (MBG); open pasture, Knox, Starke Co., Sept. 8, 1935, *Deam & Fassett 17411* (UW).

36. × **B. pinetorum** Larisey, hyb. nov.[36]
= *B. tinctoria* var. *crebra* × *alba.*

Plant 1 m. or less, sparsely appressed-pubescent to glabrate throughout, darkening slightly in drying; stem slender, delicate, ribbed, usually glabrous, occasionally finely pubescent, ciliate at the nodes, somewhat glaucous; branches arising alternately from the primary stem, ascending; leaves slender-petiolate, petioles 4–7 mm. long, usually more densely pubescent than other parts; leaflets obovate to oblanceolate, cuneate, apex rounded to obtuse, occasionally finely apiculate, rarely retuse, 2–3 cm. long, 0.8–1.3 cm. broad, delicate, finely reticu-

[36] Inter *tinctoriam* var. *crebram* et *albam* media; herba 1 m. alta vel minor; foliolae obovatae vel oblanceolatae cuneatae apice rotundatae vel obtusae interdum anguste apiculatae raro retusae; corolla gilva vel flava.

late, sparsely pubescent on lower surface or occasionally ciliate only on the mid-vein; stipules lanceolate-setaceous, less than 5 mm. long, usually persistent; terminal raceme 3–4 dm. long, lateral 1–2 dm. long, both loose, erect, only rarely flexuous; floral bracts lanceolate, 3–4 mm. long, usually caducous; pedicels slender, 5–7 mm. long; calyx-tube 4–5 mm. deep, upper lip usually entire, ovate, occasionally slightly emarginate, lobes of the lower lip deltoid-lanceolate, 2–2.5 mm. long; corolla deep cream to yellow, standard auriculate or entire, 1.1–1.3 cm. high, 0.9–1 cm. broad, wings and keel 1.2–1.5 cm. long; mature pod ovoid to oblongoid, occasionally subcylindrical, inflated, 1.3–1.7 cm. long, 0.5–0.7 cm. wide, thin but firm, strongly reticulate, purplish-brown, glaucous, tapering gradually into a long stipe and short, slender beak, beak recurved.

Distribution: pinelands, eastern Virginia.

CITATION OF SPECIMENS:

VIRGINIA: in open stand of *Pinus Taeda* 3½ mi. north of Accomac, Accomac Co., June 29, 1928, *Jones* (MBG,TYPE); in dry sandy field north of Accomac, Accomac Co., May 19, 1930, *Moldenke 1254* (MBG,USN,NYB,UP); in woods on east side of Route 13, under *Pinus Taeda*, 4 mi. north of Accomac, Accomac Co., June 4, 1935 *Tatnall 2656* (GH); sandy soil in dry open woods, mostly pine, 4 mi. north of Accomac, Accomac Co., June 29, 1928, *True* (UP).

37. B. Serenae M. A. Curtis in Am. Jour. Sci. II, **2**: 406. 1849; Chapman, Fl. South. U. S., ed. 1, 112. 1860, ed. 2, 112. 1889, and ed. 3, 122. 1897; Small, Fl. Southeast. U. S., ed. 1, 600. 1903, and ed. 2, 600. 1913; Small, Man. Southeast. Fl. 677. 1933.

Plant 1 m. or less high, virtually glabrous, occasionally sparsely pubescent in parts, darkening but not usually blackening in drying; stem slender, firm, glabrous, simply but diffusely branched, secondary branches geniculate, subdichotomous, divaricate; leaves petiolate, petioles slender, 3–5 mm. long; leaflets usually oblanceolate, cuneate, occasionally elliptic, acute to rounded at the apex, finely mucronate, rarely retuse, 1.5–3 cm. long, 0.5–1 cm. broad, usually glabrous, lower surface occasionally finely pubescent along the midvein, margins revolute; stipules minute, setaceous, deciduous; terminal racemes 1–3 dm. long, lateral ones less than 1 dm. long, flowers subverticillate, ascending; floral bracts lanceolate-setaceous, less than 3 mm. long, caducous; pedicels slender, 3–5 mm. long; calyx-tube 4–5 mm. deep, upper lip entire, ovate or truncate, rarely slightly retuse, lobes of the lower lip deltoid, 1–1.5 mm. long; corolla bright yellow, standard 1–1.2 cm. high, 1–1.2 cm. broad, wings and keel 1.2–1.4 cm. long; mature pod oblongoid, subcylindric, inflated, 1.5–3.5 cm. long, 0.6–0.8 cm. wide, thin but firm, rugose to strongly reticulate, ferruginous to purplish-brown, short-stipitate, short- and slender-beaked, ascending.

Distribution: pine barrens, South Carolina to Florida.

CITATION OF SPECIMENS:

SOUTH CAROLINA: Society Hill, July 3, 1878, *ex Herb. Canby* (MBG,USN,GH, NYB,FM); no definite locality, *Curtis 1848* (MBG,ISO-TYPE); Society Hill, *Curtis* (NYB); "in loc. humidis, vel prope," *Curtis* (GH); Aiken, June 1853, *Ravenel* (GH); pine barren, Summerville, June 10, 1891, *Taylor* (FM).

GEORGIA: mtns., Aug. 1841, *Buckley* (USN); between Tallulah Falls and Toccoa Falls, Habersham Co., Aug. 8, 1893, *Small* (USN,NYB,FM); Ocmulgee River Swamp, below Macon, May 18–24, 1895, *Small* (FM).

FLORIDA: dry open pine barrens, June 21, 1881, *Mohr* (USN,FM); dry grassy hills near Marianna, June 24, 1881, *Mohr* (GH).

38. B. macilenta Small ex Larisey, sp. nov.[37]

Plant less than 1 m. high, sparsely appressed-pubescent in parts, darkening throughout in drying but apparently not blackening; stem somewhat stout, firm, ribbed, glabrous, simply branched, branches ascending-spreading; leaves subsessile to short-petiolate, petioles slightly pubescent, less than 3 mm. long; leaflets spatulate to elliptic-spatulate, slightly cuneate, apex broadly acute, usually apiculate, 3–6 cm. long, 1–1.5 cm.

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[37] Herba vix 1 m. alta, ex partibus sparse appresso-pubescens post exsiccationem fusca sed haud nigrescens ut videtur. Caules crassiusculi firmi striati glabri simplice ramosi, ramulis patulis ascendentibus. Folia subsessilia vel brevissime petiolata, petiolis paulo pubescentibus vix 3 mm. longis, foliolis spatulatis vel spatulato-ellipticis paulo cuneatis apice late acutis plerumque apiculatis 3–6 cm. longis 1.0–1.5 cm. latis delicate membranaceis leviter reticulatis nervo medio sparse ciliatis supra saturate viridibus subtus paulo glaucis, stipulis setaceis vix 3 mm. longis saepe caducis. Racemi vix bene cogniti sed ut videtur axillares erecti compacti folia vix superantes, bracteis incognitis caducis, pedicellis 4–5 mm. longis, calycis tubo 6–7 mm. alto extus glabrato intus dense pubescente, labri inferioris laciniis deltoideis 2.0–2.5 mm. longis, labro superiore distincte emarginato. Corolla flava, vexillo 1.5 cm. alto 1.1–1.3 cm. lato, alis carinaque 1.6–1.9 cm. longis. Ovarium dense pubescens. Legumen maturum ovoideum vel subglobosum 1.0–1.2 cm. longum 0.8–1.0 cm. latum nigrum firmum vel fragile rugosum sparse pubescens longe stipitatum, stipite calycem bis superante longe angusteque rostrato.

broad, delicate, dark green above, somewhat glaucous below, finely reticulate, sparingly ciliate along the midvein; stipules setaceous, less than 3 mm. long, usually caducous; racemes imperfectly known, but apparently axillary, erect, compact, barely exceeding the foliage; floral bracts unknown, caducous; pedicels 4–5 mm. long; calyx-tube glabrate without, densely pubescent within, 6–7 mm. deep, upper lip distinctly emarginate, lobes of the lower lip deltoid, 2–2.5 mm. long; corolla dull yellow, standard 1.5 cm. high, 1.1–1.3 cm. broad, wings and keel 1.6–1.9 cm. long; ovary densely pubescent, mature pod ovoid to subglobose, 1–1.2 cm. long, 0.8–1 cm. broad, black, firm- but thin-walled, rugose, sparingly pubescent, long stipitate, stipe twice the length of the calyx, long- and slender-beaked.

It is a pleasure to publish this species in the name of the late Dr. John Kunkel Small whose work on the genus *Baptisia* has been the most comprehensive during the present century. Dr. Small had selected the type specimen and had drawn up a description under the name of *B. macilenta* to be published in his forthcoming work on the flora of the Southwest.

Distribution: prairies, western Louisiana.

CITATION OF SPECIMENS:

LOUISIANA: Chataignier, W. La., June 21, 1885, *Langlois* (NYB,TYPE).

39. B. riparia Larisey, sp. nov.[38]

Plant about 1 m. (?) high, sparingly pubescent in parts, blackening, somewhat glaucous throughout; stem stout, ribbed, glabrous, secondary branches arising alternately from a single

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[38] Herba circiter 1 m. alta plus minusve pubescens omnino paulo glauca postremo nigrescens. Caules crassiusculi striati glabri, ramis alternatis, ramulis secondariis ultimisque subdichotomis geniculatis ascendentibusque. Folia glabra marginibus juventate exceptis, petiolis 4–7 mm. longis, foliolis plerumque obovatis saepe oblanceolatis cuneatis apice obtusis vel late acutis raro paulo retusis vel apiculatis 5.5–7.0 cm. longis 1.5–2.5 cm. latis membranaceis utrinque leviter reticulatis, stipulis deltoideis lanceolatis vel setaceis saepe vix 2 mm. excedentibus caducis vel persistentibus marginibus pubescentibus. Racemi terminales erecti paulo flexuosi 1.0–1.5 dm. longi folia haud excedenti, bracteis lanceolatis 3–4 mm. longis caducis. Flores subverticillati pallide lutei, pedicello 4 mm. longo, calyce nigro glabro 8–9 mm. longo, labro superiore integro truncato vel paululo emarginato, labro inferiore 2.5–3.0 mm. longo, lobis deltoideis. Corollae vexillo 1.5–1.7 cm. alto 1.5–1.6 cm. lato, alis carinaque 2.0–2.3 cm. longis, ovario dense luteo-sericeo. Legumen maturum ignotum.

primary stem, tertiary and subsequent branches subdichotomous, geniculate, ascending; leaves glabrous except along margins in bud, petioles 4–7 mm. long, leaflets firm but fairly delicate, lightly reticulate on both surfaces, mostly obovate, occasionally oblanceolate, cuneate, apex obtuse or broadly acute, only rarely slightly retuse or apiculate, 5.5–7 cm. long, 1.5–2.5 cm. broad; stipules pubescent along margins, deltoid, lanceolate or setaceous, not usually exceeding 2 mm. long, caducous or persistent; racemes terminal, erect, somewhat flexuous, 1–1.5 dm. long, not exceeding the foliage, flowers subverticillate; floral bracts lanceolate, 3–4 mm. long, caducous; pedicels 4 mm. long; calyx black, glabrous, 8–9 mm. deep, upper lip entire, truncate or slightly notched, lobes of the lower lip deltoid, 2.5–3 mm. long; corolla pale yellow, standard 1.5–1.7 cm. high, 1.5–1.6 cm. wide, wings and keel 2–2.3 cm. long; ovary thickly pubescent with silky yellow hairs, mature pod not known.

Distribution: along river banks in northwestern Florida.

CITATION OF SPECIMENS:

FLORIDA: banks of Ochlockonee River, 10 mi. west of Tallahassee, April 20, 1933, *Totten* (UNC,TYPE).

40. B. riparia Larisey var. **minima** Larisey, var. nov.[39]

As the species except: plant 3.5–5 (?) dm. high, stem slender, sparingly pubescent in younger parts, crown of white hairs at nodes; petioles pubescent, 5–8 mm. long, leaflets pubescent along midvein of lower surface, oblanceolate-elliptic, 3.5–5 cm. long, 1–1.5 cm. broad; stipules lanceolate, 0.5–1 cm. long, persistent; racemes 1 dm. long; upper calyx-lobe entire, rounded or truncate, lower lobes ovate-deltoid; ovary pubescent with white silky hairs.

Distribution: along river banks in northwestern Florida.

CITATION OF SPECIMENS:

FLORIDA: woods near Ochlockonee River, Havana, Gadsden Co., April 15, 1934, *Griscom 21581* (GH,TYPE).

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[39] Ab specie differt: plantis verisimiliter 3.5–5 dm. altis, ramis gracilibus juventate paulo pubescentibus, nodis barbulatis; petiolis pubescentibus 5–8 mm. longis, foliolis oblanceolato-ellipticis 3.5–5.0 cm. longis, 1.0–1.5 cm. latis nervo medio subtus pubescentibus, stipulis lanceolatis persistentibus 0.5–1 cm. longis; racemis 1 dm. longis; calycis labro superiore integro rotundato vel truncato labro inferiore ovato-deltoideo; ovario villoso.

41. B. megacarpa Chapman ex Torr. & Gray, Fl. N. Am. **1**: 386. 1840; Chapman, Fl. South. U. S., ed. 1, 111. 1860, ed. 2, 111. 1889, and ed. 3, 121. 1897; Small, Fl. Southeast. U. S., ed. 1, 600. 1903, and ed. 2, 600. 1913; Small, Man. Southeast. Fl. 677. 1933.

Plant 1 m. or less high, not blackening in drying; stem somewhat stout, firm, lightly ribbed, sparsely pubescent in young parts, glabrate, glaucous, with slender, widely spreading branches; leaves on slender petioles, 1.2–2 cm. long; leaflets broadly elliptic, pale yellow-green, delicate, primary and secondary veins prominent, the latter more or less parallel, pubescent to glabrate and somewhat glaucous beneath, 4–5 cm. long, 1.5 cm. broad; stipules lanceolate, 0.5–1 cm. long, persistent or caducous; terminal raceme up to 1.5 dm. long, lateral racemes usually less than 1 dm. long, all borne opposite the branches, not exceeding the foliage; pedicels slender, 1.2–1.5 cm. long; calyx-tube 8–9 mm. deep, upper lip ovate, cleft about 1 mm., lobes of the lower lip deltoid or deltoid-ovate, 2–3 mm. long, sinuses frequently quite wide; corolla pale yellow, standard 1.7 cm. high, 1.5 cm. broad, wings and keel 2.2 cm. long; ovary glabrous, mature pod yellowish tan, parchment-like, fragile, strongly reticulate, elipsoid to ovoid, greatly inflated, 3.5–5 cm. long, 2–2.5 cm. wide, slender-stipitate, stipe not exceeding the calyx, short-beaked.

Distribution: rich soil, central Florida.

Citation of Specimens:

Florida: no definite locality, *Chapman* (GH,NYB); no definite locality, "*Chapman mis. 1846*" (MBG,type); Aspalaga, Mar. 1897, *ex Herb. Chapman* (MBG); Aspalaga, May 1898, *ex Herb. Chapman* (MBG); Gadsden Co., *Chapman* (MBG); "Talogie" Creek, Gadsden Co., 1836, *Chapman* (USN); "in calcareis prope Cupaloga, Mai 1843," *Rugel* (NYB); no definite locality, *ex Herb. J. Torrey* (GH).

42. B. sphaerocarpa Nutt. in Jour. Acad. Nat. Sci. Phila. **7**: 97. 1834; Torr. & Gray, Fl. N. Am. **1**: 384. 1840; Canby in Bot. Gaz. **4**: 131. 1879; Small, Fl. Southeast. U. S., ed. 1, 599. 1903, and ed. 2, 599. 1913.

Plant 1 m. or less high, more or less tawny- (rarely whitish-) pubescent throughout, frequently glabrate in age; stem solitary, stout, relatively firm but occasionally delicate, heavily ribbed, yellow through deep ferruginous or brownish-black, simply branched, branches straight, ascending, frequently somewhat twisted; leaves deep yellow-green, darkening into olive or brownish black upon drying, compound, subsessile to short-petiolate, petioles 1–3 mm. long, stout, channelled; young leaflets pubescent, mature glabrate, delicate, mid-vein prominent but otherwise not reticulate, broadly oblanceolate to obovate, occasionally elliptic, obtuse to obtusely acuminate, rarely retuse, never mucronate, 4.5–8 cm. long, 1.5–3.5 cm. broad; stipules narrowly lanceolate, 5 mm. long, to minute, setaceous, usually caducous, occasionally persistent; racemes terminal, 2–3 dm. long, slightly flexuous, axis twisted; flowers numerous, usually subverticillate, pedicels stout, 2–5 (rarely 8) mm. long; floral bracts lanceolate, 4–6 mm. long, caducous; calyx-tube reddish-brown or black, 0.8–1 cm. deep, upper lip cleft about 1 mm. but not usually separating, lobes of the lower lip lanceolate, 4–5 mm. long; corolla pale through deep yellow, standard slightly emarginate, 1.5–1.8 cm. high, 1.2–1.6 cm. broad, wings and keel 1.8–2.2 cm. long; pod ligneous, pericarp 2–3 mm. thick, glabrous, smooth or slightly rugose, ferruginous to brownish black, globose, usually as broad as long, 1.5–1.8 cm. long, 1.5–1.8 cm. broad, long-stipitate, stipe 5–8 mm. long, abruptly short-beaked.

Hybridizes with *B. leucantha* in Oklahoma, and *B. leucophaea* in Arkansas and Oklahoma.

Distribution: along stream banks and in moist ravines, or occasionally in open prairies of Arkansas and Oklahoma.

Citation of Specimens:

Arkansas: Fort Smith, *Bigelow 1853-4* (USN,NYB); near Conway, Faulkner Co., spring 1936, *Diemer 1435* (MBG); vicinity of Little Rock, May 1837, *Engelmann* (MBG); Little Rock, *Gray* (GH); ravines, Little Rock, May 2, 1885, *Hasse A 510* (ANSP); creek bottom, June 1885, Little Rock, *Hasse 247* (MBG); Little Rock, May and July 1885, *Hasse* (NYB); near Little Rock, May 28, 1886, *Hasse* (MBG); vicinity of Fort Tawson, June and July, *Leavenworth* (NYB); Little Rock, May 18, 1884, *Letterman* (MBG,NYB,ANSP); along stream, highway 67/70, outskirts of Little Rock, Pulaski Co., April 27, 1935, *Lodewyks 163* (MBG); prairie, *Nuttall* (ANSP,type, NYB); moist open ground near Hot Springs, Garland Co., May 15, 1924, *Palmer 24956* (MBG); along banks of small stream near Mansfield, Sebastian Co., May 24, 1931, *Palmer 39302* (MBG,NYB, GH).

Oklahoma: prairies, without definite locality, April 29, 1905, *Bebb 21004* (WU); Limestone Gap, May 10, 1887, *Butler* (MBG,USN); low hills, Ouachita Nat. For., Talihina, Le Flore Co., May 17, 1936, *Demaree 12700* (NYB); near Fanshawe, Le Flore Co., May 5, 1935, *Goodman 2552* (MBG); dry field west of Sulphur, Murray Co., May 1, 1926, *Stratton* (MBG).

43. B. viridis Larisey, sp. nov.[40]

Plant 1 m. or less high, more or less appressed-pubescent when young, frequently glabrate in parts at maturity; stem occasionally solitary, usually several, slender, firm, lightly ribbed, straw-colored to reddish-tan, widely branched, lower branches dichotomous, terminal and lateral ones strongly geniculate, usually ascending; leaves pale yellow-green, retaining color in drying, pubescent above and below; lowermost trifoliolate, petiolate, petioles 0.3–1 cm. long, leaflets oblanceolate to obovate with slightly cuneate base, or elliptic, obtuse, retuse or slightly mucronate at apex, 2.5–5 cm. long, 1–2.5 cm. broad, lateral leaflets usually ascending, somewhat smaller than the terminal leaflet; leaves of terminal and lateral geniculate branches bifoliolate or unifoliate, petiolate, petioles 2–5 mm. long, leaflets frequently unequal in size, broadly elliptic, 2.5–5 cm. long, 1–3 cm. broad, as long or twice as long as the

[40] Herba 1 m. vel minor alta juventate plus minusve appresse-pubescens maturitate saepe glabrata. Caules plerumque plures aliquando solitarii graciliusculi firmi paulo striati straminei vel fulvi late ramosi inferne dichotomi superne valde geniculati plerumque ascendentes. Folia diuturne dilute stramineo-viridia utrinque pubescentia, inferiora 3-foliolata petiolata, foliolis obovatis vel oblanceolatis vel ellipticis apice retusis vel paulo mucronulatis basi paululo cuneatis 2.5–5.0 cm. longis 1.0–2.5 cm. latis, lateralibus quam foliolo medio paululo minoribus saepissime ascendentibus, petiolo 3–10 mm. longo, superiora saepe 2-foliolata petiolata, petiolis 2–5 mm. longis saepissime 1-foliolata subsessilia vel brevissime petiolata late elliptica 2.5–5 cm. longa 1–3 cm. lata internodia aequantia vel 2-plo superantia; stipulis subulatis minutis saepissime caducis vel haud manifestis; racemi numerosi compacti erecti paulo flexuosi contorti, terminali 2–3 dm. longi, laterali saepe 1.5–2.5 dm. longi. Flores numerosi sat regulariter positi vel haud raro subverticillati, pedicellis crassiusculis 3–5 (raro 10) mm. longis, bracteis lanceolatis vel subsetaceis 3–5 mm. longis caducis; calycis tubo 4–7 mm. longo, labro superiore ovato paululo fisso sed vix lobato, labri inferiori lobis deltoideis vel lanceolatis acuminatis tubum ca. dimido aequantibus. Corolla saturate flava, vexillo orbiculari-reniforme 1.0–1.5 cm. longo 1 cm. lato reflexo, alis carinaque 1.5–2.0 cm. longis. Legumen subglobosum vel late oblongoideum 1.2–2.0 cm. longum, 1.4–1.6 cm. latum abrupte sed longe (10–13 mm.) rostratum glabrum lignosum fulvum, stipite 5–6 mm. longo calycem circumscissilem vix superante.

internodes, ascending; stipules subulate, minute, usually caducous, or lacking altogether; racemes numerous, compact, erect, slightly flexuous, axis twisted, the terminal 2–3 dm. long, the lateral usually only 1.5–2.5 dm. in length; flowers numerous, evenly spaced or occasionally subverticillate, pedicels stout, 3–5 (rarely 10) mm. long; floral bracts lanceolate to setaceous, 3–5 mm. in length, caducous; calyx-tube 4–7 mm. deep, upper lip ovate, slightly cleft but lobes rarely separating, lobes of lower lip deltoid to lanceolate, acuminate, at least one-half the length of the tube; corolla deep yellow, standard orbicular, reniform, 1 cm. broad, 1–1.5 cm. high, reflexed, wings and keel 1.5–2 cm. long; pod ligneous, pericarp 1–2 mm. thick, glabrous, reddish-tan, subglobose, frequently broader than long, 1.2–2 cm. long, 1.4–1.6 cm. broad, stipe 5–6 mm. long, barely exceeding the calyx which becomes circumscissile at the base, abruptly but long-beaked, beak 1–1.3 cm. long.

Hybridizes with *B. leucantha* in Louisiana and Texas, and *B. leucophaea* var. *glabrescens* in Louisiana and Texas.

Distribution: Louisiana, Arkansas, Oklahoma and south to Texas; introduced along railroads in Missouri.

Citation of Specimens:

Louisiana: prairie west of Crowley, Acadia Parish, July 16, 1935, *Brown 5809* (LU); prairie north of Crowley, Acadia Parish, April 26, 1936, *Brown 6273* (LU); prairie along RR. 4 mi. north of Rayne, Acadia Parish, April 27, 1936, *Brown 6293* (LU); prairies, Crowley, April 2, 1911, *Cocks 10* (NYB,TU); prairies, Crowley, April 15, 1920, *Cocks* (TU); coast prairies between Rayne and Crowley, Acadia Parish, July 4, 1934, *Harper 3235* (MBG,USN,GH,NYB); prairie about 1 mi. W. of Crowley, Acadia Parish, April 7, 1936, *Harper 3475* (MBG,USN,GH, ANSP); prairies, Opelousas, April 1880, *Langlois* (NYB,PM); prairies, Alakapus, May 27, 1883, *Langlois 11* (NYB); plains around Abbeville, May 28, 1883, *Langlois* (FM).

Missouri: Frisco RR., Tyson Station, St. Louis Co., 1900, *Barnes* (MBG); Frisco RR. 100 yards east of Allenton, May 25, 1896, *Letterman* (MBG); Allenton May 1897, *Letterman* (MBG); near Allenton on Frisco track, May 12, 1912, *Letterman* (MBG); cleared lands along Frisco RR., near Wynne Junction, Barry Co., June 5, 1926, *Palmer 30463* (MBG); swales, cleared lands along RR. near Seligman, Berry Co., June 3, 1926, *Palmer 30474* (MBG); Springfield, June 1907, *Standley* (USN).

Arkansas: May 1837, *collector unknown* (WU).

Oklahoma: lowlands, prairie, Wichita Mtns., April 18, 1928, *Barkley* (UD); without definite locality, 1877, *Butler* (MBG); dry ridge pastures, Davis, Murray Co., April 4 and 24, 1936, *Demaree 12275* (UT,USN); prairie, Arbuckle Mtns., April 1908, *Gage* (UO); prairies, northwest of Hugo, May 12, 1930, *Sears 1332* (UO); prairies, common in sandy soil near Colbert's Station, June 17, 1891, *Sheldon 17* (UM,USN).

TEXAS: along RR. 2 mi. east of Pine Island, Jefferson Co., April 20, 1936, *Anderson & Hubricht* (MBG); Beaumont, April 15, 1930, *Benke 5370* (GH,FM); sandy soil, Houston, Harris Co., April 10, 1903, *Biltmore Herb. 14778* (UM); abundant on low flat coast prairie, Orange, April 17, 1899, *Bray* (USN,UT); Genoa, Harris Co., Mar. 19, 1938, *Chandler 2684-A* (MBG); Houston, Mar. 20, 1938, *Chandler 2684-B* (MBG); near Turning Basin, Harris Co., April 14, 1934, *Cory 8131* (GH); 14 mi. southwest of Orange, Cow Bayou, Orange Co., May 15, 1937, *Cory 22321 & 22322* (MBG); 2¾ mi. north of Paris, Lamar Co., May 21, 1937, *Cory 23114* (MBG); Rio Brazos, 1833, *Drummond* (GH); prairies north of Houston, Harris Co., April 20, 1899, *Eggert* (MBG); dry hills north of Longview, Gregg Co., June 7, 1899, *Eggert* (MBG); Rosenberg, April 13, 1900, *Eggert* (MBG); Houston, April 5, 1913, *Fisher 335* (USN); Houston, April 21, 1914, *Fisher* (WU); Houston, Mar. 22, 1938, *Fisher 3844* (FM); wet prairies, Houston, Mar. 20, 1872, *Hall 160* (MBG,TYPE, USN,GH,NYB,FM,COTYPES); no definite locality, *Lindheimer* (MBG); near Houston, April 1839, *Lindheimer* (MBG); Houston, Mar. 1842, *Lindheimer* (GH); Leonard, Collin Co., May 1, 1886, *Merrill* (NYB); Bonheur, April 16, 1896, *Milligan 9515* (WU); no definite locality, 1889, *Neally 69* (USN,NYB); no definite locality, May 1883, *Oyster 23809* (WU); Columbia, Brazoria Co., Mar. 29, 1914, *Palmer 5046* (MBG,USN,FM); prairies, Ganado, Jackson Co., Mar. 10, 1916, *Palmer 9228* (MBG,USN); prairies near Texarkana, Bowie Co., April 23, 1923, *Palmer 22436* (MBG,GH); along RR. at Eads Station, Smith Co., April 23, 1901, *Reverchon 2655* (MBG); Sabine, April 25, 1903, *Reverchon* (MBG); 10 mi. south of Angleton, Brazoria Co., June 19, 1937, *Reed 27556 (258)* (MBG); sandy prairie, Beaumont, April 23, 1903, *Reverchon 3738* (MBG); Dallas, June 26, 1903, *Reverchon* (MBG); prairies, Paris, April 10, 1904, *Reverchon 4294* (MBG,GH); near Houston, May 6, 1899, *Rose 4191* (USN,NYB,FM); Cleveland-Dayton, April 19, 1930, *Tharp* (UT); Chambers Co., April 7–10, 1936, *Tharp* (UT); El Campo, June 1923, *Tharp 2314* (UT); Lovelady, April 21, 1933, *Tharp* (UT); gravelly hill across Mo. Pac. RR. at 24th St., Austin, Mar. 31, 1933, *Tharp* (UT); Walker Co., 1920, *Warner 13* (USN); no definite locality, *Wright* (GH).

44. × **B. fragilis** Larisey, hyb. nov.[41]
= *B. viridis* × *leucantha.*

Plant about 1 m. high, minutely pubescent to glabrate throughout, blackening slightly in drying; stem slender, firm, or occasionally fairly stout, delicate, ribbed, reddish, somewhat glaucous, widely branched, branches ascending-spreading; leaves dark green, blackening slightly, usually compound, occasionally simple through fusion, irregularly lobed, peti-

[41] Inter *viridem* et *leucantham* media; herba usque ad 1 m. alta; folia plerumque composita interdum simplicia irregulariter lobata, foliolis oblanceolatis vel obovatis cuneatis apice rotundatis plerumque apiculatis raro retusis; corolla flava.

olate, petioles 3–6 mm. long, leaflets usually glabrate at maturity, delicate, midvein prominent, not otherwise reticulate, margins revolute, oblanceolate to obovate, cuneate, rounded at apex, frequently apiculate, rarely retuse, 2.5–3.5 cm. long, 1.5 cm. broad; stipules minute, lanceolate to setaceous, 1–3 mm. long, usually caducous, occasionally persistent; racemes 1–2 dm. long, slightly flexuous; flowers subverticillate; floral bracts lanceolate to setaceous, 4 mm. long, caducous; pedicels 4–6 mm. long, fairly stout; calyx-tube black, 8–9 mm. deep, 6–7 mm. wide, upper lip entire or minutely cleft, lobes not usually separating, lobes of the lower lip broadly acute separated by a wide sinus, 2–2.5 mm. long; corolla yellow, blackening, standard emarginate, 1.5–1.7 cm. high, 1.4–1.5 cm. broad, wings and keel 2 cm. long; ovary black, glabrous, oblong, stipe equalling the length of the calyx, style 11–12 mm. long; mature pod imperfectly known, but ligneous.

Distribution: eastern Louisiana and Texas.

Citation of Specimens:

Louisiana: along RR. 2 mi. east of Pine Island, Jefferson Co., April 20, 1936, *Anderson & Hubricht* (MBG,type).

Texas: Nome, April 7, 1938, *Fisher 3832* (FM).

45. × **B. sulphurea** Engelm. in Bot. Gaz. **3**: 65. 1878; Canby in Bot. Gaz. **4**: 132. 1879; Small, Fl. Southeast. U. S. 599, ed. 1. 1903, and ed. 2, 599. 1913.

= *B. sphaerocarpa* × *leucantha.*

Plant at least 1 m. high, minutely pubescent or glabrate throughout, blackening in drying; stem solitary, fairly stout, delicate, ribbed, branches arising alternately from main stem, subdichotomous, spreading; leaves dark green, compound, petiolate, petioles 2–7 mm. long, young leaflets pubescent along margins and midvein, virtually glabrous at maturity, firm, midvein prominent on lower surface but otherwise not reticulate, broadly oblanceolate to obovate, slightly cuneate toward base, rounded, obtuse, slightly retuse, occasionally apiculate, 3.5–5 cm. long, 1.5–2.3 cm. broad, lateral leaflets converging, somewhat smaller than the primary leaflet; stipules lanceolate, 8–10 mm. long, persistent; racemes 1 dm. or less, flexuous, flowers subverticillate, floral bracts unknown, caducous; pedicels somewhat stout, 2–4 mm. long; calyx-tube black, 7–8 mm. deep, 6–7 mm. wide, upper lip entire, truncate, or slightly emarginate, lobes of the lower lip deltoid, 3 mm. deep; flowers dull yellow, standard 1.5–1.7 cm. high, 1.4–1.5 cm. broad, wings and keel 2–2.2 cm. long; ovary black, glabrous, glaucous, oblong-ovoid, stipe equalling the length of the calyx, beak 1–1.2 cm. long, slightly recurved; mature pod imperfectly known, but ligneous.

Distribution: prairies, Oklahoma.

CITATION OF SPECIMENS:

OKLAHOMA: rare, prairies, Tabaksi Co., "Indian Territory," fl. May, *Butler* (MBG,TYPE); prairies 10 mi. north of Limestone Gap, May 22, 1877, *Butler* (MBG, NYB,FM); Kiowa, between Arkansas and Red rivers, May 22, 1877, *Butler* (GH).

46. B. australis (L.) R. Br. in Ait. Hort. Kew., ed. 2, **3**: 6. 1811; Ell. Sketch Bot. S. Car. & Ga. **1**: 468. 1821; DC. Prodr. **2**: 100. 1825; Maund, Bot. Gard. **6**: 567. 1835–6; Torr. & Gray, Fl. N. Am. **1**: 385. 1840; Ralph, Ic. Carpolog. 44, *pl. 40.* 1849; Chapman, Fl. South. U. S., ed. 1, 112. 1860, ed. 2, 112. 1889, and ed. 3, 121. 1897; Step, Fav. Fl. **1**: 130, *pl. 64.* 1896; Britton & Brown, Illust. Fl. North. U. S. ed. 1, **2**: 265, *fig. 2049.* 1897, in part, and ed. 2, **2**: 344, *fig. 2453.* 1913, in part; Small, Fl. Southeast. U. S., ed. 1, 601. 1903, and ed. 2, 601. 1913; Sedgwick & Cameron, Gard. Month by Month, 144. 1907. *Illust.;* Gray, New Man. Bot., ed. 7, 506. 1908; Keeler, Gard. Fl. 241. 1910. *Illust.;* Mathews, Field Book Am. Wild Fl. 209. 1912. *Illust.;* Small, Man. Southeast. Fl. 678. 1933.

B. exaltata Sweet, Br. Fl. Gard. **1**: *pl. 97.* 1825; Jour. Hort. III, **34**: 511. 1897. *Illust.*

B. versicolor Lodd. Bot. Cab. **12**: *pl. 1144.* 1826.

B. confusa Sweet ex G. Don, Gen. Syst. [Hort. Brit.], ed. 2, 123. 1830.

B. caerulea Michx. in Eaton & Wright, Man. N. Am. Bot., ed. 8, 154. 1840.

Sophora caerulea Trew, Pl. Rar. 6, *pl. 14.* 1779.

Sophora australis L. Syst. Veg., ed. 14, 391. 1784; Ait. Hort. Kew. **2**: 45. 1789; Sims in Curt. Bot. Mag. I, **15**: 509. 1801.

Podalyria australis Willd. in L. Sp. Pl., ed. 4, **2**: 503. 1799; Vent. Desc. Fl. Nouv. Jard. Cels. 56, *pl. 56.* 1800.

Ripasia cerulea Raf. New Fl. N. Am. **2**: 48. 1836 [1837].

Plant 1.5 m. high, glabrous throughout, more or less glaucous; stem stout, furrowed, erect, simply branched, branches usually ascending, lateral ones occasionally spreading or drooping; leaves petiolate, petioles semiamplexicaul, channeled, 0.5–1.2 cm. long, leaflets somewhat delicate, subsessile to shortly petiolate, obovate to obovate-lanceolate, cuneate, slightly attenuate to obtuse, rarely retuse at the apex, 4–8 cm. long, 1.5–3 cm. broad; stipules lanceolate or ovate-lanceolate, acuminate, 0.7–1.5 cm. long, usually persistent; racemes loose, terminal, erect, flexuous, 2–5 cm. long; flowers distantly scattered, solitary or subverticillate; bracts ovate-lanceolate, 1–1.2 cm. long, caducous; pedicels slender, 0.7–1.2 cm. long; calyx-tube 0.9–1 cm. deep, 5–7 mm. broad, upper lip barely cleft, lobes of the lower lip deltoid, acute, 2.5–3 mm. deep; corolla dull violet to deep blue, inner petals frequently lighter, standard deeply emarginate, sometimes auriculate, laterally reflexed, 2.2 cm. long, wings and keel 2.5 cm. long; mature pod grayish- to brownish-black, oblong-elliptic, firm, slightly inflated, wrinkled, 3.5–4 cm. long, 1–1.5 cm. broad, mucronate, short-stipitate, stipe not exceeding the calyx.

Distribution: rocky soil, clay or sand along river banks, Vermont to North Carolina, west to southern Indiana and Tennessee.

Citation of Specimens:

Vermont: Westminster, Sept. 29, 1901, *Blanchard* (GH); Royalton, July 18, 1891, *Eggleston 2565* (GH,NYB,UM); established on bank of White River, Royalton, June 25, 1902, *Eggleston 2847* (GH,NYB); by White River, Royalton, June 12, 1900, *Wild* (GH).

Pennsylvania: on sand bars along Allegheny River below Aspinwall, Allegheny Co., June 6, 1933, *Bright 8820* (UM); Brownsville, Fayette Co., Aug. 16, 1868, *Garber* (MBG,GH,ANSP); abundant, Clarion River, 1845, *Henderson* (ANSP); Allegheny Co., June 14, 1869, *Knife* (USN,NYB); sandy shores, Allegheny River 7 mi. above Pittsburgh, *Shafer 615* (GH); Allegheny River bank at mouth of Bear Creek, Allegheny Co., June 8, 1884, *Shafer* (UM).

Maryland: gravelly river bank, High Island, May 19, 1895, *Kearney* (OU); rocky flat, Chain Bridge, June 17, 1924, *Pennell 12082* (ANSP); rocky islands, Potomac, Montgomery Co., June 6, 1881, *Smith* (USN); Chain Bridge, Oct. 1897, *Tidestrom* (ND).

District of Columbia: vicinity of Washington, Sept. 20, 1873, *Chickering* (ND); vicinity of Washington, May 30, 1874, *Chickering* (NYB); along Potomac

River near Glen Echo Junction, Aug. 30, 1905, *House 1484* (MBG); near Washington, 1884, *McCarthy 53* (UN); moist grounds, banks of the Potomac, Washington, May 22, 1877, *Morong* (MBG,NYB); Potomac Flats near Chain Bridge, Washington, July 14, 1895, *Pollard 501* (NYB); near Chain Bridge along Potomac River, above Washington, July 4, 1912, *Russell* (UM); rocky flats of Potomac, May 9, June 27, 1896, *Steele* (DU,UM); vicinity of Washington, May 25, Sept. 21, 1879, *Ward* (MBG); Little Falls of Potomac, May 30, 1909, *Williamson* (ANSP).

VIRGINIA: James River south of Natural Bridge Station, May 30, 1909, *Bartram* (NYB,GH); Harper's Ferry, June 1872, *Canby* (ANSP); Harper's Ferry, May 21, 1911, *Greene* (ND); bank of Shenandoah River, Page Co., May 23, 1900, *Miller* (USN); Carter's Ferry, Draper's Valley, Pulaski Co., June 4, 1871, *Shriver* (GH).

NORTH CAROLINA: Willardville, *Ashe* (NYB); waste grounds between Watts and Dollar Streets, Durham, Durham Co., May 8, 1938, *Blomquist 10253* (UNC); no definite locality, May 1884, *McCarthy* (WU).

OHIO: gravel beaches of Little Miami, Terrace Park, Sept. 20, 1910, *Braun* (LB); gravel beaches of Little Miami, Terrace Park, May 25, 1911, *Braun* (LB); Monroe Co., 1892, *Herzer* (OU); Olive Twp., Meigs Co., May 30, 1936, *Jones* (NYB, OU); Pomeroy, Meigs Co., Aug. 26, 1895, *Kellerman* (OU); river bank near Cincinnati, June, *Lea 10-1* (ANSP); Steubenville, May 25, 1878, *Mertz* (NYB); Fernbank on banks of river near North Bend, *Short* (ANSP); Cincinnati, Hamilton Co., July 1879, *Spurlock* (OU); Leroy, Lake Co., *Tyler* (OU); near Painesville, June 5, 1888, *Werner* (UM).

WEST VIRGINIA: near mouth of Blue Stone River, Summers Co., July 16, 1930, *Berkley 1116* (MBG); near Wheeling, May 25, 1878, *Mertz* (GH); shores of Ohio River, Wheeling, May 31, July 28, 1879, *Mertz* (USN,ANSP); near mouth of Blue Stone River, Summers Co., July 16, 1929, *W. U. U. Bot. Exp.* (GH); vicinity of Thurmond, June 22, 1903, *Biltmore 136c* (UM).

INDIANA: along river bank 3 mi. east of Madison, May 25, 1936, *Banta 10877* (IU); river bank, Madison, May 5, 1878, *Barnes* (MBG,WU); Hanover, *Coulter* (MBG); hard clay, rocky soil, slope of bank of Ohio River 4 mi. east of Madison, Jefferson Co., Sept. 23, 1919, *Deam 30,167* (CD); rare on low rocky bank of the Ohio River at Chas. Dean's Landing, Jefferson Co., June 19, 1923, *Deam 38,901* (CD); frequent on stony ledges of slope of bank of the Ohio River about 2 mi. east of North, Switzerland Co., May 29, 1930, *Deam 48,558* (CD); rocky slope of the bank of the Ohio River 2 mi. north of Derby, Perry Co., *Deam 51,592* (CD); rare along the N. Y. Cent. tracks in Lake Co., near the Porter Co. line, June 9, 1935, *Hull* (CD); sandy shore, Ohio River, Marble Hill, Jefferson Co., June 19, 1923, *Pennell 11780* (ANSP); low wet ground along the Ohio River 3 mi. east of Madison, May 16, 1925, *Weatherwax 3205* (IU).

KENTUCKY: river bank, South Fork, Cumberland Rd., McCreary Co., June 18, 1935, *Braun* (LB); Ohio River bank near Warsaw, Gallatin Co., June 1, 1936, *Braun* (LB); no definite locality, *Chapman* (NYB); Shelbyville, *Flint* (GH); banks of the Ohio River, coll. of 1860, *Short* (MBG,ANSP); rocky banks 8 mi. northeast of Elizabethtown, Hardin Co., Sept. 6, 1927, *Wherry & Pennell 13659* (ANSP).

TENNESSEE: Orchard Knob near Chattanooga, May 4, 1902, *Canby 25* (GH); La Vergne, June 1885, *Gattinger* (USN); river bank, Clinch River near Kyles Ford, Hancock Co., July 27, 1935, *Underwood & Sharp 3050* (CD).

47. B. minor Lehm. Ind. Semin. Hort. Hamb. 16. 1827; in Linnaea **3**: Litt. 119. 1828; in Nov. Act. Nat. Cur. (Leop. Carol. Deutsch. Akad. Naturforsch. Nova Acta) **14**: 803. 1828 [1829]; Larisey in Am. Jour. Bot. **26**: 538–39. 1939.

B. australis (L.) R. Br. var. β, Torr. & Gray, Fl. N. Am. **1**: 385. 1840.

B. texana Buckl. in Proc. Acad. Nat. Sci. Phila. **13**: 452. 1861; *Ibid.* **14**: 163. 1862.

B. vespertina Small ex Rydb. Fl. Prairies & Plains Central N. Am. 456. 1932.

B. australis (L.) R. Br. var. *minor* Fernald in Rhodora **39**: 312. 1937.

Plant 6–12 dm. high, glabrous throughout, more or less glaucous; stem slender, firm, lightly ribbed, geniculate, widely dichotomously branched; leaves subsessile to short-petiolate, petioles 2–4 mm. long, leaflets firm, reticulate, obovate to obovate-cuneate, occasionally elliptic, apiculate, rarely obtuse or retuse, 2–3.4 cm. long, 0.5–1 cm. broad; stipules lanceolate to setaceous, 3–9 mm. long, persistent or caducous; racemes terminal, erect, compact, not usually flexuous, 1–2.5 dm. (rarely 3.5 dm.) long; flowers usually evenly spaced, sometimes subverticillate but very closely arranged; floral bracts cordate- to ovate-lanceolate, 7–9 mm. long, caducous; pedicels stout, 5–7 mm. long; calyx-tube 9–10 mm. deep, 6–8 mm. broad, upper lip subconnate, lobes of lower lip usually ovate, sometimes acute, 2–3 mm. long; corolla dull violet to deep blue, inner petals lighter, frequently tinged with yellow, standard emarginate, laterally reflexed, 2.5 cm. long, wings and keel 2.7–3 cm. long; mature pod oblong, brownish-black, ligneous but brittle, much inflated, not wrinkled, 3–6 cm. long, 1.5–2.5 cm. broad, tapering gradually into a short beak, long-stipitate, stipe twice as long as the calyx.

Hybridizes with *B. leucophaea* in Missouri, Kansas and Oklahoma.

Distribution: dry hills, limestone glades and prairies, Missouri and Kansas, southwest to Texas; introduced along railroads in Nebraska.

CITATION OF SPECIMENS:

MISSOURI: center of long glade, Ledge Ridge, Mo. Bot. Gard. Arboretum, Gray Summit, Franklin Co., May 16, 1937, *Anderson* (MBG); St. Genevieve Co., May 7, 1939, *Anderson* (MBG); uncommon, introduced, Courtney, Jackson Co., May 13, 1896, *Bush 325* (MBG); common in barrens, Eagle Rock, June 2, 1897, *Bush 27* (MBG); common on prairie, Webb City, May 12, 1902, *Bush 1585* (MBG); prairies, Lake City, May 20, 1921, *Bush 9358-A* (MBG); rocky glades, Reed's Spring, April 30, 1936, *Bush 15346* (MBG); barrens, Baxter, May 27, 1936, *Bush 15565* (MBG); glades, Gray Summit, May 1, 1938, *Cutler* (MBG); Jefferson Co., June 23, 1891, *Eggert* (MBG); dry hills north of DeKalb, Jefferson Co., June 24, 1891, *Eggert* (MBG); dry hills north of Victoria, Jefferson Co., July 7, 1891, *Eggert* (MBG); Hematite, Jefferson Co., July 7, 1891, *Eggert* (MBG,NYB); rocky open places, Jefferson Co., May 22, 1892 (June 23, 1891), *Eggert* (GH); dry hills, St. Francois Co., June 10 (July 3), 1892, *Eggert* (GH); Victoria, Jefferson Co., May 21, 1893, *Eggert* (MBG,NYB); Victoria, May 11, 1896, *Eggert* (MBG, NYB); dry rocky hills north of De Soto, June 27, 1898, *Eggert* (MBG); glades, De Soto, Jefferson Co., *Ham* (NYB); Jefferson Co., May 28, 1887, *Hasse* (MBG); Victoria, Jefferson Co., July 8, 1890, *Hitchcock* (MBG); Dittmer, Jefferson Co., June 10, 1928, *Kellogg 1797* (MBG); Allenton, May 10, June 20, 1896, *Letterman* (MBG,NYB); Allenton, May 5, 1897, *Letterman* (MBG); near Crescent, Aug. 3, 1911, *Letterman* (NYB); uncommon, introduced along RR., Sheffield, Jackson Co., May 23, 1896, *Mackenzie 844* (MBG); rare, Santa Fe RR. near Rock Creek, May 23, 1896, *Mackenzie* (NYB); open limestone slopes of "Bald Joe," Stone Co., April 30, 1924, *Palmer 24622* (MBG); rocky slopes, bald knobs, along Mo.-Ark. state line near Eagle Rock, Barry Co., April 30, 1926, *Palmer 29851* (MBG); limestone glades 4 mi. north of Bloomsdale, St. Genevieve Co., June 12, 1930, *Steyermark 1482* (MBG); limestone glade in upland woods near Pomme de Terre River, 1½ mi. west of Doran Spring, 4 mi. south of Hermitage, Hickory Co., July 12, 1934, *Steyermark 13380* (MBG); natural prairie between Caplinger Mills and Stockton, about 3 mi. north of Stockton, Cedar Co., July 13, 1934, *Steyermark 13422* (MBG); rocky upland prairie glade 5 mi. north of Warsaw, Benton Co., May 24, 1936, *Steyermark 10700a* (MBG); upper lime barrens on top of bluff along Pomme de Terre River around Buzzard's Roost, 2 mi. northeast of Rondo, Polk Co., Aug. 1, 1937, *Steyermark 24100* (MBG); glades of Jefferson Co., May 24, 1885, *Wislizenus 96* (MBG).

ARKANSAS: open places, Carroll Co., May 9, 1936, *Bush 15375* (MBG); Beaver, April 21, 1929, *Davis* (WU); Eureka Springs, April 30, 1909, *Kellogg* (MBG); no definite locality, *Nuttall* (ANSP); common, dolomite hills, Carroll Co., April 20, 1929, *Palm 6507* (USN); open rocky hillsides, Eureka Springs, Carroll Co., May 10, 20, 1914, *Palmer 5523* (MBG); in grassy situations, *Pitcher* (ANSP); Eureka Springs, April 19, 1899, *Trelease* (MBG).

NEBRASKA: probably Jefferson Co., *Knight* (UN); apparently very rare, RR. south of Pioneer Park near Lincoln, Lancaster Co., May 15, 1934, *Sperry* (UN).

KANSAS: Geuda, Sumner Co., May 5, 1886, *Bassler* (UM); Kanopolis, Ellsworth Co., summer of 1898, *Becker* (KA); prairies, Lindsborg, May 1887, *Bodin* (UM); hillside not far from Lake City, Barber Co., May 2, 1936, *Bondy 396* (MBG); on high prairie, Greenwood Co., May 8, 1879, *Broadhead* (MBG); Strong City, Chase Co., May 7, 1888, *Carleton* (KA); Washington Co., July 24, 1897, *Clothier & Whitford* (KA); Labette Co., Aug. 18, 1897, *Clothier & Whitford* (KA); Elk Co., Aug. 20 & 21, 1897, *Clothier & Whitford* (KA); Cowley Co., Aug. 22, 1897, *Clothier &*

Whitford (KA); Sedgwick Co., Aug. 24, 1897, *Clothier & Whitford* (KA); Woodson Co., Aug. 29, 1897, *Clothier & Whitford* (KA); prairies, Edwards Co., May 1932, *Finch 23* (MBG); Cloud Co., 1930, *Fraser 328* (KA); herb in the sand dunes of Medora, Reno Co., May 14, 1932, *Gates 17098* (KA); herb in the prairie at northwest corner of Wingfield Twp., Oct. 3, 1935, *Gates 18643* (MBG); Ft. Riley, May 16, 1892, *Gayle 461* (NYB); Wilson Co., May 5, 1896, *Haller* (KA); widely distributed southeast of Salina, Saline Co., April 24, 1930, *Hancin 178* (KA); Manhattan, May 10, 1883, *Higginbotham* (KA); Fairchild, *Hitchcock* (KA); White Water, Butler Co., July 1892, *Hitchcock* (KA); Concordia, Cloud Co., June 17, 1897, *Hitchcock* (KA); Clay Co., July 1895, *Hitchcock* (KA); Lincoln Co., July 1895, *Hitchcock* (KA); Ottawa Co., July 1895, *Hitchcock* (KA); Barton Co., Aug. 1895, *Hitchcock* (KA); Morris Co., Aug. 1895, *Hitchcock* (KA); Rice Co., Aug. 1895, *Hitchcock* (KA); Franklin Co., July 1896, *Hitchcock* (KA); Anderson Co., July 1896, *Hitchcock* (KA); Pratt Co., Aug. 1896, *Hitchcock* (KA); Harper Co., Aug. 1896, *Hitchcock* (KA); Edwards Co., Sept. 1, 1897, *Hitchcock* (KA); Stafford Co., Sept. 1, 1897, *Hitchcock* (KA); Manhattan, April 26, 1891, *Jackson* (NYB); prairie southeast of Monmouth, Cherokee Co., May 2, 1930, *Jacobs 18* (KA); Manhattan, May 17, 1887, *Kellerman* (KA); Manhattan, Riley Co., May 28, 1889, *Kellerman* (MBG); Shawnee Co., Aug. 20, 1896, *Lockhart* (KA); dry prairie west of Wabaunsee, Wabaunsee Co., May 9, 1927, *Maus 13* (KA); near Altamont, Labette Co., May 11, 1924, *Nelson* (KA); prairie, Riley Co., Sept. 18, 1895, *Norton* (MBG,NYB,KA,NMC); south of Smith Hill, June 1867, *Parry* (MBG); common at Salina, June 1, 1867, *Parry* (MBG); no definite locality, Oct. 1934, *Pennell 19329* (MBG); Wichita, May 1903, *Poole 75* (GH); vicinity of South Haven, along the road, 4 mi. east of town, July 4, 1929, *Rydberg & Imler 579* (NYB); vicinity of Coldwater, camp ground, July 6, 1929, *Rydberg & Imler 676* (NYB); Emporia, May 13, 1890, *Tyler* (MBG); Wichita, Sedgwick Co., May 1929, *Wellman* (WU); Cowley Co., April 1898, *White* (MBG); open knolls 5 mi. north of Manhattan, Riley Co., May 16, 1935, *Williams & Williams 2110* (MBG); prairies near Pleasant Valley Creek, 150 mi. southwest of Independence, May 28, 1846, *Wislizenus* (MBG).

OKLAHOMA: dry open places ½ mi. east of Norman, April 29, 1927, *Babb 120* (UO); Woodward, Aug. 29, 1892, *Bailey* (GH); dry upland 4 mi. east of Norman, April 30, 1928, *Barkley* (UO); open prairie 2 mi. southwest of Norman, June 18, 1928, *Berry 45* (UO); Huntsville, Kingfisher Co., April 28, 1896, *Blankinship* (GH, WU); Lincoln Co., May 6, 1896, *Blankinship* (GH); Huntsville, Kingfisher Co., May 20, 1896, *Blankinship* (MBG); common, Catoosa, May 8, 1895, *Bush 910* (MBG,NYB,ND,UM); without definite locality, coll. of 1877, *Butler 4* (MBG); Arbuckle Mtns. above Turner Falls, Davis, Murray Co., April 24, 1936, *Demaree 12282* (UT); prairie north of Woodward, Woodward Co., June 5, 1901, *Eggert* (MBG); Cherokees, June 1835, *Engelmann 179* (MBG); dry waste land or native grass land, Spike Hill, Arbuckle Mtns. April 4, 1927, *Fieder 86* (UO); Arbuckle Mtns., April 27, 1935, *Goodman 2456* (MBG); breaks of Canadian River at Pack Saddle Bridge, Ellis Co., May 26, 1935, *Goodman 2583* (MBG); rich soil east of Norman, May 4, 1930, *Gowan 68* (UO); prairies 2½ mi. north of Norman, May 8, 1930, *Gowan* (UO); grassy creek valley near Mannsville, Johnston Co., May 5, 1916, *Griffith 3493* (MBG,GH); Norman, May 5, 1917, *Jeffs* (UO); prairie northeast of Oklahoma City, April 29, 1928, *Johnston* (UO); Fort Supply, *Kimball* (MBG); west of Alva, June 1, 1931, *McKelvey 2496* (GH); west of Tulsa, June 2, 1931, *McKelvey 2513* (GH); Platt Nat. Park, top of Bromide Mtn., April 5, 1935, *Merrill 80* (NYB); Stillwater, May 1, 1897, *Myers* (OAM); in open places near Sulphur, June 15, 1930, *Ruth 1616* (USN); grassy side of Red Butte near Cora, Woods Co., May 21, 1913, *Stevens 545* (GH,UM); prairie near Alva, Woods Co., May 22, 1915, *Stevens 547½* (MBG,GH,NYB,UM); in open dry woods near Miami, Ottawa Co., Aug. 26, 1913, *Stevens 2291* (GH,NYB).

TEXAS: northern Texas, May, *Buckley* (ANSP,TYPE of *B. texana* Buckl.); near McKinney, April 11, 1904, *Freeman* (MBG); Lipscomb, July 1, 1903, *Howell 6* (USN); 7 mi. east of McLean, Wheeler Co., *Hubricht, Shoop, Heinze B1451* (MBG); Leonard, Collin Co., May 1, 1886, *Merrill* (NYB); Bonheur, April 25, 1896, *Milligan 9516* (WU); Grayson Co., April 10, 1933, *Polson* (UT); limestone bluff, Dallas, 1880, *Reverchon 183* (MBG); prairies, Sherman, April 22, 1904, *Reverchon 4293* (MBG,GH,NYB); waste places, vicinity of Dallas, April 27, 1929, *Stephenson 168* (UT).

CULTIVATED SPECIMENS: ex Hort. Hamb. "A." 1827, *Lehmann* (GH,TYPE).

48. B. minor Lehm. var. **aberrans** Larisey, var. nov.[42]

As the species except: branches usually subdichotomous-ascending rather than dichotomous-spreading-drooping; leaflets obovate-oblanceolate; racemes occasionally intercalary, flowers frequently somewhat smaller; occurs out of natural range.

Distribution: dry open ground or hills, central North Carolina southwest to northwestern Georgia and adjacent Tennessee.

CITATION OF SPECIMENS:

NORTH CAROLINA: Stokes Co., June 1896, *Ashe* (MBG,OU); open dry ground, Durham, Durham Co., May 27, 1930, *Blomquist* (DU); upper New Hope Creek, Duke Forest, Orange Co., May 8, 1933, *Lynn* (DU); Durham, Durham Co., May 1917, *Wolfe* (DU).

GEORGIA: sandy roadside 8.5 mi. south of Chickamauga, Walker Co., April 24, 1938, *Pyron & McVaugh 2690* (MBG,TYPE).

TENNESSEE: hills above Chattanooga, May 25, 1876, *Engelmann* (MBG); Chattanooga, June 11, 1883, *James* (OU).

49. × **B. bicolor** Greenman & Larisey in Am. Jour. Bot. **26.** 539. 1939.

= *B. minor* × *leucophaea.*

Plant less than 1 m. high, tawny-pubescent in parts, blackening slightly in drying; stem somewhat stout, heavily ribbed, finely pubescent to glabrate, somewhat glaucous, simple below,

[42]Ab specie differt ramis plerumque subdichotomo-ascendentibus haud dichotome patulo-nutantibus; foliolis obovato-oblanceolatis; racemis subinde intercalatis; floribus frequenter paulo minoribus.

subdichotomously branched and divaricately spreading above; leaves subsessile to short-petiolate, petioles 2–4 mm. long; leaflets spatulate-oblanceolate to narrowly obovate, 1.5–5.5 cm. long, 0.5–1 cm. broad, glabrous or sparingly pubescent toward the base and along the midrib and margins; stipules triangular- to ovate-lanceolate, 0.5–2 cm. long, usually persistent; racemes axillary, 1–3.5 dm. long, frequently flexuous, not usually secund; floral bracts ovate- to lanceolate-acuminate, 0.9–1.7 cm. long, usually persistent, occasionally caducous; pedicels stout, 0.5–2 cm. long, glabrate; calyx-tube 1 cm. deep, upper lip entire, ovate, or slightly emarginate, lobes of the lower lip deltoid, 3–3.5 mm. long; corolla bicolorous, standard purple, 2–2.2 cm. high, 1.8–2 cm. broad, wings and keel cream or yellow, 2–2.4 cm. long; ovary densely pubescent, mature pod oblongoid, barely inflated, somewhat distorted, narrowed at both ends, tapering gradually into a long stipe and persistent style, body 2.5–3.5 cm. long, 0.8–1.2 cm. broad, strongly reticulate, somewhat strigillose.

Distribution: prairies, southwestern Missouri, Kansas, and Oklahoma.

Citation of Specimens:

Missouri: glades, Dittmer, Jefferson Co., May 4, 1930, *Kellogg 15216* (MBG); frequent on upland prairies, Webb City, Jasper Co., May 4, 1902, *Palmer 127* (MBG, type); rocky upland prairies near Webb City, Jasper Co., May 10, 1931, *Palmer 39282* (MBG,GH,NYB).

Kansas: rich, black soil, stony prairie land 1 mi. southwest of College, Riley Co., May 7, *Bayliss* (KA); on hills west of Poor House, April 13, *Dolby* (KA); about 2½ mi. southwest of Iron Mound, Saline Co., May 3, 1930, *Hancin 215* (KA); hilltop near Manhattan, Riley Co., May 21, 1920, *Herr 9* (KA); Manhattan, Riley Co., May 12, *Kellerman* (KA).

Oklahoma: prairie near Tecumseh, April 22, 1932, *Barkley 47* (MBG,UO); prairie 2 mi. east of Norman, May 10, 1924, *Bruner* (USN); Fort Sill, Comanche Co., April 17, 1916, *Clemens 11623* (GH); 6 mi. northwest of Stillwater, May 18, 1931, *Featherly* (MBG); Ripley, July 17, 1931, *Featherly* (MBG); in open woodlands, southern Okla., near Interstate Bridge, April 11, 1928, *Nelson 10816* (MBG).

Excluded Species

Baptisia fraxinifolia Nutt. Mss. ex Torr. & Gray, Fl. N. Am. 1: 387. 1840 = Thermopsis fraxinifolia M. A. Curtis, fide Index Kew.

B. Hugeri Small in Bull. Torr. Bot. Club **25**: 139. 1896 = Thermopsis mollis (Michx.) M. A. Curt. ex A. Gray in Mem. Am. Acad. N. S. **3**: 47, *fig. 9.* 1848.

B. mollis (Michx.) Nutt. Gen. N. Am. Pl. **1**: 281. 1818 = Thermopsis fraxinifolia M. A. Curtis, fide Index Kew.

B. mollis (Michx.) DC. Prodr. **2**: 100. 1825 = Thermopsis mollis M. A. Curtis ex Gray, fide Index Kew.

B. nepalensis Hook. Exot. Fl. **2**: *pl. 131.* 1825 = Piptanthus nepalensis Sweet, fide Index Kew.

B. triflora Loudon, Ladies' Fl. Gard. Orn. Perenn. *pl. 34.* 1843. in Ic. = "Rafnia triflora Thunb. in textu. 137."

Doubtful Species and Nomina Nuda

Baptisia retusa Raf. New Fl. N. Am. **2**: 47. 1836 [1837].

Efforts to obtain authentic material or information additional to that given in Rafinesque's description were unsuccessful. His description is not sufficiently clear to warrant placing it in any known species with certainty.

Baptisia lupinoides Burbidge in Gard. Chron. **21**: 827. Jan.–June 1884.

This plant was in cultivation in England, and from the description given it is impossible to place it definitely in any recognized species. No authentic material could be located, and reference to it appears no place else in the literature.

Baptisia versicolor Raf. New Fl. N. Am. **4**: 107. 1836 [1837], *nomen nudum.*

Index to Exsiccatae

Italicized numerals refer to collectors' numbers, s.n. *(sine numero)* to unnumbered collections, and parenthetical numerals to the numbers of taxonomic entities.

Abbott, E. K. *s.n.* (32).
Adams, J. W. *354* (32); *863* (33).
Allen, A. *s.n.* (32); *s.n.* (33).
Ammerman, E. *s.n.* (27).
Amslie, G. C. *s.n.* (27).
Anderson, E. S. *s.n.* (15); *s.n.* (31); *s.n.* (47).
Anderson, E. S. & L. Hubricht. *s.n.* (27); *s.n.* (43); *s.n.* (44).
Anderson, E. S. & R. Peck. *s.n.* (27).
Anderson, F. *s.n.* (33).
Anderson, J. P. *s.n.* (15); *s.n.* (27).
Angst, C. E. *1427* (15).
Anthony, R. B. *s.n.* (27).
Archias, L. H. *3* (15).
Arsène, G. *11851* (27).
Ashcroft, G. B. *s.n.* (32).
Ashe, W. W. *s.n.* (22); *s.n.* (46); *s.n.* (48).
Aughey, S. *s.n.* (15); *s.n.* (27).

Babb, M. *120* (47).
Babcock, H. H. *s.n.* (27).
Backman, J. *s.n.* (23).
Bailey, —. *s.n.* (47).
Bain, S. M. *401* (27).
Baker, —. *s.n.* (15).
Ball, C. R. *546* (12).
Ballard, C. A. *s.n.* (27).
Banta, E. *10877* (46).
Barbour, W. C. *4* (33).
Barce, Barce, & W. Welch. *6126* (15).
Barkley, E. D. (Mrs. F. A.) *136* (15); *232* (27); *47* (49).
Barkley, F. A. *s.n.* (15); *s.n.* (43); *s.n.* (47).
Barkley, Mrs. M. W. *s.n.* (15).
Barnes, C. R. *s.n.* (43); *s.n.* (46).
Barnhart, J. H. *2186* (5).
Bartlett, H. H. *2651* (23).
Bartley, F. & L. L. Pontius. *s.n.* (27).
Bartram, E. B. *s.n.* (23); *s.n.* (25); *s.n.* (46).
Bartram, E. B. & B. F. Long. *s.n.* (14).
Bassett, F. L. *s.n.* (15).
Bassler, T. *s.n.* (47).
Bates, J. M. *3180* (15); *5847* (32).
Bayliss, J. C. *s.n.* (49).
Bebb, M. S. *s.n.* (15).
Beck, J. *26908* (27).
Becker, M. *s.n.* (47).
Benke, H. C. *3800-1* (29); *5370* (43).
Berkley, E. E. *1240* (30); *1116* (46).
Berlandier, J. L. *289* (16); *2554* (19).
ex Bernhardi Herb. *s.n.* (32).
Berry, R. E. *45* (47).
Berryman, W. *s.n.* (5).
Bessey, C. E. *s.n.* (27).
Bigelow, J. N. *s.n.* (15).
Bigler, *s.n.* (27).
ex Biltmore Herb. *1600a, 1600b,* (2); *1595f* (11); *14783a* (12); *s.n.* (27); *1597, H-6046* (30); *1262, 1262d* (31); *137a* (32); *s.n.* (33); *14778* (43); *136c* (46).
Bissell, C. H. *514–42* (33).
Blackmon, G. H. & Enlow. *s.n.* (11).
Blain, W. L. *238* (20).
Blake, S. F. *10857* (32).
Blakley, O. W. *1428* (12).
Blanchard, F. *s.n.* (33); *s.n.* (34); *s.n.* (46).
Blankinship, J. W. *s.n.* (27); *s.n.* (47).
Blanton, F. S. *6429* (5); *6573* (8); *263* (10); *6387* (30).
Blomquist, H. L. *3895* (31); *3893, 3894* (32); *10253* (46); *s.n.* (48).
Bodin, J. E. *s. n.* (15); *s.n.* (47).
Boettcher, F. L. *137* (33).
Bombard, M. L. & A. L. Haas. *s.n.* (11).
Bondy, E. *396* (47).
Boott, W. *s.n.* (32).
Boykin, S. *s.n.* (10); *s.n.* (22).
Brainerd, E. L. *s.n.* (16).
Braun, E. L. *s.n.* (27); *s.n.* (32); *s.n.* (33); *s.n.* (46).
ex Herb. E. L. Braun. *s.n.* (33).
Bray, W. L. *22.* (17); *s.n.* (43).
Breakey, E. P. *s.n.* (15); *s.n.* (27).
Breithaupt, C. F. *9286* (15).
Bridge, J. *s.n.* (16).
Bright, J. L. *4779* (5); *2955* (22); *2953* (23); *2594* (31); *15565* (33); *8820* (46).
Broadhead, G. C. *s.n.* (15); *s.n.* (47).
Brown, C. A. *6253, 6267, 6489, 6533* (12); *3956, 5206, 6192, 6272, 6282, 6291, 6345, 6433* (17); *6273, 6276* (19); *2603, 3967, 4088* (27); *5308* (28); *2774* (33); *5809, 6273, 6293* (43).
Brownfield, J. *643* (23).
Bruner, W. E. *s.n.* (15); *s.n.* (49).
Buchanan, W. F., Jr. *s.n.* (9).
Buckley, S. B. *s.n.* (3); *s.n.* (37); *s.n.* (47).
Bull, Z. R. *110* (15).
Burglehaus, F. H. *s.n.* (33).
Burk, M. *301* (15); *s.n.* (27).
Burnham, S. H. *s.n.* (33).
Bush, B. F. *s.n., 207, 214, 264* (12); *7, 59, 73, 304, 1115, 14763, 15376, 15386* (15); *2321, 2755, 13304, 13334, 13467* (16); *67* (17); *68* (21); *60, 74, 87, 311, 11854, 15387* (27); *27, 323, 910, 1585, 9358, 15346, 15375, 15505* (47).
Butler, Geo. D. *s.n.* (15); *s.n.* (20); *s.n.* (27); *s.n.* (42); *s.n.* (45); *4* (47).

Cain, S. A. *7433* (32).
Camp, S. N. & D. R. *s.n.* (27); *642* (33).
Camp, W. H. *1281, 1340* (34).
Campbell, —. *s.n.* (15).
Canby, W. J. *s.n.* (46).
Canby, W. M. *s.n.* (2); *s.n.* (3); *s.n.* (9); *s.n.* (22); *s.n.* (31); *s.n.* (32); *s.n.* (33); *s.n.* (35).
Canby, W. M. & C. H. Sargent. *20* (14); *19* (22).
Canby, W. M., C. H. Sargent & B. F. Bush. *27* (16).
Carleton, M. A. *s.n.* (15); *s.n.* (27); *s.n.* (47).
Chandler, A. *2685* (27); *2684-A, 2684-B* (43).
Chapman, A. W. *s.n.* (1); *s.n.* (2); *s.n.* (5); *s.n.* (6); *s.n.* (9); *s.n., 190* (10); *s.n.* (14); *s.n.* (15); *s.n.* (22); *s.n., 792965* (30); *s.n.* (31); *s.n.* (41); *s.n.* (46).
Chase, A. *2492* (33).
Chase, V. H. *107, 4143* (27).
Cheney, L. S. *s.n.* (15); *s.n.* (16).
Chickering, J. W. *s.n.* (46).
Churchill, C. H. *2051, 2052a, 2052b* (15); *2054* (27).
Churchill, J. R. *s.n.* (33).
Clabaugh, N. C. *56* (33).
Clark, O. M. *2821* (15); *s.n.* (27).
Cleburne, W. *s.n.* (15); *s.n.* (27).
Clemens, M. K. (Mrs. J.) *11622* (15); *11623* (49).
Cleveland, —. *s.n.* (4).
Clokey, I. W. *s.n.* (27).
Clothier, G. L. *s.n.* (15).
Clothier, G. L. & H. H. Whitford. *s.n.* (15); *s.n.* (27); *s.n.* (47).
Clover, E. U. *769* (21).
Clute, W. N. *134* (32).
Coberly, E. D. *s.n.* (27).
Cocks, R. S. *1630, s.n.* (12); *s.n., 1790a, 1790b* (17); *s.n.* (19); *s.n., 1626* (27); *10, s.n.* (43).
Coker, W. C. *s.n.* (25); *s.n.* (31).
Collins, J. F. *s.n.* (33).
Cook, F. A. *s.n.* (12).
Core, E. L. *s.n.* (32).
Correll, D. S. *691* (32).
Corson, M. *s.n.* (15).
Cory, V. L. *2174, 22836* (12); *8120* (27); *8131, 22321, 22322, 23114* (43).
Coulter, J. M. *s.n.* (46).
Cratty, R. I. *s.n.* (15).
Crawford, E. W. *29* (17).
Crocket, J. L. *s.n.* (12).
Cruikshanks [Crookshanks], D. R. *7* (15).
Cummins, A. *s.n.* (33).
Curtis, M. A. *s.n.* (5); *s.n.* (14); *s.n.* (22); *s.n.* (23); *s.n.* (31); *s.n.* (32); *1848, s.n.* (37).
Curtiss, A. H. *6833* (2); *698, 4828* (5); *699, 5899, 6406* (8); *6840* (9); *689, s.n.* (10); *6379* (11); *6810* (24); *697* (30).
Curtiss, C. C. *s.n.* (32).
Cuthbert, A. *176* (2); *177* (4); *179, s.n.* (14); *s.n.* (23); *180* (30).
Cutler, H. C. *s.n., 881* (17); *s.n.* (27); *s.n.* (47).

Darlington, —. *s.n.* (22).
Davis, Rev. J. *1315a, 1315b, 1315c, 9142* (14); *1323, 4401* (15); *s.n., 609, 1714, 3151, 3773* (27); *s.n., 7805* (32); *s.n., 1493* (33).
Davis, J. J. *s.n.* (15); *s.n.* (27); *s.n.* (47).
Deam, C. C. *31562, 31625, 31683, 36708, 40522, 40570, 51926, 53840* (15); *1428, 2344, 6758, 8299, 8902, 9064, 9609, 16256, 20625, 20699, 20766, 21783, 25265, 25787, 25877, 25905, 28464, 31386, 31568, 31648, 31682, 31747, 31833, 39347, 47035, 52673, 58992* (27); *s.n., 17971, 39066, 49180, 58993, 58996* (33); *s.n., 38811, 58994, 58995* (35); *30167, 38901, 48558, 51592* (46).
Deam, C. C. & N. C. Fassett. *17411* (35).
Deam, Mrs. C. C. *13636* (27).
Deane, W. *s.n.* (27).
Demaree, D. *11970, 11995* (15); *1206* (16); *12702* (27); *12275* (43); *12282* (47).

Denniston, R. H. *s.n.* (27).
Dewart, P. W. *s.n.* (16); *101* (27).
Dick, W. M. *s.n.* (32).
Dickson, D. & R. S. Cocks. *1791* (12).
Diemer, M. E. *1435* (42).
Dixon, R. A. *64, 525, 607a* (12).
Dodd, D. R. *s.n.* (27).
Dodge, C. K. *s.n., 6468* (33).
Doggett, K. N. *s.n.* (14).
Dolby, S. *s.n.* (49).
Douglass, E. *s.n.* (16).
Drummond, T. *s.n.* (21); *s.n.* (43).
Drushel, J. *s.n.* (27); *3302, 6267, 6957* (32).

Eames, A. *s.n.* (33).
Earle, F. S. *3120* (26).
Edmondson, C. *s.n.* (15).
Eggert, H. *s.n.* (2); *s.n.* (12); *s.n.* (15); *s.n.* (16); *s.n.* (17); *s.n.* (18); *s.n.* (19); *s.n.* (27); *s.n.* (32); *s.n.* (43); *s.n.* (47).
Eggleston, W. W. *4995* (26); *2565, 2847* (46).
Eggleston, W. W. & J. R. Churchill. *s.n.* (33).
Ehrlers, J. H. *s.n.* (27).
Elliott, S. *s.n.* (23); *s.n.* (32).
Emig, W. H. *437* (15).
Engberg, C. C. *s.n.* (15).
Engelmann, G. *1002* (12); *s.n.* (15); *s.n.* (27); *s.n.* (32); *179* (47); *s.n.* (48).
Evermann, B. W. *754* (27).

Fassett, N. C. *16468, 16540, 16541, 16641, 17364, 17790, 17791, 17792, 17793, 17794* (15); *4365, 4367, 16354, 16535, 16536, 16538, 16539, 16648, 16664, 17772, 17783, 17786, 17789* (27); *10610* (32).
Fassett, N. C. & O. A. Bushnell. *16565, 16729* (15); *16573, 16730* (27).
Fassett, N. C. & A. A. Drescher. *14217* (15).
Fassett, N. C. & H. P. Hansen. *17368* (16).
Fassett, N. C. & F. Hotchkiss. *3436* (15); *3099* (27).
Fassett, N. C. & C. F. McGraw. *17776* (27).
Fassett, N. C. & L. R. Wilson. *4366* (15).
Featherly, H. I. *s.n.* (15); *s.n.* (49).
Featherman, A. *s.n.* (12).
Fendler, A. *s.n.* (12).
Fernald, M. L., L. Griscom & B. Long. *4658* (32).
Fernald, M. L. & B. Long. *3972* (33).
Fernald, M. L., B. Long & J. M. Fogg. *5319* (32); *s.n.* (33).
Fernald, M. L., B. Long & R. F. Smart. *5804* (32).
Fernald, M. L., K. M. Wiegand & A. Eames. *14356* (33).
Fernholz, D. L. & S. C. Wadmond. *s.n.* (15); *s.n.* (27).
Fieder, M. *s.n.* (47).
Fielder, M. *59* (15).
Finch, A. *23* (47).
Fink, B. *s.n.* (15); *578* (27).
Fisher, C. L. *s.n., 34104* (12); *s.n.* (15); *37267* (17); *71* (19); *s.n., 335, 3844* (43); *3832* (44).
Fisher, —. *s.n.* (33).
Fitzpatrick, T. J. & M. F. L. *s.n.* (15); *s.n.* (27).
Flint, W. F. *s.n.* (46).
Floyd, M. F. *s.n.* (7).
Fogg, J. W., Jr. *5490* (31); *162* (33).
Folsum, T. *65* (15).
Fox, O. O. *27* (27).
Fraser, S. V. *329* (15); *328* (47).
Freeman, O. M. *s.n.* (47).
Freiberg, G. W. *s.n.* (27).
Fritchy, J. Q. A. *s.n.* (27); *s.n.* (33).
Fullmer, E. L. *s.n.* (27).

Gage, —. *s.n.* (43).
Gailliard, E. H. & L. M. Bragg. *3672, 3673* (32).
Galen, J. *s.n.* (33).
Garber, A. P. *s.n.* (24); *s.n.* (46).
Garner, F. *s.n.* (27).
Gates, F. C. *s.n., 10861* (27); *17098, 18643* (47).
Gattinger, A. *s.n.* (46).
Gayle, E. E. *461* (47).
Gershey, A. *356* (33).

ex Herb. L. R. Gibbes. *s.n.* (14); *s.n.* (22); *s.n.* (23); *s.n.* (31); *s.n.* (32).
Gillett, Q. *s.n.* (15).
Gilman, —. *803* (5).
ex Herb. N. M. Glatfelter. *s.n.* (15); *s.n.* (16); *s.n.* (27); *s.n.* (32); *s.n.* (33).
Gleason, H. A. *s.n.* (15); *s.n.* (27).
Goodman, G. J. *2359* (12); *2557* (27); *2456, 2583* (47).
Gordon, R. B. & F. B. Chapman. *s.n.* (27).
Gowan, R. L. *s.n., 68* (47).
Graves, E. W. *2114, s.n.* (15).
Gray, A., C. S. Sargent, J. H. Redfield & W. M. Canby. *s.n.* (22).
Greene, B. D. *s.n.* (33).
Greene, E. L. *s.n.* (46).
Greenman, J. M. *3888* (15); *4780* (16); *3891, 4786* (27); *185, 458, 2279* (33).
Greenman, J. M., C. E. Kobuski, & E. L. Larsen (Mrs. K. Doak). *s.n.* (27).
Griffith, F. *3493* (47).
Griscom, L. *18393* (10); *21581* (40).

Hagen, A. *s.n.* (15).
Hale, J. *s.n.* (12); *s.n.* (15); *s.n., 210* (17); *309* (19); *s.n.* (27).
Hall, E. *s.n.* (15); *s.n.* (17); *160* (43).
Haller, W. C. *s.n.* (15); *s.n.* (47).
Ham, H. E. *s.n.* (47).
Hamerstrom, F. W. *s.n.* (27).
Hancin, J. *156* (15); *178* (47); *215* (49).
Handley, C. O. *A-141* (5); *A-147* (10).
Hapeman, H. *s.n.* (15).
Harden, A. *s.n.* (9).
Harkness, W. F. *s.n.* (9).
Harper, A. R. *s.n.* (32).
Harper, R. A. *s.n.* (15).
Harper, R. M. *802, 1310* (2); *49, 80* (5); *2095* (9); *s.n., 3528* (15); *27* (17); *3476* (19); *1315* (32); *3235, 3475* (43).
Harriott, J. T. *s.n.* (31).
Harvey, F. L. *s.n., 7* (15); *16* (27).
Hasse, H. E. *s.n.* (15); *s.n.* (27); *s.n.* (47).
Hayden, F. V. *s.n.* (12); *s.n.* (15); *s.n.* (27).
Heading, H. M. *s.n.* (9).
Heddle, J. R. *1095, 2504* (15); *s.n., 544* (27).
Heller, A. A. *1523* (18).
Henderson, J. *s.n.* (46).
Herr, G. *s.n.* (15); *9* (49).
Herzer, H. *s.n.* (46).
Hexamer, A. C. & F. W. Maier. *s.n.* (23); *s.n.* (32).
Hicks, G. H. *s.n.* (27); *s.n.* (33).
Higginbotham, J. N. *s.n.* (47).
Hitchcock, A. S. *s.n., 356, 357* (5); *s.n.* (15); *s.n.* (16); *s.n.* (27); *s.n.* (47).
Holm, T. *s.n.* (32); *s.n.* (33).
Holzinger, J. M. *s.n.* (15).
Hooks, Mrs. J. L. *s.n.* (17); *s.n.* (37).
Hopkins, M. H. *2983, 2984, 2988* (2).
Hotchkiss, H. & P. Jones. *4159* (27).
Houghton, H. W. *3800* (12); *3603* (14).
House, H. D. *1862* (14); *3359* (22); *1484* (46).
Howell, A. H. *1165* (10); *779* (14); *644* (27); *6* (47).
Hubricht, L., C. Shoop & D. Heinze. *B1451* (47).
Huger, A. M. *s.n.* (9).
Hull, E. D. *s.n.* (46).
Hunnewell, F. W. *4694* (34).
Hyams, M. E. *s.n.* (22); *s.n.* (31).

Ingraham, R. H. *s.n.* (33).

Jackson, A. *s.n.* (47).
Jacobs, A. A. *18* (47).
James, E. *s.n.* (15).
James, J. F. *s.n.* (48).
Jeffs, R. E. *s.n.* (15); *s.n.* (27); *s.n.* (47).
Johnston, L. A. *s.n.* (15); *s.n.* (47).
Jones, C. H. *s.n.* (46).
Jones, F. M. *s.n.* (22); *s.n.* (33); *s.n.* (36).
Jones, M. E. *s.n.* (15); *29325* (21); *s.n.* (27).

Kearney, T. H. *s.n.* (9); *s.n.* (27); *s.n., 76* (33); *s.n.* (46).

Keefe, A. M. *s.n.* (32).
Kellerman, W. A. *s.n.* (15); *s.n.* (27); *s.n.* (33); *s.n.* (46); *s.n.* (47); *s.n.* (49).
Kellogg, J. H. *s.n.* (15); *1798* (17); *s.n.* (20); *s.n.*, *103*, *1799*, *15217* (27); *1797*, *s.n.* (47).
Kennedy, G. G. *s.n.* (33).
Killian, O. L. *s.n.* (12).
Kincaid, F. & E. West. *s.n.* (10).
Knife, S. W. *s.n.* (43).
Knight, W. C. *s.n.* (47).
Kraus, E. J. *s.n.* (32); *s.n.* (33).
Kriebel, R. M. *708* (27).
Kunz, H. F. *102* (16); *8* (27).
Kurz, H. *s.n.* (1); *s.n.* (5); *s.n.* (9).

Langlois, A. B. *s.n.*, *8*, *9*, *29*, (12); *s.n.* (13); *s.n.*, *4*, *5* (17); *s.n.* (27); *s.n.* (28); *10*, *171* (29); *s.n.* (38); *s.n.*, *11* (43).
Lansing, O. L., Jr. *2586*, *2986* (27).
Lapham, I. A. *s.n.* (15); *s.n.* (27).
Larisey, M. M. *4* (16); *1*, *2* (27).
La Rue, C. D. *s.n.* (33).
Lea, M. C. *s.n.* (32); *s.n.* (33).
Lea, T. G. *10-1* (46).
Leavenworth, M. C. *s.n.* (15).
Le Conte, J. E. *s.n.* (5); *s.n.* (9); *s.n.* (23).
Ledman, O. S. *s.n.* (27).
Leeds, A. N. *2559* (9).
Lehman, V. *s.n.* (17).
Lehmann, J. G. C. *s.n.* (47).
Leonard, W. H. *s.n.* (27).
Letterman, G. W. *s.n.* (12); *s.n.* (15); *s.n.* (17); *s.n.* (27); *s.n.* (43); *s.n.* (47).
Lewton, F. L. *73* (17).
Lighthipe, L. H. *s.n.*, *228* (5); *565* (9); *s.n.* (32); *s.n.* (33).
Lindheimer, F. J. *s.n.*, *51* (17); *s.n.* (43).
Lindheimer, F. J. & S. B. Buckley. *s.n.* (17).
Little, E. L., Jr. *1257* (15); *614*, *1251* (27).
Little, E. L., Jr. & C. E. Olmsted. *s.n.* (27).
Lloyd, F. E. & S. M. Tracy. *251* (27).
Lockhart, J. *s.n.* (47).
Lodewyks, M. C. *41*, *203* (15); *174* (16); *176*, *368* (27).
Long, B. N. *25855* (32).
Loomis, H. *s.n.* (23).
Loomis, H. & H. B. Croom. *s.n.* (1).
Lownes, J. *s.n.* (27).
Lyman, S. *s.n.* (33).
Lynn, W. E. *s.n.* (32); *s.n.* (48).

MacFarlane, J. M. *s.n.* (22).
MacFarlane, J. M. & M. E. Davis. *s.n.* (22).
Mackenzie, K. K. *s.n.*, *13184* (15); *s.n.* (27); *1558* (32); *844*, *s.n.* (47).
Macoun, J. M. *564*, *34197* (33).
Magee, E. E. *s.n.* (33).
Maguire, B. *E3379* (14).
Manning, S. *s.n.* (27); *s.n.* (32).
Manning, W. E. *s.n.* (15).
Martens, J. W. *s.n.* (33).
Martin, B. *7242* (15).
Mathews, A. C. *s.n.* (31).
Mathias, M. (Mrs. G. Hassler). *833* (16).
Maus, P. M. *51*, *843* (15); *113*, *848* (27); *13* (47).
Maxon, W. R. *3812* (17).
Maxwell, F. R. *s.n.* (15).
McAtee, W. L. *3013* (27).
McCarthy, G. *s.n.* (22); *s.n.* (31); *s.n.* (32); *53*, *s.n.* (46).
McCarthy, C. & J. H. Schuette. *s.n.* (33).
McDonald, F. E. *s.n.* (15).
McGregor, E. A. *25* (14); *656* (23); *162* (32).
McKelvey, S. D. *1743* (21); *2496*, *2513* (47).
Mead, S. B. *s.n.* (27).
Mearns, E. A. *225* (16); *224* (27).
Mell, C. D. *126* (27).
Mellichamp, J. H. *s.n.* (24).
Meredith, H. B. *s.n.* (15).
Merner, H. L. *14864* (15).
Merrill, E. D. *s.n.* (43).
Merrill, F. J. H. *s.n.* (43); *s.n.* (47).
Merrill, G. M. *80* (47).

Mertz, H. N. *s.n.* (46).
Meyer, E. *7844* (17).
Miller, G. S. *s.n.* (46).
Miller, —. *E3383* (14).
Milligan, Mrs. J. M. *s.n.* (12); *s.n.* (15); *s.n.* (16); *9515* (43); *9516* (47).
Millspaugh, C. F. *399* (33).
Moffatt, W. S. *148, 646* (15); *645* (27).
Mohr, C. M. *s.n.* (8); *s.n.* (9); *s.n.* (10); *s.n.* (11); *s.n.* (15); *s.n.* (37).
Moldenke, H. N. *1059a, 1061* (5); *1130* (9); *1253, 1179a* (22); *1107* (30); *12536* (31); *1220* (32); *1254* (36).
Moldenke, H. N. (E. A. Friend). *10432* (31).
Monachino, J. *84* (33).
Moore, R. H. *s.n.* (32).
Morong, T. *s.n.* (46).
Morrison, J. L. *951* (15); *1093* (27).
Mosely, E. L. *s.n.* (27).
Mosier, C. A. *s.n.* (27).
Murphy, C. A. *s.n.* (15).
Myers, I. J. *118* (27).
Myers, S. E. *s.n.* (15); *s.n.* (47).

Nagle, J. F. *s.n.* (27).
Nash, G. V. *s.n.* (33).
Neally, G. C. *71, 73* (12); *69* (43).
Neisler, H. M. *s.n.* (23).
Nelson, A. *10817* (15).
Nelson, D. (Mrs. A.). *s.n.* (15); *s.n.* (47); *10816* (49).
Nieuwland, J. A. *10372* (27); *s.n.* (32).
Norton, J. B. *997* (27); *s.n.* (47).
Norton, J. B. & G. L. Clothier. *s.n.* (27).
Nuttall, T. *s.n.* (3); *s.n.* (12); *s.n.* (15); *s.n.* (20); *s.n.* (31); *s.n.* (47).

Oelmiller, A. *s.n.* (15).
Olds, G. B. *32* (27).
Olney, S. T. *s.n.* (33).
O'Neill, H. *s.n.* (5); *619* (30).
Oosting, H. J. *74* (30); *34111, 34145* (31); *34854, 34631* (33).
Orcutt, C. R. *5963* (21).
Ownbey, M. F. & R. P. *s.n.* (15).
Oyster, J. H. *23809* (43).

Palm, C. E. *6507* (47).
Palmer, E. J. *5213, 7570, 7631, 39303* (12); *39958* (14); *119, 128, 5563, 17928, 24494, 33276* (15); *24547* (16); *5001, 7841, 9072, 33316* (17); *17935* (26); *2464, 9427* (27); *38521* (30); *5046, 9228, 22436, 30463, 30474, 39282* (43); *5525, 24622, 29851* (47); *127* (49).
Palmer, E. J. & J. A. Steyermark. *40679* (15); *40269* (27).
Pammel, L. H. *s.n., 590* (15); *s.n.* (27).
Pammel, L. H. & V. C. Fisk. *s.n.* (15).
Pammel, L. H. & — Zimmerman. *327* (27).
Panton, M. H. *12* (15).
Parker, C. C. *s.n.* (27).
Parry, C. C. *s.n.* (15); *s.n.* (47).
Patterson, H. N. *s.n.* (15); *s.n.* (27).
Penfound, W. T. *1-16* (17).
Pennell, F. W. *12082, 11780* (46); *19329* (47).
Perkins, A. E. *s.n.* (23).
Perry, R. C. *s.n.* (32).
Petersen, N. F. *s.n.* (27).
Philson, F. J. *s.n.* (25).
Pitcher, Z. *s.n.* (15); *s.n.* (27); *s.n.* (47).
Plank, E. N. *s.n.* (27).
Pollock, W. M. *s.n.* (32); *s.n.* (33).
Pollard, C. L. *501* (46).
Polson, L. *14* (15); *s.n.* (47).
Poole, S. F. *75* (47).
Popenoe, W. *s.n.* (27).
Porter, T. C. *s.n.* (22).
ex Herb. Porter, T. C. *s.n.* (26).
Potzger, J. E. *2069* (33).
Pound, R. *s.n.* (33).
Powell, H. C. *17572* (15).
Price, S. F. *s.n.* (15).
Prior, A. *s.n.* (2).
Pyron, J. H. & R. McVaugh. *2457* (2); *2122, 2269, 2270* (9); *2799, 2883* (22); *2153, 2206, 2249* (30); *2690* (48).

Randolph, L. F. & F. C. *565* (31); *1067* (33).
Rapp, S. *1* (2).

Ravenel, H. W. *s.n.* (2); *s.n.* (3); *s.n.* (14); *s.n.* (23); *s.n.* (32); *s.n.* (37).
Reade, J. M. *E3381* (14); *E3371*, *E3390* (32).
Redfield, J. H. *11701* (22); *1186* (32); *s.n.* (33).
Reed, H. R. *27556-258* (43).
Rehn, J. A. *s.n.* (30).
Reverchon, J. *s.n.*, *11*, *184*, *2652*, *2654*, *3739*, *3740* (12); *s.n.* (15); *s.n.* (17); *1935* (27); *2655*, *s.n.*, *3738*, *4294* (43); *183*, *4293* (47).
Reynolds, M. C. *s.n.* (7); *s.n.* (9); *s.n.* (16).
Rice, W. S. & — Rast. *E3391* (14).
Rich, W. P. *s.n.* (33).
Ridgway, R. *909* (15).
Riegel, M. *s.n.* (14); *29* (26).
Riehl, N. *342* (15); *421* (27).
Roberts, T. S. *s.n.* (27).
Robinson, —. *s.n.* (27).
Rolfs, P. N. *676* (8); *85*, *671* (11).
Rose, J. N. *4192* (17); *4191* (43).
Rosendahl, C. O. *401* (27).
Rosendahl, C. O. & F. K. Butters. *3155* (15); *3061* (27).
Rugel, F. *s.n.* (1); *191* (5); *s.n.* (10); *190* (14); *s.n.* (22); *s.n.* (30); *s.n.* (32); *s.n.* (41).
Runyon, R. *1465* (16).
Russell, C. *s.n.* (27).
Russell, H. L. *s.n.* (15); *421* (27).
Russell, P. G. *s.n.* (46).
Ruth, A. *s.n.* (9); *62*, *621* (12); *s.n.*, *2217* (23); *306* (33).
Rydberg, P. A. *s.n.* (14); *8000* (31).
Rydberg, P. A. & R. Imler. *65* (27); *579*, *676* (47).

Sandberg, J. H. *s.n.* (27); *s.n.* (32).
Sartwell, H. P. *s.n.* (27).
Saurman, P. F. *s.n.* (10).
Schallert, G. J. *8456* (27).
Schallert, P. O. *s.n.* (27); *s.n.* (31); *859* (32).
Schrenk, J. *s.n.* (32).
Schuette, J. H. *s.n.* (27).
Schulz, E. D. *s.n.* (33).
Sears, P. B. *1332* (43).
Seymour, F. C. *1237* (32); *s.n.*, *679* (33).
Shafer, J. A. *615*, *s.n.* (46).
Shannon, J. I. *201* (27).
Sheldon, —. *17* (43).
Short, C. W. *s.n.* (46).
Shriver, H. *s.n.* (46).
Skavlem, H. L. *s.n.* (27).
Small, J. K. *s.n.* (2); *10413* (5); *s.n.* (22); *s.n.* (24); *s.n.* (26); *s.n.* (33); *s.n.* (37).
Small, J. K. & J. B. De Winkeler. *9085* (5).
Small, J. K., J. B. De Winkeler & C. A. Mosier. *11328* (5); *11181* (30).
Small, J. K., R. M. Harper & H. Gunter. *9671* (1).
Small, J. K., C. A. Mosier & P. A. Matthaus. *s.n.* (22); *s.n.* (27).
Small, J. K., J. W. Small & J. B. De Winkeler. *11450* (1); *11453* (5).
Smith, A. H. *s.n.* (14).
Smith, B. H. *s.n.* (15).
Smith, H. H. *274* (15); *6804*, *7835* (27); *2465*, *2544* (32).
Smith, H. L. *115* (27).
Smith, J. D. *s.n.* (2); *s.n.*, *447* (9); *93* (12); *97* (17); *s.n.* (22); *s.n.* (46).
Smith, J. C. *s.n.* (27).
Smith, L. B. & A. R. Hodgdon. *4197* (15).
Somes, M. P. *3095* (15).
Spence, E. J. *s.n.* (31).
Sperry, T. *s.n.* (47).
Springer, J. R. *s.n.* (9).
Spurlock, T. W. *s.n.* (46).
Stair, L. D. *s.n.* (33).
Standley, P. C. *9129* (15); *9454* (27); *57413* (32); *s.n.* (43).
Stanfield, S. W. *s.n.* (17).
Steele, E. S. *s.n.* (27); *s.n.* (33); *s.n.* (46).
Steele, E. S. & Mrs. E. S. *42* (33).
Steiger, T. L. *s.n.* (15); *s.n.* (27).
Steiner, E. *5608* (27).
Steinmetz, F. H. *s.n.* (33).
Stephens, J. L. *s.n.* (9); *s.n.* (24).
Stephenson, *168* (47).

Stevens, G. W. *2762* (15); *74* (16); *455, 547½, 2291* (47).
Stevens, M. E. *s.n.* (33).
Steyermark, J. A. *933, 13421* (15); *886, 8059, 13213, 13799* (16); *1353, 1471, 14379, 11293, 12825* (27); *993* (32); *1842, 13380, 13422, 10700-a, 24100* (47).
Stone, W. *616* (24).
Straub, F. C. *79* (9).
Sudworth, G. B. *131* (32).

Tatnall, R. *3363* (22); *2656* (36).
Taylor, Mrs. B. *s.n.* (27).
Taylor, K. A. *s.n.* (14); *s.n.* (22); *s.n.* (23); *s.n.* (37).
Taylor, W. R. *s.n.* (15).
Tees, G. M. *s.n.* (23).
Tharp, B. C. *5420, s.n.* (12); *2295, 3504* (17); *s.n., 5963* (18); *4739* (27); *2314, s.n.* (43).
Thomas, E. S. *s.n.* (27).
Tidestrom, I. *11399, 11514, 12254* (33); *s.n.* (46).
Tisdale, W. B. & E. West. *s.n.* (22).
Topping, D. L. *s.n.* (33).
Torrey, J. *s.n.* (15); *s.n.* (41).
Totten, H. R. *s.n.* (30); *s.n.* (39).
Tower, S. F. *s.n.* (33).
Tracy, S. M. *9100* (8); *3450* (12); *9346* (21).
Trelease, W. *s.n.* (16); *s.n.* (23); *198* (27); *s.n.* (47).
Trentham, S. O. *s.n.* (32).
True, R. *s.n.* (22); *s.n.* (36).
Tyler, E. E. *s.n.* (15).
Tyler, F. J. *s.n.* (46); *s.n.* (47).

Uhler, F. N. & P. A. Warren. *s.n.* (27).
Umbach, L. M. *s.n., 11964* (15); *s.n., 641, 1056, 3500, 3599 (31508), 3717, 11501* (27).
Underwood, J. K. & A. J. Sharp. *3050* (46).

Van Rensselaer, *s.n.* (27).
Van Vleet, A. H. *s.n.* (27).
Vasey, G. R. *s.n.* (10); *1182* (27); *s.n.* (33).

Wallace, C. *s.n.* (2); *s.n.* (31); *s.n.* (32).
Ward, L. F. *s.n.* (46).
Warner, S. R. *12* (12); *13* (43).
Watts, I. B. *s.n.* (15).
Weatherby, C. A. *6140* (14); *6111* (22).
Weatherwax, P. *3205* (46).
Webb, R. J. *534* (33).
Webber, H. J. *s.n.* (15); *s.n., 344* (27).
Weinzirl, J. *s.n.* (15).
Welch, W. *5858* (15); *5818* (27); *s.n.* (32).
Weller, S. *s.n.* (15).
Wellman, F. L. *s.n.* (15); *s.n.* (47).
Werner, W. C. *s.n.* (33); *s.n.* (46).
West, E. *s.n.* (1); *s.n.* (2); *s.n.* (5); *s.n.* (7); *s.n.* (9).
Whaley, C. *115* (27).
Wheeler, H. E. *s.n.* (12); *s.n.* (27).
Wheeler, W. A. *1034* (15).
Wherry, E. F. *s.n.* (14); *s.n.* (16).
Wherry, E. F. & F. W. Pennell. *13659* (46).
White, M. *s.n.* (15); *s.n.* (47).
Whitehouse, E. *s.n.* (12); *s.n.* (27).
Wiegand, K. M. *s.n.* (34).
Wiegand, K. M. & W. H. Manning. *1493, 1494* (31); *1491* (32).
Wild, —. *s.n.* (46).
Wilkins, H. *1417* (20).
Williams, C. B. *7* (16).
Williams, L. O. & R. *2110* (47).
Williamson, C. S. *s.n.* (2); *s.n.* (15); *s.n.* (24); *s.n.* (31); *s.n.* (46).
Williamson, S. M. *s.n.* (27).
Winter, J. M. *3* (27).
Wislizenus, F. A. *725* (15); *922* (32); *96, s.n.* (47).
Wolfe, J. J. *s.n.* (48).
Wolff, S. E. *1385* (17).
Woodson, R. E., Jr. *324* (15); *259, 740* (27).
Woodson, R. E., Jr. & E. S. Anderson. *1538* (12).
Woodson, R. E. & R. Schery. *115* (5).
Wright, C. *s.n.* (15); *s.n.* (17); *s.n.* (43).
W.U.U. Bot. Exp. *s.n.* (46).

York, H. H. *s.n.* (18).
Young, M. S. *s.n.* (12).

General Index

Accepted names are in Roman type; synonyms in *italics;* the principal references and new names in **bold face** type.

Explanation of Plate

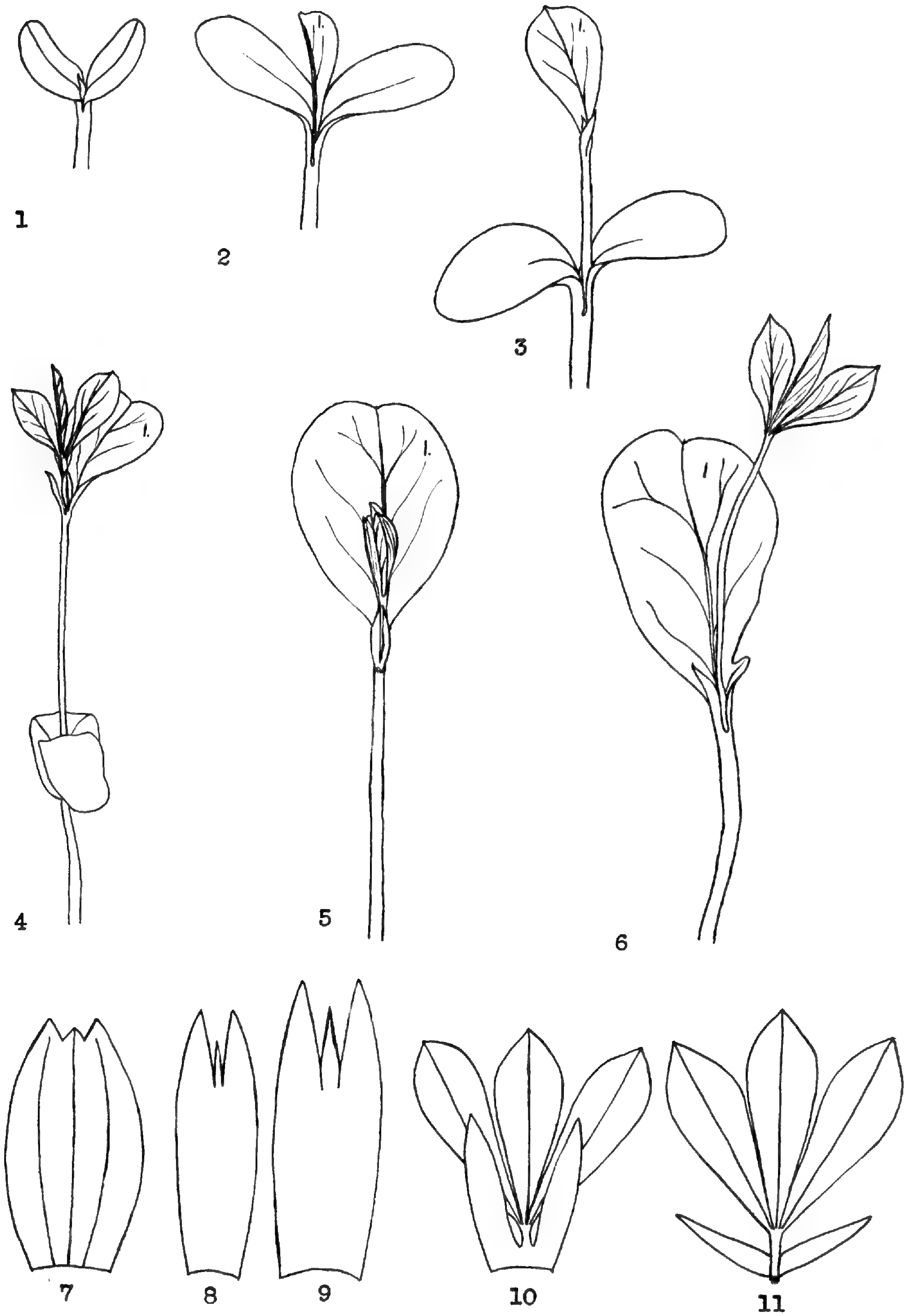
PLATE 16

SEEDLING STUDIES IN *B. AUSTRALIS* SHOWING ORIGIN OF LEAVES AND STIPULES

Figs. 1–5. Normal development: no fusion of stipules with primary, unifoliolate leaf.

Fig. 6. Abnormal development: fusion of one stipule with primary leaf.

Figs. 7–11. Series illustrating origin of trifoliolate, stipulate leaves from basal scales.



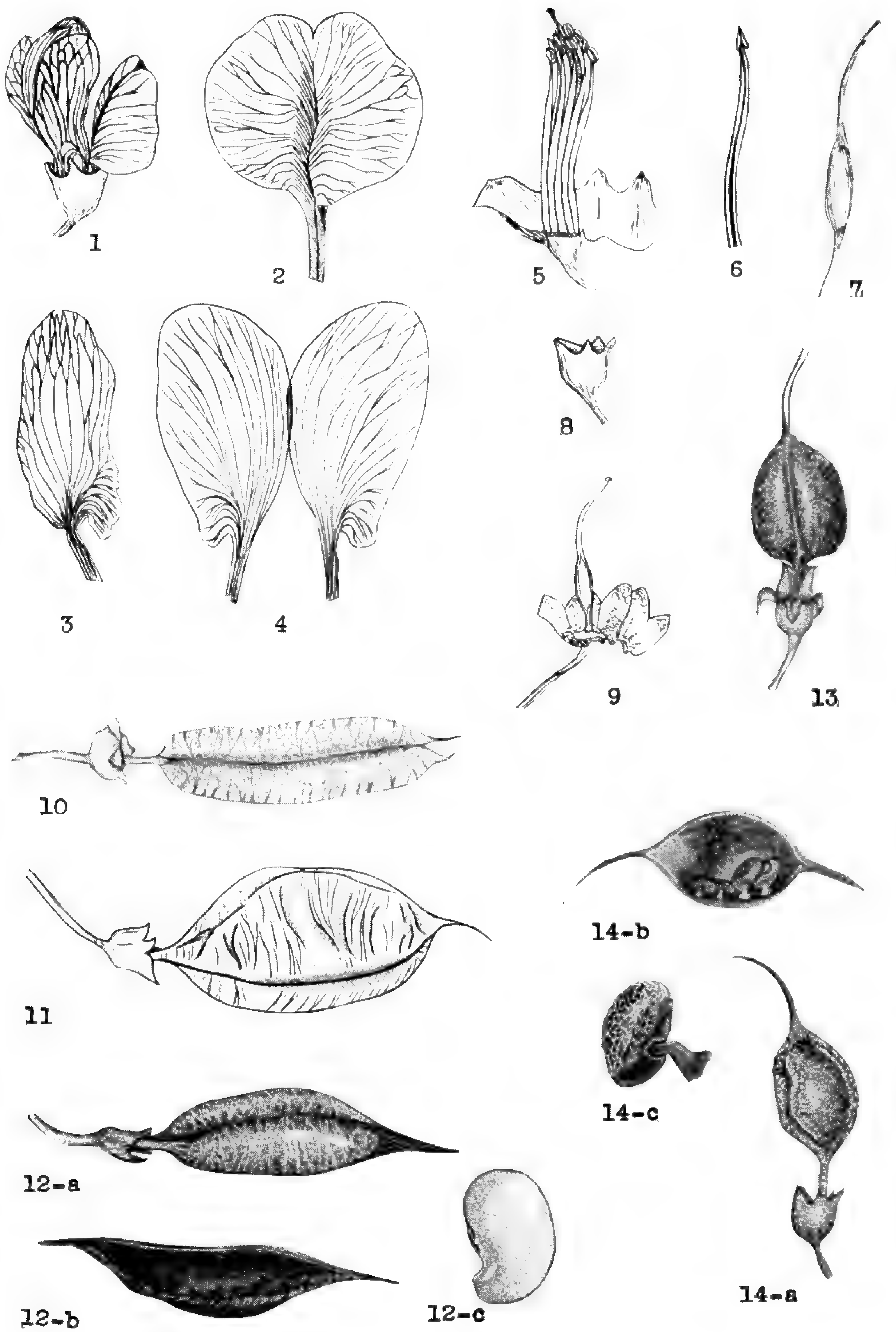
LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 17

FLORAL AND FRUIT CHARACTERS

Fig. 1. Flower, *B. tinctoria* (× 1⅔).
Fig. 2. Standard, *B. tinctoria* (× 2½).
Fig. 3. Wing, *B. tinctoria* (× 2½).
Fig. 4. Keel petals, *B. tinctoria* (× 3⅓).
Fig. 5. Calyx dissected to show insertion of stamens, *B. tinctoria* (× 2½).
Fig. 6. Stamen, *B. tinctoria* (× 3).
Fig. 7. Pistil, *B. tinctoria* (× 3).
Fig. 8. Calyx, *B. tinctoria* (× 1⅔).
Fig. 9. Calyx dissected to show insertion of pistil, *B. perfoliata* (× 1⅔).
Fig. 10. Mature pod, *B. alba* (× 1⅔).
Fig. 11. Mature pod, *B. megacarpa* (× ⅚).
Fig. 12. a. mature pod, *B. minor;* b. one side removed to show persistent ligneous funicle (× ⅚); c. ovule (× 6⅔).
Fig. 13. Mature pod, *B. perfoliata* (× 1⅔).
Fig. 14. a. mature pod, *B. tinctoria;* b. one side removed to show insertion of ovules (× ⅚); c. ovule (× 8⅓).



LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 18

TYPES OF LEAVES

Figs. 1-4. Ternately compound types of leaves.

Fig. 1. Leaf of *B. australis* (× 5/6).

Fig. 2. Leaf of *B. alba* (× 1⅔).

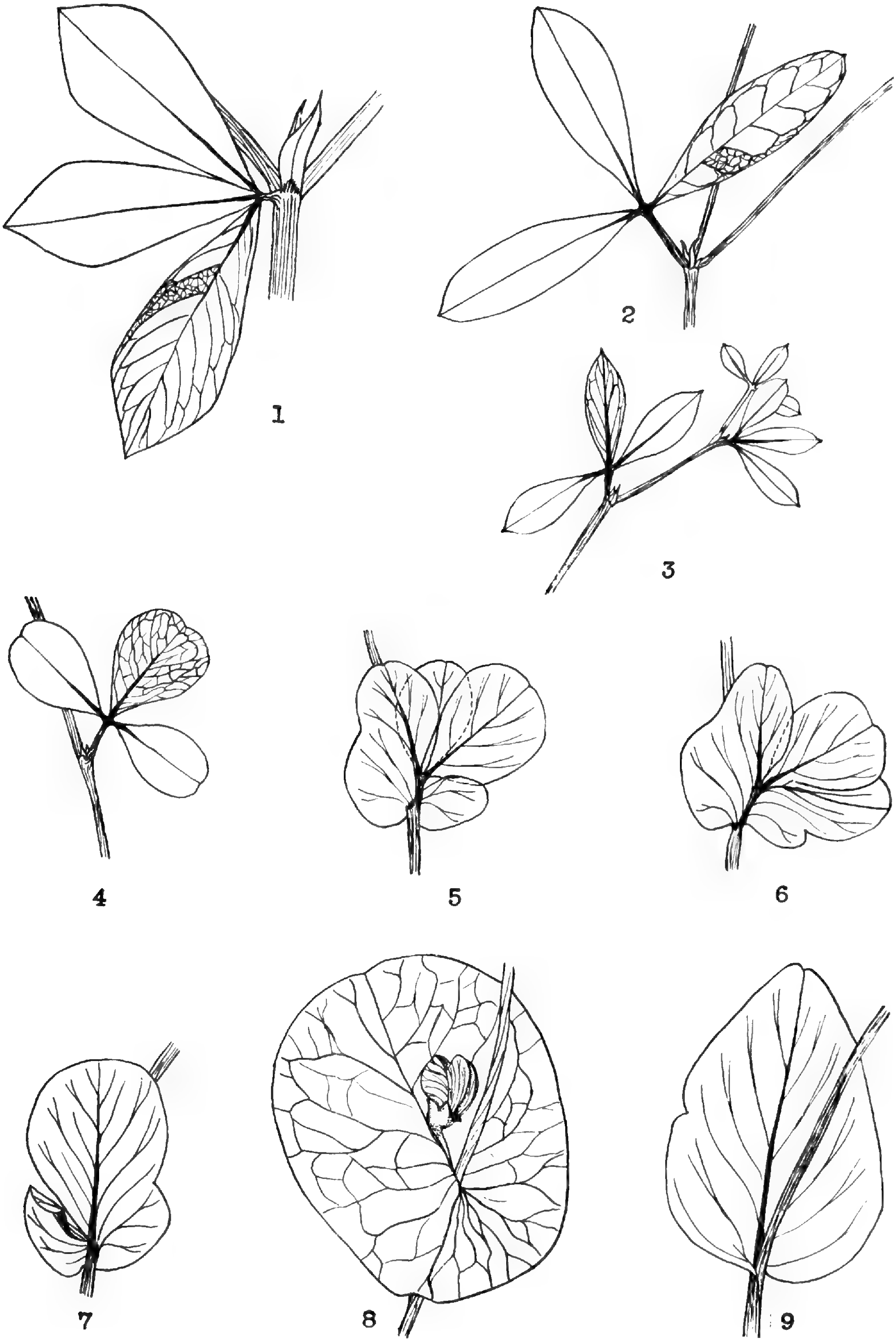
Fig. 3. Leaf of *B. minor* (× 5/6).

Fig. 4. Leaf of *B. tinctoria* (× 2½).

Figs. 5, 6, & 7. Transition stages from compound to simple leaf type in *B. microphylla* (× 5/6).

Fig. 8. Perfoliate leaf of *B. perfoliata* (× 5/6).

Fig. 9. Simple leaf of *B. simplicifolia* (× 5/6).



LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 19

Fig. 1. *B. sphaerocarpa* Nutt. From *Butler s.n.*, in Herbarium of the Missouri Botanical Garden.

Fig. 2. × *B. sulphurea* Engelm. From type specimen, *Butler s.n.*, in Herbarium of the Missouri Botanical Garden.

Fig. 3. *B. leucantha* Torr. & Gray. From *Butler s.n.*, in Herbarium of the Missouri Botanical Garden.

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LARISEY—MONOGRAPH OF BAPTISIA

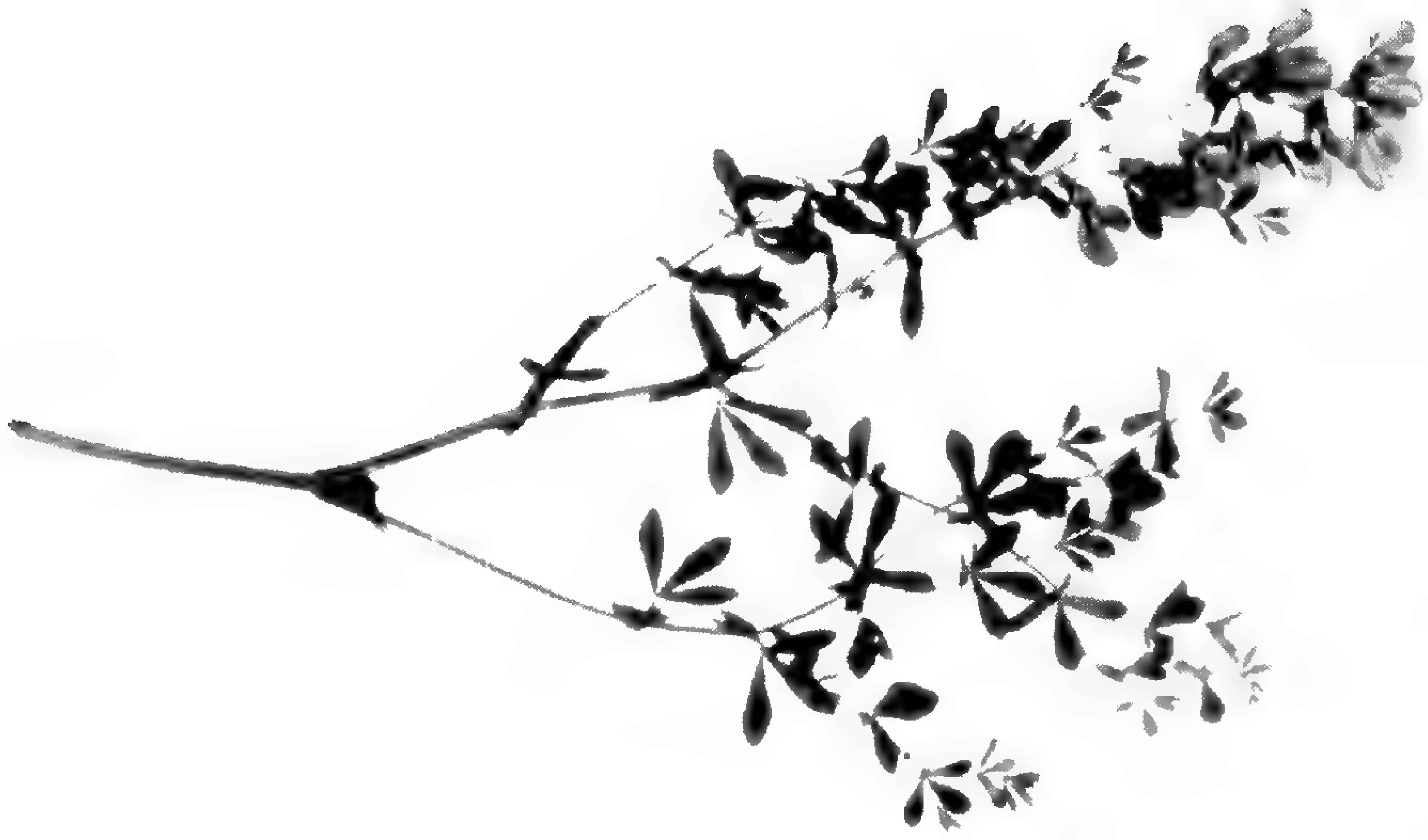
Explanation of Plate

PLATE 20

Fig. 1. *B. minor* Lehm. From *Anderson s.n.*, in Herbarium of the Missouri Botanical Garden.

Fig. 2. × *B. bicolor* Greenman & Larisey. From type specimen, *Palmer 127*, in Herbarium of the Missouri Botanical Garden.

Fig. 3. *B. leucophaea* Nutt. From *Cruikshanks* [Crookshanks] 7, in Herbarium of the Missouri Botanical Garden.



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LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 21

Fig. 1. *B. leucophaea* Nutt. var. *glabrescens* Larisey. From *Brainerd s.n.*, in Herbarium of the Missouri Botanical Garden.

Fig. 2. × *B. intermedia* Larisey. From cotype, *Harper 3476*, in the Gray Herbarium.

Fig. 3. *B. viridis* Larisey. From *Harper 3475*, in the United States National Herbarium.

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LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 22

Fig. 1. *B. leucantha* Torr. & Gray. From *Anderson & Hubricht s.n.*, in Herbarium of the Missouri Botanical Garden.

Fig. 2. × *B. fragilis* Larisey. From type specimen, *Anderson & Hubricht s.n.*, in Herbarium of the Missouri Botanical Garden.

Fig. 3. *B. viridis* Larisey. From *Anderson & Hubricht s.n.*, in Herbarium of the Missouri Botanical Garden.

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LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 23

Fig. 1. *B. tinctoria* (L.) Vent. var. *crebra* Fern. From *Deam 58,996*, in Herbarium of the Missouri Botanical Garden.

Fig. 2. × *B. Deamii* Larisey. From type specimen, *Deam 58,994*, in Herbarium of the Missouri Botanical Garden.

Fig. 3. *B. leucantha* Torr. & Gray. From *Deam 58,992*, in Herbarium of the Missouri Botanical Garden.

1 2 3

LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 24

Fig. 1. *B. alba* (L.) Vent. From *Jones s.n.*, in Herbarium of the Missouri Botanical Garden.

Fig. 2. × *B. pinetorum* Larisey. From type specimen, *Jones s.n.*, in Herbarium of the Missouri Botanical Garden.

Fig. 3. *B. tinctoria* (L.) Vent. var. *crebra* Fern. From *Jones s.n.*, in Herbarium of the Missouri Botanical Garden.

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LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 25

Fig. 1. *B. pendula* Larisey. From type specimen, *Curtiss 6810*, in Herbarium of the Missouri Botanical Garden.

Fig. 2. *B. pendula* Larisey var. *obovata* Larisey. From type specimen, *Coker s. n.*, in Herbarium of the University of North Carolina.

Fig. 3. *B. pendula* Larisey var. *macrophylla* Larisey. From type specimen, *Palmer 17,935*, in Herbarium of the Missouri Botanical Garden.

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LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 26

Fig. 1. *B. riparia* Larisey. From type specimen, *Totten s.n.*, in Herbarium of the University of North Carolina.

Fig. 2. *B. riparia* Larisey var. *minima* Larisey. From type specimen, *Griscom 21581*, in Gray Herbarium.

Fig. 3. *B. psammophila* Larisey. From type specimen, *Biltmore Herb. H/6046*, in Gray Herbarium.

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LARISEY—MONOGRAPH OF BAPTISIA

EXPLANATION OF PLATE

PLATE 27

Fig. 1. *B. intercalata* Larisey. From cotype specimen, *Langlois s.n.*, in Herbarium of the New York Botanical Garden.

Fig. 2. *B. intercalata* Larisey. From type specimen, *Langlois s.n.*, in Herbarium of the New York Botanical Garden.

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LARISEY—MONOGRAPH OF BAPTISIA

Explanation of Plate

PLATE 28

Fig. 1. *B. macilenta* Small ex Larisey. From type specimen, *Langlois s. n.*, in Herbarium of the New York Botanical Garden.

Fig. 2. *B. leucantha* Torr. & Gray var. *divaricata* Larisey. From type specimen, *Langlois s. n.* in Herbarium of the University of Wisconsin.

Fig. 3. *B. leucantha* Torr. & Gray var. *pauciflora* Larisey. From type specimen, *Langlois 10,* in Herbarium of the New York Botanical Garden.

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LARISEY—MONOGRAPH OF BAPTISIA

A REVISION OF THE NORTH AMERICAN SPECIES OF THE GENUS THERMOPSIS[1]

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INTRODUCTION

During a monographic treatment of the genus *Baptisia*, interest was aroused in the state of taxonomic confusion into which its closest generic affinity, *Thermopsis*, had fallen. According to the "Index Kewensis" and the Gray Herbarium Catalogue, it is comprised of thirty species: eight Asiatic, not considered in this revision; and twenty-two North American—four from the southeastern United States, and eighteen from the western United States. The latter group constitutes a western geographical supplement of *Baptisia* whose western limits roughly coincide with the eastern limits of *Thermopsis*.

The problems were found to be largely bibliographical. The present treatment proposes no novelties, but has indicated two new combinations. It consists largely of a drastic reduction of a number of species. The four heretofore recognized southeastern species are reduced to three, and the eighteen western species have been reduced to seven species and five varieties. A key to the species, and brief descriptions with complete citations of synonyms and type or authentic specimens are given.

Relative uniformity, particularly within the western group, makes delimitation of entities difficult in many cases. As in *Baptisia*, flower structure furnishes little of value in this respect, and has therefore been given little emphasis. Fruit and vegetative characters seem to be the best bases for the separation of species, and have been stressed accordingly. Considerable doubt is felt by the author as to the validity of the two varieties of *T. rhombifolia: annulocarpa* and *arenosa*, for they

[1] Issued May 10, 1940.

are frequently difficult to distinguish from the species. Likewise, *T. pinetorum* and *T. divaricarpa* are separated on rather weak bases. However, a consideration of geographical distribution substantiates their individuality. All others seem fairly distinct.

Appreciation is expressed to the following institutions through whose cooperation and facilities this work was made possible: The Missouri Botanical Garden, the Gray Herbarium of Harvard University, the New York Botanical Garden, the Academy of Natural Sciences of Philadelphia, the Field Museum of Natural History, Duke University, the University of North Carolina, the University of Colorado, the University of Wyoming, and the University of California.

Abbreviations

MBG—Missouri Botanical Garden.
GH—Gray Herbarium.
ANSP—Academy of Natural Sciences of Philadelphia.
FM—Field Museum.
COL—University of Colorado.
WYO—University of Wyoming.
CAL—University of California.

Taxonomy

Thermopsis R. Br. in Ait. Hort. Kew. ed. 2, **3**: 3. 1811.
Thermia Nutt. Gen. N. Am. Pl. **1**: 282. 1818.
Scolobus Raf. in Jour. Phys. **89**: 259. 1819.
Drepilia Raf. New Fl. N. Am. **2**: 52. 1836 [1837].

Perennial herbs with woody rhizomes. Plant usually less than 1 m. high, more or less pubescent throughout. Stem slender or stout, simply branched, branches erect or divaricate. Stipules conspicuous, persistent, frequently foliaceous, ovate-cordate to lanceolate-acuminate, 1–5 cm. long. Petioles 1–4 cm. long. Leaves trifoliolately compound, leaflets linear, elliptic, oblanceolate, or obovate, 3–8 cm. long. Flowers racemose, racemes terminal or axillary, compact or lax, few- to many-flowered. Floral bracts conspicuous, semi-persistent, ovate-cordate to lanceolate, 0.6–1.2 cm. long. Pedicels 1–3 cm. long. Calyx-tube campanulate, bilabiate, upper lip truncate to emarginate, lobes of the lower lip deltoid to lanceolate, usually one-half the length of the tube. Corolla papilionaceous, pale through deep yellow, 1–1.5 cm. in length. Legume sessile or very short-stipitate, usually linear, occasionally elliptic, not inflated, occasionally lomentaceous, straight, recurved, or annular, ascending or divaricate, 5–10 cm. long.

Distribution: North America: southeastern and western United States. Asia.

KEY TO THE SPECIES

1a. Plants of the southeastern United States
- 1b. Stipules foliaceous....................................*1. T. caroliniana*
- 2b. Stipules not foliaceous
  - 1c. Leaflets 2–4 cm. long....................................*2. T. mollis*
  - 2c. Leaflets 5–7 cm. long....................................*3. T. fraxinifolia*

2a. Plants of the western United States
- 1b. Pods divaricate
  - 1c. Pods more or less recurved
    - 1d. Plants from North Dakota and Saskatchewan, south to Nebraska and Colorado
      - 1e. Plant sparsely appressed-pubescent................*4. T. rhombifolia*
      - 2e. Plant densely silvery-pubescent....*5. T. rhombifolia* var. *annulocarpa*
      - 3e. Plant glabrate......................*6. T. rhombifolia* var. *arenosa*
    - 2d. Plants from Oregon and California
      - 1e. Plant sparingly strigose...........................*13. T. gracilis*
      - 2e. Plant silvery-canescent................*14. T. gracilis* var. *argentata*
      - 3e. Plant glabrate.........................*15. T. gracilis* var. *venosa*
  - 2c. Pods virtually straight.............................*7. T. divaricarpa*
- 2b. Pods ascending
  - 1c. Pods glabrate..*8. T. pinetorum*
  - 2c. Pods conspicuously pubescent
    - 1d. Leaflets linear..*9. T. montana*
    - 2d. Leaflets obovate to broadly elliptic
      - 1f. Plant softly pubescent to glabrate..................*10. T. ovata*
      - 2f. Plant woolly-tomentose.......................*11. T. macrophylla*
      - 3f. Plant silvery-silky canescent......*12. T. macrophylla* var. *velutina*

1. T. caroliniana M. A. Curt. in Am. Jour. Sci. I. **44**: 80. 1843.

Plant 0.8–1 m. high; stem stout, sparingly pubescent to glabrate, erect, simply branched; stipules foliaceous, clasping, broadly ovate, 4–5 cm. long, 2–3 cm. broad; petioles 4–6 cm. long; leaflets obovate, glaucous and finely appressed-pubescent below, 5–8 cm. long, 2.5–4 cm. broad; raceme compact, erect, 1.5–2.5 dm. long; bracts ovate, 3–6 mm. long, caducous; pedicels 2–4 mm. long; calyx-tube silky villous; legume firm, densely villous, straight, appressed to rachis, 4–5 cm. long.

Distribution: North Carolina to Georgia and Tennessee.

CITATION OF SPECIMENS:

NORTH CAROLINA: open woods near Highlands, Macon Co., July 3, 1897, *Biltmore Herb. 133b* (MBG); Highlands, 1889, *Boynton* (MBG); in montibus Carolinae et Georgiae, 1842, *Buckley* (MBG); Haywood Co., *Curtis* (GH, probable TYPE).

GEORGIA: banks of Tallulah River below Berton P. O., Aug. 18–20, 1893, *Small* (MBG).

TENNESSEE: hills around Nashville, *Gattinger, Curt. 700* (MBG); Harpeth hills near Nashville, 1875, *Gattinger* (MBG).

2. **T. mollis** (Michx.) M. A. Curt. ex A. Gray in Mem. Am. Acad. N. S. **3**: 47, *fig. 9*. 1848.

Podalyria mollis Michx. Fl. Bor. Am. **1**: 264. 1803.

Baptisia mollis (Michx.) DC. Prodr. **2**: 100. 1825.

Baptisia Hugeri Small in Bull. Torr. Bot. Club **25**: 139. 1898.

Thermopsis Hugeri Small, Fl. Southeast. U. S. 596, 1331. 1903.

Plant 3–5 cm. high, softly pubescent throughout; stem diffusely branched, branches slender; stipules varying from ovate to lanceolate, 0.4–1.2 cm. long; petioles 0.5–1.5 cm. long; leaflets broadly elliptic, occasionally ovate, apex acuminate, tawny-pubescent along the veins of the lower surface, 2–4 cm. long, 1–2 cm. broad; racemes compact, flexuous, 0.5–1.5 dm. long; bracts lanceolate, semi-persistent, 0.8–1 cm. long; pedicels 0.5–1 cm. long; calyx minutely pubescent; pods firm, elliptic, appressed-pubescent, divaricate, 3–4 cm. long.

Distribution: Virginia to North Carolina and Georgia.

CITATION OF SPECIMENS:

VIRGINIA: dry ridges near Hampden Sidney College, Prince Edward Co., June 1884, *Blair* (MBG).

NORTH CAROLINA: no definite locality, *Curtis* (ANSP,TYPE); no definite locality, *Curtis mis. 1842* (MBG); Statesville, *Hyams* (MBG); no definite locality, *Schweinitz* (ANSP).

GEORGIA: Cornelia, May 1, 1897, *Huger* (MBG,COTYPE of *T. Hugeri* Small).

3. **T. fraxinifolia** (Nutt.) M. A. Curt. in Am. Jour. Sci. I. **44**: 81. 1843.

Baptisia mollis (Michx.) Nutt. Gen. N. Am. Pl. **1**: 281. 1818.

Baptisia fraxinifolia Nutt. Mss. ex Torr. & Gray, Fl. N. Am. **1**: 387. 1840.

Plant 4–6 dm. high, lightly appressed-pubescent throughout; stem occasionally glabrate, branched, branches geniculate, slender; stipules lanceolate, 0.8–1 cm. long, persistent; petioles 1.5–2.5 cm. long; leaflets obovate-elliptic, lower surface pubescent along the veins, 5–7 cm. long, 2–3 cm. broad; racemes loose, flexuous, 1–2 dm. long; bracts ovate-cordate, 0.5–1.5 cm. long, semi-persistent; pedicels 0.5–1.2 cm. long; calyx glabrate; pods linear, delicate, minutely pubescent, recurved, divaricate, 7–8 cm. long.

Distribution: North Carolina to Georgia and Tennessee.

Citation of Specimens:

North Carolina: southeastern North Carolina, *Ashe* (MBG); Pilot Mtn., July 1895, *Ashe* (MBG); rich, shady slopes, Biltmore, May 1 & 10, 1896, *Biltmore Herb. 1025* (MBG); in montibus Carolinae et Georgiae, 1842, *Buckley* (MBG); no definite locality, 1842, *Curtis* (MBG); in vicinity of Table Rock Mtn., Aug. 2, 1890, *Heller* (MBG); Asheville, June 1925, *Kraus* (MBG); no definite locality, *Nuttall* (ANSP, type of *B. fraxinifolia* Nutt.); dry soil, Black Mtns., Sept. 4, 1931, *Sharp* (MBG).

Tennessee: Lookout Mtn., May 1869, *Canby* (MBG).

4. **T. rhombifolia** Nutt. ex Richards. in Frankl. Narr. First Journ. App. 737. 1823.

Cytisus rhombifolius Nutt. in Fras. Cat. 1813; Pursh, Fl. Am. Sept. Suppl. **2**: 741. 1814.

Thermia rhombifolia Nutt. Gen. N. Am. Pl. **1**: 282. 1818.

Plant 2–4 dm. high, appressed-pubescent throughout; stem slender, firm, geniculate, sparingly branched; stipules ovate-cordate, 0.5–1 cm. long; petioles 0.5–1 cm. long; leaflets obovate-cuneate to elliptic or oblanceolate, 2–3 cm. long, 1–2 cm. broad; racemes loose, usually less than 1 dm. long; bracts lanceolate, 5–7 mm. long, usually caducous; calyx-tube usually somewhat villous; pods silky villous, lomentaceous, recurved to annular, divaricate, 4–6 cm. long.

Distribution: North Dakota and Alberta, south to Nebraska and Colorado.

Citation of Specimens:

North Dakota: clay soil near top of butte, Medora, June 1, 1912, *Bergman* (MBG); sandy bluffs, Bismarck, May 1891, *Lanterman* (MBG).

South Dakota: hilltop near Lead, June 24, 1928, *Lee* (MBG); eroded banks and ravines, Bad Lands, near Wall, Pennington Co., June 15, 1929, *Palmer 37290* (MBG); open rocky woods near Lead, Lawrence Co., June 17, 1929; *Palmer 37352* (MBG); foothills, Black Hills, Rapid City, June 30, 1909, *White* (MBG).

Nebraska: sandy banks of Missouri, Fort Pierre, June 1853, *Hayden* (MBG); river bottoms above Council Bluffs, June 10, 1853, *Hayden* (MBG); Frankl. Exp., *Hooker* (ANSP); common in dry washes and slopes, Sioux Co., May-June 1927, *Kramer 52* (MBG); no definite locality, *Nuttall* (ANSP,type).

Saskatchewan: open hillside, Lupton, May 11, *Clokey 1800* (MBG); Estevan, June 22, 1907, *Cowles 18* (MBG).

Alberta: prairie and stubble, Craigmyle district, May 25, 1922, *Brinkman* (MBG); dry gravelly soil, Red Deer Valley, vicinity of Rosedale, May 10, 1915, *Moodie 860* (MBG).

Montana: Custer, 1890, *Blankinship 22* (MBG); Westby, June 17, 1927, *Larsen 20* (MBG).

Wyoming: disintegrated rocks, Ridge, Albany Co., June 18, 1901, *Goodding 38* (MBG); slate slides, Alcova, Natrona Co., June 29, 1901, *Goodding 151* (MBG); Table Mtn., June 2, 1894, *Nelson 121 & 122* (MBG); open stony ridges, Arlington, July 10, 1924, *Nelson 10145* (MBG); shale soil 8 mi. northwest of Hulett, Crook Co., June 6, 1935, *Ownbey 646* (MBG); dry soil, Telephone Canyon, Laramie Hills, Albany Co., May 30, 1936, *Ownbey 1027* (MBG); dry slopes, Bates Hole, June 20, 1926, *Payson & Payson 4760* (MBG); dry hillsides 6 mi. west of Keycee, Johnson Co., April 27, 1934, *Rollins 413* (MBG); plains at base of Cheyenne Mtn., May 4, 1891, *Smith* (MBG); dry plains, Carbon Co., May 27, 1932, *Williams 397* (MBG); in gravel, Telephone Canyon, east of Laramie, Albany Co., June 18, 1935, *Williams 2218* (MBG); pine forest, South Fork of Clear Creek, Johnson Co., June 26, 1936, *Williams & Williams 3117a* (MBG).

Colorado: Canyon City, May 1871, *Brandegee 19 & 22* (MBG); infrequent on sandstone rock 5 mi. east of Boulder, April 30, 1921, *Hanson C41* (MBG); Platteville, April 17, 1908, *Johnston 462* (MBG); Fern Lake Trail, Estes Park, June 20, 1929, *Mathias 408* (MBG); Manitou, May 15, 1892, *Mulford* (MBG); on plains 2 mi. north of Simla, Elbert Co., June 23, 1937, *Ownbey 1296* (MBG); Mt. Pass, July 1, 1886, *Trelease* (MBG); Gregory Cañon, Boulder Co., May 21, 1912, *Vestal 368* (MBG).

5. T. rhombifolia var. **annulocarpa** (Nels.) L. Wms. in Ann. Mo. Bot. Gard. **23**: 450. 1936.

T. annulocarpa A. Nels. in Bull. Torr. Bot. Club **26**: 239. 1899.

As the species except somewhat more densely silvery-pubescent throughout, and pods usually completely annular.

Distribution: Wyoming.

Citation of Specimens:

Wyoming: along roadsides, Bills' Flat, Big Horn Co., July 25, 1901, *Goodding 353* (MBG); among rocks on naked slopes near summits of Ferris Mtns., July 25, 1898, *Nelson 4971* (WYO,type of *T. annulocarpa* Nels.); in clay and sandy ravines, Fort Steele, Carbon Co., June 16, 1900, *Nelson 7252* (MBG); barren slopes above snow bank, Bates Hole, June 20, 1926, *Payson & Payson 4799* (MBG); in pine forest on South Fork of Clear Creek, Johnson Co., June 26, 1936, *Williams & Williams 3117* (MBG).

6. T. rhombifolia var. **arenosa** (Nels.) Larisey, comb. nov.

T. arenosa A. Nels. in Bot. Gaz. **25**: 276, *pl. 18. fig. 4.* 1898.

As the species except somewhat larger in general habit and tending to become glabrate.

Distribution: Wyoming.

CITATION OF SPECIMENS:

WYOMING: Laramie Hills, July 17, 1897, *Nelson 3182a* (WYO, TYPE of *T. arenosa* Nels.); sandy washes, Laramie Hills, June 1906, *Nelson* (MBG); sandy soil, foot of Telephone Canyon, Laramie Mtns., Albany Co., June 8, 1933, *Porter 1291 & 1329* (MBG).

7. T. divaricarpa A. Nels. in Bot. Gaz. **25**: 275. 1898.

Plant 4–6 dm. high, softly pubescent to glabrate throughout; stem slender, firm, branched; stipules ovate-lanceolate, 1.5–2.5 cm. long; petioles 1–2 cm. long; leaflets oblanceolate-elliptic, 3–4 cm. long, 1–2 cm. broad; racemes loose, erect, 1–2 dm. long; bracts ovate-lanceolate, 8–10 mm. long, usually caducous; pedicels 4–6 cm. long; calyx-tube softly pubescent to glabrate; pods lomentaceous, softly pubescent to glabrate, usually straight, or only slightly recurved, divaricate, 4–7 cm. long.

Distribution: Wyoming and Colorado.

CITATION OF SPECIMENS:

WYOMING: rocky bars near Little Laramie River, Albany Co., June 15, 1901, *Goodding 10* (MBG); stream bank near Centennial, Albany Co., June 24, 1929, *Goodman 632* (MBG); Telephone Canyon, Pole Creek, Medicine Bow Mtns., July 16, 1925, *Hanna 96* (MBG); J. Johnson's ranch, Aug. 8, 1897, *Nelson 3903* (WYO, TYPE); along banks, Sand Creek, Albany Co., June 2, 1900, *Nelson 7031* (MBG); creek banks, Mandel, Albany Co., July 24, 1903, *Nelson 1910* (MBG); edge of thickets, Fish Creek, Albany Co., July 4, 1917, *Nelson 9784* (MBG); moist creek bottom, Crow Creek, Laramie Hills, Albany Co., July 11, 1935, *Rollins 977* (MBG); dry hillside among sage-brush near Crow Creek, Laramie Mtns., Albany Co., June 20, 1935, *Williams 2236* (MBG).

COLORADO: Breckenridge, Rocky Mtns., 1871, *Brandegee 279* (MBG); Brookvale, Clear Creek Co., June 11, 1918, *Churchill* (MBG); Ward, July 7, 1906, *Daniels 109* (MBG); Clear Creek Valley, Idaho Springs, Aug. 2, 1874, *Engelmann* (MBG); slopes, Anita Peak, Routt Co., Aug. 3, 1903, *Goodding 1779* (MBG); common 10 mi. west of Boulder on dry slopes near Boulder Falls, July 5, 1920, *Hanson c375* (MBG); Boulder, Aug. 21, 1884, *Letterman* (MBG); near Breckenridge, Summit Co., Aug. 1901, *Mackenzie 256* (MBG); near houses, Wagon Wheel Gap Exp. Station, Mineral Co., June 3, 1900, *Murdoch 4524* (MBG); moist mountain meadows, Trails' End, Aug. 26, 1923, *Nelson 10019* (MBG); wet creek banks, Salida, May 18, 1925, *Nelson 10495* (MBG); stream banks, Idaho Springs, Sept. 3, 1928, *Nelson 10948* (MBG); dry slopes, Tolland, July 4, 1923, *Overholts, Roberts & Shope 140* (MBG); Idaho Springs, July 20, 1884, *Smith* (ANSP); Lyons, May 23, 1892, *Smith* (MBG); Manitou Park, July 7, 1891, *Trelease* (MBG); Golden, June 30, 1933, *Zobel* (MBG).

8. T. pinetorum Greene, Pittonia **4**: 138. 1900.

T. pauciflora Thornber ined.

Plant 3–4 dm. high, sparsely pubescent to glabrate; stem slender, firm, branched; stipules broadly lanceolate, 1.5–3.5 cm. long, lowermost frequently longer than the leaflets; petioles 1.5–3 cm. long; leaflets broadly oblanceolate to elliptic, glabrous above, sparsely appressed-pubescent below, 4–5 cm. long, 1.5–3 cm. broad; racemes loose, few-flowered, usually less than 1 dm. long; bracts ovate-cordate, semi-persistent; pedicels 5–10 mm. long; calyx silky-villous; pods straight, ascending, glabrate, 4–6 cm. long.

Distribution: Colorado to New Mexico, Utah, and Arizona.

Citation of Specimens:

Colorado: Flat Top Mtn., Estes Park, Aug. 14, 1933, *Allen 3* (MBG); Larimer Co., May 10, 1895, *Baker* (MBG); Los Pinos (Bayfield), May 23, 1899, *Baker 442* (fl.) (MBG,WYO,part of type, CAL,ND); Marshall Pass, July 19, 1901, *Baker 485* (fr.) (MBG,FM,WYO,CAL,ND,part of type); Chicken Creek, La Plata Mtns., July 6, 1898, *Baker, Earle & Tracy 350* (MBG); dry soil, Mount Vernon Cañon, Jefferson Co., June 20, 1921, *Bethel & Clokey 4186* (MBG); Estes Park, Aug. 14, 1933, *Burton* (MBG); meadow, Fremont Ranger Station, Rio Grande Nat. Forest, Mineral Co., May 27, 1911, *Murdoch 4519* (MBG); dry hillsides, Tolland, June 25, 1913, *Overholts* (MBG); Ward, 1908, *Pace 296* (MBG); aspen groves, Uncompahgre Divide, W. Montrose Co., July 3, 1924, *Payson & Payson 3898* (MBG); Denver, May 23, 1892, *Smith* (MBG).

New Mexico: Solitario, vicinity of Las Vegas, July 9, 1926, *Arsène 17863* (MBG); canyon, vicinity of Santa Fe, July 31, 1926, *Arsène & Benedict 16925* (MBG); Balsam Park, Sandia Mtns., May-June 1915, *Ellis 40* (MBG); base of mountains in Santa Fe Creek Valley 5 mi. above town, May 1847, *Fendler 185* (MBG); along Pecos River 8 mi. east of Glorietta, San Miguel Co., June 9, 1897, *Heller & Heller 3681* (MBG); in Mogollon Mtns. near west fork of Gila River, Socorro Co., Aug. 23, 1903, *Metcalfe 593* (MBG).

Arizona: Chiricahua Mtns., Barfoot Park, north slope, Aug. 19, 1907, *Blumer 1590* (MBG); Matzatzal Mtns., Gila Co., *Collom 286* (MBG); Chiricahua Mtns., Rustlers' Park, June 18-19, 1930, *Goodman & Hitchcock 1162* (MBG); yellow pines, Flagstaff, Aug. 4, 1922, *Hanson A81* (MBG); Baker's Butte, June 2, 1890, *Jones* (MBG); Flagstaff, June 1883, *Rusby 551* (MBG); stony creek banks, Flagstaff, April 21, 1925, *Nelson 10200* (MBG); Oak Creek Canyon, May 24, 1935, *Nelson & Nelson 2108* (MBG).

UTAH: gravel, Silver Reef, May 4, 1894, *Jones 5158* (MBG); Elk Ridge, west ridge, San Juan Co., June 23, 1932, *Maguire & Redd 1918* (MBG); near timberline, La Sal Mtns., Grand Co., July 22, 1924, *Payson & Payson 3957* (MBG); moist shaded locations in canyon, Geyser Basin, San Juan Co., July 19, 1912, *Walker 315* (MBG).

9. T. montana Nutt. ex Torr. & Gray, Fl. N. Am. **1**: 388. 1840.

T. fabacea (Pall.) DC. ex Hooker, Fl. Bor. Am. **1**: 128. 1838.

T. angustata Greene, Pl. Baker. **3**: 34. 1901.

T. stricta Greene, Pl. Baker. **3**: 34. 1901.

Plant 6–8 dm. high, slightly villous to glabrate in parts; stem stout, succulent, sparingly branched, branches ascending; stipules linear-lanceolate, ascending, 2–3 cm. long; petioles 1–3 cm. long; leaves ascending, leaflets linear to linear-lanceolate, converging, 3–8 cm. long; racemes compact, erect, 1–2 dm. long, bracts lanceolate, 0.8–1.2 cm. long, semi-persistent; pedicels 4–6 mm. long; calyx-tube silky villous; pods villous, straight, erect, closely appressed to rachis, 5–7 cm. long.

Distribution: Montana south to Colorado, west to Oregon and Nevada.

CITATION OF SPECIMENS:

MONTANA: frequent, low ground, Bozeman, June 28, 1899, *Blankinship* (MBG); low ground, Belgrade, June 2, 1906, *Blankinship 681* (MBG); Sheridan, June 1895, *Fitch* (MBG); East Gallatin Swamps, July 24, 1896, *Flodman 614* (MBG); meadow, Armsted, Beaverhead Co., June 20, 1920, *Payson & Payson 1734* (MBG).

WYOMING: river bottoms, Henry's Fork, Uintah Mtns., June 26, 1902, *Goodding 1192* (MBG); meadows, Slater, Colo.-Wyo. line, Carbon Co., July 31, 1903, *Goodding 1733* (MBG); moist, grassy bottom-land along Ham's Fork, Granger, June 11, 1931, *Hanna 735* (MBG); moist peat in meadow of grasses and sedges, Lonetree, Uintah Co., June 21, 1934, *Harrison & Larsen 7915* (MBG); moist grassy places, Fort Bridger, June 27, 1926, *Heller 13949* (MBG); among willows and cottonwoods, Evanston, Uintah Co., June 14, 1900, *Nelson 7216* (MBG); wet river lands, Baggs, July 4, 1926, *Nelson 10720* (MBG); Laramie, June 28, 1899, *Pammel 57* (MBG); in wet swales, hills east of Lyman, June 8, 1932, *Rollins 147* (MBG).

COLORADO: Fort Collins, May 15, 1896, *Baker* (MBG); Sapinero, June 19, 1901, *Baker 173* (fl.) (MBG,WYO,CAL,ND,part of TYPE of *T. stricta* Greene); Gunnison, July 24, 1901, *Baker 604* (fr.) (MBG,WYO,CAL,ND,part of TYPE of *T. stricta* Greene); clearing, Everett Lake, Lake Co., July 5, 1919, *Clokey 3588* (MBG); no definite locality, 1871, *Greene* (MBG); low wet grassy banks of White River, 2 mi. east of Meeker, Rio Blanco Co., Aug. 18, 1935, *Maguire & Piranian 12844* (MBG); rocky mountain slopes between Corona Station and Tolland, Gilpin Co., June 24, 1926, *Palmer 31258* (MBG); river bottom, Naturita, May 20, 1914, *Payson 330* (MBG); Canyon City, 1888, *Wislizenus 843* (MBG).

IDAHO: Bear Lake, Aug. 8, 1898, *Mulford 280* (MBG); wet sandy banks, Devil Creek, Owyhee Co., June 27, 1912, *Nelson & Macbride 1742* (MBG).

UTAH: Kimballs, vicinity of Salt Lake City, June 3, 1908, *Clemens* (MBG); north slope of Abajo Mtns., July 1-2, 1930, *Goodman & Hitchcock 1389* (MBG); damp meadow near Bear River, Summit Co., Aug. 10, 1931, *Greenman & Greenman 4620* (MBG); Fish Lake, Aug. 10, 1927, *Harris c27572* (MBG); deep shade of aspen grove, Ashley Forest, Duchesne Co., June 13, 1934, *Harrison & Larsen 7623* (MBG); dry rocky hillside, Carter Creek, Daggett Co., June 19, 1934, *Harrison & Larsen 7883* (MBG); grassy bank of Sheep Creek at Manila Rd., Daggett Co., July 11, 1933, *Hermann 4728* (MBG); edge of aspens in wet meadow, Goodman ranch, Bear River Valley, Summit Co., Aug. 9, 1933, *Hermann 5764* (MBG); Heyrum, May 15, 1898, *Mulford 44* (MBG); in woods, shady banks of Bear River, Uintah Mtns., July 26-Aug. 7, 1902, *Pammel & Blackwood 4113* (MBG); Fish Lake, July 9, 1875, *Ward 344* (MBG); Sheep Creek Canyon, vicinity of Flaming Gorge, Daggett Co., May 29, 1932, *Williams 432* (MBG).

NEVADA: vicinity of Current, Nye Co., May 1916, *Bentley* (MBG); Star Valley, foothills of Ruby Mtns., July 20, 1896, *Greene* (ND,TYPE of *T. angustata* Greene); Star Canyon southeast of Deeth, Elko Co., July 10, 1912, *Heller 10575* (MBG); Wells, June 22, 1930, *Jones 25461* (MBG); Eureka, Eureka Co., July 2, 1904, *Kennedy 838* (MBG); North Fork, Humboldt River, Elko Co., Aug. 6, 1913, *Kennedy 4474* (MBG); sandy river banks, Mountain City, Aug. 13, 1912, *Nelson & Macbride 2200* (MBG); Camp Hallick, 1876, *Palmer* (MBG).

OREGON: moist sunny bottoms of South Fork, John Day, Prairie City, Grant Co., June 5 & 17, 1925, *Henderson 5384* (MBG); Canyon City, May 20, 1885, *Howell* (MBG); dry woods, summit of Blue Mtns., near Meacham, Umatilla Co., May 10, 1928, *Gale 254* (MBG).

EXACT LOCALITY UNKNOWN: Rocky Mountains, *Nuttall* (ANSP,TYPE).

10. T. ovata (Rob.) Rydb. in Bull. Torr. Bot. Club **40**: 43. 1913.

T. montana subsp. *ovata* Rob. in Contr. U. S. Nat. Herb. **2**: 349. 1906.

T. xylorrhiza Nels. in Bot. Gaz. **52**: 265. 1911.

Plant 6–8 dm. high, softly pubescent to glabrate throughout; stem stout, succulent, sparingly branched; stipules foliaceous, obovate to ovate-cordate, 2–4 cm. long; petioles 2–4 cm. long; leaflets obovate to broadly elliptic, 6–8 cm. long, 2–4 cm. broad; racemes loose, 2–3.5 dm. long; bracts foliaceous, ovate-cordate, 1–1.5 cm. long; calyx-tube villous; pods silky-villous, ascending, usually but not always closely appressed to the rachis, 5–7 cm. long.

Distribution: Wyoming west to Washington, and Oregon.

CITATION OF SPECIMENS:

WYOMING: Evanston, July 28, 1897, *Nelson 3863* (MBG).

IDAHO: forest, Nez Perces Co., Aug. 1896, *Brown* (MBG); grassy ditch, arid transition ½ mi. southeast of Lapwai, Nez Perces Co., May 3, 1935, *Constance, Clark, Dillon, Machlis & Rollins* (MBG); sandy bank of Middle Fork Clearwater River, at mouth of Squaw Creek, 3 mi. below Lowell, Canadian Zone, Nez Perces National Forest, Idaho Co., May 30, 1936, *Constance & Rollins 1621* (MBG); Latah Co., 1896, *Elmer 363* (MBG); Cedar Mtns., Latah Co., July 1899, *Elmer 1535* (MBG); near Lewiston, Nez Perces Co., May 7, 1896, *Heller & Heller 3035* (MBG); Indian Valley, July 13, 1899, *Jones 6222* (MBG); shady loam slopes, Falks' Store, Canyon Co., May 24, 1910, *Macbride 99* (MBG,WYO,CAL,TYPE of *T. xylorrhiza* Nels.); moist loamy flats, Falks' Store, Canyon Co., May 10, 1911, *Macbride 800* (MBG); natural meadow lands, Squaw Creek (Sweet), May 9, 1911, *Macbride 845* (MBG); Latah Co., June 16, 1893 (June 21, 1894), *Piper 1489* (MBG,FM,TYPE); sandy shores, valley of Hatwai Creek, Nez Perces Co., April 28, 1892, *Sandberg, MacDougal & Heller 68* (MBG).

WASHINGTON: light shade of lodgepole forest 4 mi. north of Table Rock, Blue Mtns., Columbia Co., July 20, 1935, *Constance, Clarke, Staats & Van Vleet* (MBG); Oxford Prairie, Chehalis Co., June 12, 1897, *Lamb 1197* (MBG,ANSP,FM,CAL); roadsides north of Hoquiam, Grays Harbor Co., May 9, 1931, *Thompson 6238* (MBG); roadside near Humptulips, Grays Harbor Co., July 10, 1931, *Thompson 7342* (MBG).

OREGON: moist situations, eastern Ore., June 24, 1899, *Cusick 2203* (MBG); Summit, June 1, 1892, *Mulford* (MBG); open woods near summit of Blue Mtn., between Pendleton and La Grande, June 14, 1928, *Thompson 4723* (MBG); damp field south of Imbler, Union Co., June 15, 1928, *Thompson 4830a* (MBG); wooded slopes of Sexton Mtn., Josephine Co., April 9, 1934, *Thompson 10209* (MBG).

11. T. macrophylla Hook. & Arn. Bot. Beech. Voy. 329. 1840; Torr. & Gray, Fl. N. Am. **1**: 388. 1840; Torr. in Pac. Rail. Rept. **4**: 81. 1856.

T. fabacea (Pall.) DC. ex Torr. Bot. Mex. Bound. Surv. 58. 1856.

T. californica S. Wats. in Proc. Am. Acad. **11**: 126. 1876.

T. robusta Howell in Erythea **1**: 109. 1893.

Plant 4–6 dm. high, woolly-tomentose throughout; stem stout, diffusely branched, branches ascending; stipules foliaceous, ovate-cordate, 2–3.5 cm. long; petioles 1.5–2.5 cm. long; leaflets obovate-cuneate to oblanceolate or occasionally elliptic, 4–7 cm. long, 3–4 cm. broad; racemes loose or compact, straight, erect, 1.5–2.5 dm. long; bracts ovate-cordate, 0.5–1 cm. long, semi-persistent; pedicels 4–6 mm. long; calyx appressed-pubescent; pods densely appressed-pubescent, erect, 6–8 cm. long.

Distribution: Oregon and upper California.

Citation of Specimens:

Oregon: Coast Mtns., Curry Co., June 1884, *Howell 75* (GH); Coast Mtns., 40th parallel, June 8, 1884, *Howell* (FM).

California: in moist grassy places in open hills, Crystal Springs Lake, San Mateo Co., May 1, 1902, *Baker 685* (MBG); Knoxville, Napa Co., May 8, 1903, *Baker 3081* (MBG); Pac. R.R. Exp., 1853–4, *Bigelow* (ANSP); dry hillsides, Coast Range, San Rafael, May 1865, *Bolander* (MBG); near Mendocino, Mendocino Co., May 1898, *Brown 732* (MBG); no definite locality, *Douglas* (GH, probable type); Tassajara Hot Springs, Monterey Co., June 1901, *Elmer 3289* (MBG); Mount Hamilton, Santa Clara Co., June 1903, *Elmer 5023* (MBG); Marin Co., April 4, 1921, *Epling 5233* (MBG); no definite locality, 1846, *Fremont 149* (MBG); Lagunitas, Marin Co., April 28, 1918, *Grinnell* (MBG); Smith Creek, foot of Mt. Hamilton, Santa Clara Co., May 10, 1907, *Heller 8518* (MBG,ANSP,FM); damp soil in ditch along highway about 5 mi. south of Calistoga, Napa Co., April 12, 1924, *Heller 13837* (MBG); between Santa Rosa and Agua Caliente, Sonoma Co., April 22, 1902, *Heller & Brown 5343* (MBG); Mt. Tamalpais, April 10, 1906, *Hobson* (MBG); Napa Co., Mar. 1852, *Thurber 548* (MBG,FM); San Luis Obispo, May 9, 1882, *Jones 2660* (MBG).

12. T. macrophylla var. **velutina** (Greene) Larisey, comb. nov.

T. californica var. *velutina* Greene in Erythea **1**: 81. 1893.

T. velutina Greene in Erythea **3**: 19. 1895.

T. gracilis var. *velutina* Jepson, Man. Fl. Pl. Calif. 515. 1925.

As the species except somewhat stouter though smaller throughout, and with a more silvery-silky appressed pubescence.

Distribution: California.

Citation of Specimens:

California: open flat 1 mi. south of Lagunitas, April 20, 1930, *Bracelin 10* (MBG); Crystal Springs Lake, San Mateo Co., May 1903, *Elmer 4824* (MBG); Mount Hamilton, July 1891, *Greene 32762 & 3* (MBG,ND,type of *T. velutina* Greene); Mount Hamilton, Santa Clara Co., May 31, 1907, *Heller 8606* (MBG, ANSP,FM); mountains, San Diego, Aug. 1879, *Orcutt 594* (MBG); Santa Cruz Mtns., 1888, *Parry* (MBG); warm slope, Cuyamaca Lake area, San Diego Co., May 18, 1935, *Purer 6616* (MBG).

13. T. gracilis Howell in Erythea **1**: 109. 1893.

Plant 4–8 dm. high, sparingly strigose throughout; stem erect, slender, branches spreading; stipules broadly ovate-cordate to lanceolate, 1–2 cm. long; petioles 2–3 cm. long; leaflets obovate to oblanceolate, 3.5–5.5 cm. long, 2–3 cm. broad; racemes loose, 1–1.5 dm. long; bracts broadly ovate, 0.7–1.2 cm.

long, semi-persistent; pedicels 0.5–1 cm. long; calyx silky villous; pods densely villous, recurved, divaricate, lomentaceous, 4–5 cm. long.

Distribution: Oregon.

CITATION OF SPECIMENS:

OREGON: summit of lower Siskiyou Mtns., July 3, 1902, *Cusick 2927* (MBG); Corvallis, May 1922, *Epling 5615* (MBG); Waldo, April 1892, *Howell* (CAL); Waldo, July 1894, *Howell 1495* (MBG,ANSP,CAL).

14. T. gracilis var. **argentata** (Greene) Jeps. Fl. Pl. Calif. 515. 1893.

T. argentata Greene in Erythea **3**: 18. 1899.

As the species except silvery-canescent throughout, and having somewhat longer stipules.

Distribution: California.

CITATION OF SPECIMENS:

CALIFORNIA: Modoc Co., 1893, *Baker* (ND,TYPE of *T. argentata* Greene); Forestdale, Modoc Co., Aug. 14, 1899, *Baker* (MBG,ANSP,WYO,CAL); near Egg Lake, Modoc Co., Aug. 1894, *Baker & Nutting* (CAL,WYO).

15. T. gracilis var. **venosa** (Eastw.) Jeps. Man. Fl. Pl. Calif. 515. 1925.

T. venosa Eastw. in Bull. Torr. Bot. Club **32**: 198. 1905.

As the species except glabrous and somewhat more delicate throughout, stipules more foliaceous, and leaflets more conspicuously veined.

Distribution: Oregon and California.

CITATION OF SPECIMENS:

OREGON: Grave Creek, May 14, 1889, *Hammond 74* (MBG); open woods on trail to Tennessee Pass 2 mi. from Kirby, April 20, 1926, *Henderson 5981* (MBG).

CALIFORNIA: Dunsmuir, Siskiyou Co., July 23, 1912, *Eastwood 1319* (MBG); Shasta Springs on road to McCloud, May 27, 1923, *Eastwood 11865* (MBG); between Lamoine & Williams ranch on state highway in yellow pine and oak belt, Shasta Co., June 19, 1919, *Heller 13250* (MBG); McCloud Fork, Shasta Co., April 24, 1913, *Smith 110* (MBG).

DOUBTFUL SPECIES

T. subglabra Henderson in Rhodora **32**: 26. 1930.

The type specimen of this species was not available; from the description it appears to be *T. gracilis* var. *venosa*.

General Index

New combinations are printed in **bold face** type; synonyms in *italics;* and previously published and accepted names in ordinary type.

Annals
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SUPPLEMENTARY NOTES ON SALVIA: AUDIBERTIA[1]

CARL C. EPLING
Associate Professor of Botany, University of California, Los Angeles

At the time I described and illustrated *Salvia Brandegei* (Ann. Mo. Bot. Gard. **25**: 117, *pl. 20.* 1938) I had not seen it in flower, my visit to Santa Rosa Island having been made with the object of securing seeds. The drawing therefore was made from pressed material of which, at that time, there were not many collections. The stamens of all the plants examined were included in the tube and the style was exserted as shown in the plate referred to. Several transplants were brought back, however, and grown at the Blaksley Botanic Garden at Santa Barbara through the courtesy of Mr. M. van Rensselaer. Upon examination of these plants in flower, seven in all, it was found that, although some had the structure which was illustrated in the above-mentioned plate, others had exserted stamens but included styles, as shown in plate 29, herewith presented. This drawing was made by me from living material and put in wash by Mr. S. de Hospodar of the Works Progress Administration. Amongst the seven transplants mentioned above either one type or the other is found to be constant on a given individual. Mr. Wm. Hovanitz, who recently visited the island, kindly examined the living plants there and found the same to be true of them. In so far as I am aware, this is the only American *Salvia* in which this differentiation of floral structure is to be found.

[1] Issued September 25, 1940.

10a. Salvia (Audibertia: Jepsonia) chionopeplica, sp. nov.
Pl. 29, figs. 3 and 4.

Frutex pilis ramosis densis utrimque floccoso-niveus; foliorum laminis ovatis vel oblongis 1.5–2 cm. longis, 7–12 mm. latis, in apice rotundatis, in basi ad petiolos 5–10 mm. longos angustatis, marginibus crenulatis, pagina superiore bullulata, inferiore reticulato-venosa, ambabus niveis; floribus in glomerulis densis globosis floccoso-niveis modo solitariis modo duobus, bracteis subfoliosis integris obtusis subtentis; calycibus florentibus 9–10 mm. longis, in maturitate 12–13 mm. longis ore obliquo dentibus duobus inferioribus ad superiorem adjunctis; corollarum caerulearum tubo 13 mm. longo ad medium intus dense piloso-annulato, labia superiore 4 mm. alta, inferioris paulo longioris lacinia media plana obcuneata ut videtur deflexa; staminibus valde exsertis, ut videtur arcuatis; stylo ut videtur deflexo.

MEXICO: BAJA CALIFORNIA. 36 mi. east of Rosario, 12. IV. 1931, *I. L. Wiggins 5300* (Stanford Univ., TYPE).

This most interesting plant is the ninth species of *Audibertia* to be found in northern Lower California and the only one endemic to that region. In habit of foliage and inflorescence it is similar to *S. Clevelandii.* The leaves are more bullate, however, and snowy with a dense branched pubescence. Such pubescence is otherwise characteristic in *Audibertia* only of *S. leucophylla.* The bracts and flowers are nearly those of *S. leucophylla,* but blue rather than rose color. According to the collector, they were "clear lavender with red spots." The orifice of the calyx, like that of *S. leucophylla,* is nearly entire. Although the two lower teeth are still perceptible, they are wholly joined to the upper. In *S. leucophylla,* they are obsolete or nearly so. The conformation of the corolla is similar to that species, but the stamens appear to be arcuate, rather than thrust out and the style is apparently declined. The species occurs in the *Larrea-Franseria* formation. The wash drawing was made by Mr. H. Harthende of the Works Progress Administration.

Salvia Munzii × apiana.—*Salvia Munzii* occurs in an almost pure stand near the upper Otay Dam in San Diego Co., Calif., covering the slope for many acres. Along the slope at its southern border it comes into contact with *S. apiana.* Along this interface two hybrid plants were recently found by Mr. Harlan Lewis. Like those from Lower California, these hybrids closely resemble *S. Munziana* in vegetative habit and in inflorescence, but have larger leaves and are whiter. The flowers, however, are about intermediate and the hybrid may readily be distinguished from *S. Munzii* by the marked exsertion of the stamens. A traverse of a mile was recently made through an area on San Antonio Mesa, Lower California, where these two species occur together, and of about 3,000 plants of both species only one was found to be of hybrid origin. This will give an approximate notion of the infrequency of the hybrid, when both species occur abundantly together.

Pollen smears were made from both parent species and the hybrid found at Otay Dam. These showed 16 pairs of chromosomes for both species. Stewart (Am. Jour. Bot. **26**: 731. 1939) has reported 15 for *S. Munzii.* However, his count was made from root-tip material, and, because of the small size of the chromosomes of *Salvia,* it is difficult to obtain accurate counts from somatic material. Nevertheless, it is possible that his count was correct for the material which he examined. The hybrid also had 16 pairs, but there were a number of chromosome aberrations, chiefly chromosome bridges with accompanying fragmentation. This suggests that there may have been one or more inversions. Pollen fertility in the hybrid was about 60–75 per cent, compared to 95–100 per cent in both species. The strong secondary association of at least 4 chromosomes in *Salvia apiana* suggests that this species may be a polyploid.

The hybrids of *S. apiana* × *mellifera* and *S. apiana* × *Munzii* are readily distinguishable; the former is usually more like *S. apiana,* particularly in the inflorescence. The differences in flower color and the occurrence of albinos suggest that the inheritance of this character in the two species is due to different factors.

The author is indebted to Dr. Thomas W. Whitaker for the data contained in paragraph two.

Explanation of Plate

PLATE 29

Figs. 1 and 2. *Salvia Brandegei* drawn from life (flower × 5, stamen × 10).

Figs. 3 and 4. *Salvia chionopeplica* (habit sketch one-half natural size, flower drawn from a boiled specimen, × 5).

EPLING — SALVIA: AUDIBERTIA

MERTENSIA DRUMMONDII (LEHM.) G. DON[1]

LOUIS O. WILLIAMS

Research Associate, Botanical Museum of Harvard University, Cambridge, Mass.

In my "Monograph of the Genus *Mertensia* in North America" (Ann. Mo. Bot. Gard. **24**: 17–159. 1937) *Mertensia Drummondii* (Lehm.) G. Don was placed among the doubtful and excluded species, the type not being known. Since then Dr. A. E. Porsild, of the National Museum of Canada, has loaned me two specimens which seem undoubtedly to belong to *Mertensia Drummondii* and which help to clarify that species. In addition a specimen cited on page 113 of the monograph under *Mertensia viridis* A. Nels., belongs to *M. Drummondii.*

Mertensia Drummondii should be inserted on page 117 of the monograph, following the varieties of *M. viridis.* An account of the species is as follows:

19f. Mertensia Drummondii (Lehm.) G. Don, Gen. Hist. **4**: 319. 1838. Pl. 30.

Lithospermum Drummondii Lehm., Pug. **2**: 26. 1828.

Mertensia sibirica var. *Drummondii* Gray in Proc. Am. Acad. **10**: 53. 1875.

Stems erect or ascending, 7–15 cm. long, 1–few from each rootstalk; basal leaves elliptic (only one seen), acute, petiolate, blade 20 mm. long and 5 mm. broad, strigillose above, glabrous below, petiole about as long as the blade; cauline leaves sessile or nearly so, elliptic to broadly lanceolate, acute or obtuse, 1.5–3.5 cm. long, 5–10 mm. broad, strigillose above, glabrous below; inflorescence crowded, a modified scorpioid cyme; pedicels glabrous, 1–10 mm. long; calyx 4–8 mm. long, the lobes divided almost to the base, lanceolate, acute, ciliate; corolla-tube 4–7 mm. long, glabrous within; corolla-limb 4–7 mm. long, moderately expanded, about as long as or a little shorter than the tube; fornices inconspicuous, glabrous; anthers about 1.5–2 mm. long; filaments as long as the anthers; style usually exceeding the corolla-tube.

[1] Issued September 25, 1940.

Distribution: known definitely only from the Northwest Territories in the vicinity of Coronation Gulf.

Northwest Territories: "Camp Necessity," Clifton Point, west end of Dolphin and Union Strait, 1916, *Girling 687* (Nat. Mus. Canada); Wollaston Land, Lat. 69–70° N., Long. 115° W., Aug. 11, 1915, *Jenness 410* (Nat. Mus. Canada).

Without locality: a specimen marked "ex herb. Hooker, *Lithospermum Drummondii*, Fl. Bor.-Am.," and "Nov. 1874. I say it is *M. sibirica* Don var. *Drummondii*. Large-flowered form. A. Gr[ay]." (New York Botanical Garden).

A curious species which is most closely allied to *Mertensia viridis* A. Nels. It seems to be an outlying species of a group of which the center of distribution is in Colorado. The closest station of an allied species of *M. Drummondii* is more than 1500 miles to the south.

Explanation of Plate

PLATE 30

Mertensia Drummondii. Habit sketch × 1⅓; flower parts × 3⅓.

WILLIAMS—MERTENSIA DRUMMONDII

CONTRIBUTIONS TOWARD A FLORA OF PANAMA[1]

IV. Miscellaneous Collections, chiefly by Paul H. Allen

ROBERT E. WOODSON, JR.
Assistant Curator of the Herbarium, Missouri Botanical Garden
Assistant Professor in the Henry Shaw School of Botany of Washington University
AND ROBERT W. SCHERY
Assistant in the Henry Shaw School of Botany of Washington University

MARSILEACEAE
(W. R. Maxon, Washington)

Marsilea polycarpa H. & G.—panamá: vicinity of Bejuco, June 18, 1939, *A. H. G. Alston & P. H. Allen 1867.* New to Panama, but widely dispersed in tropical America.

POLYPODIACEAE
(W. R. Maxon, Washington)

Alsophila villosa (H. & B.) Desv.—chiriquí: trail from San Felix to Cerro Flor, alt. 100–850 m., Aug. 13–14, 1939, *P. H. Allen 1940.* New to North America, agreeing closely with typical material from Caracas. Range in South America: Colombia, Venezuela, the Guianas, and Brazil.

Anemia millefolia Gardn.—coclé: vicinity of El Valle, Dec. 8, 1938, *P. H. Allen 1166.* New to North America. Previously known from Brazil and Colombia.

Cyathea conspersa Christ—chiriquí: vicinity of Cerro Punta, Jan. 21–24, 1939, *P. H. Allen 1522.* New to Panama. Known otherwise only from Costa Rica, where it is fairly common.

Dicranopteris mellifera (Christ) Underw.—coclé: north rim of El Valle, July 9, 1939, *P. H. Allen 1893.* A monstrous form. New to Panama, having been known only from Costa Rica.

Diplazium Sanctae-Rosae Christ—chiriquí: trail from Cerro Punta to headwaters of Río Caldera, alt. 2250–2500 m.,

[1] Issued September 25, 1940.

Jan. 14, 1939, *P. H. Allen 1447*. New to Panama. Known only from Costa Rica previously.

DRYOPTERIS SCALARIS (Christ) C. Chr.—COCLÉ: vicinity of El Valle, alt. 600–1000 m., Dec. 8, 1938, *P. H. Allen 1163;* PANAMÁ: hills above Campana, alt. 600–800 m., Dec. 23, 1938, *P. H. Allen 1325*. New to Panama. Known previously from southern Mexico to Costa Rica.

HYMENODIUM CRINITUM (L.) Fée—PANAMÁ: cloud forest, Cerro Campana, alt. ca. 800 m., July 1, 1939, *P. H. Allen 1877*. New to Panama. Not uncommon in the West Indies; on the continent known previously from Mexico to Costa Rica.

POLYPODIUM KUNZEANUM C. Chr.—COCLÉ: vicinity of El Valle, alt. 800–1000 m., Sept. 5, 1938, *P. H. Allen 748*. New to Panama. A rare species, known previously from Colombia, Peru, and Brazil.

POLYPODIUM NANUM Fée—CHIRIQUÍ: trail from San Felix to Cerro Flor, alt. 100–850 m., Aug. 13–14, 1939, *P. H. Allen 1946*. New to North America, our other specimens being from Trinidad, French Guiana, British Guiana, and Brazil. A variable species, probably an aggregate.

RHIPIDOPTERIS STANDLEYI Maxon—COCLÉ: vicinity of El Valle, alt. 600–1000 m., Dec. 8, 1938, *P. H. Allen 1260*. New to Panama. Known previously only from Costa Rica.

GRAMINEAE

(J. R. Swallen, Washington)

BOUTELOUA FILIFORMIS (Fourn.) Griffs.—PANAMÁ: vicinity of San Carlos, alt. 0–10 m., Dec. 5, 1938, *P. H. Allen 1148*. Previously known to extend from the southwestern United States to Guatemala.

POA ANNUA L.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. 1800–2000 m., Jan. 6–14, 1939, *P. H. Allen 1378*. A weedy species that might be expected almost anywhere, but previously unreported for Panama.

LUZIOLA SPRUCEANA Benth.—CANAL ZONE: vicinity of Juan Mina, alt. 30 m., Nov. 26, 1939, *A. G. B. Fairchild 2048* in part;

same locality, Jan. 14, 1940, *A. G. B. Fairchild 2096.* A South American species which has been found once before in Central America (Honduras).

ARACEAE
(P. C. Standley, Chicago)

SPATHIPHYLLUM **Zetekianum** Standl., sp. nov. Planta erecta terrestris ca. 60 cm. alta; folia numerosa, petiolo lamina vulgo bene longiore gracillimo 12–20 cm. longo, geniculo ca. 1 cm. longo instructo, vagina brevi persistente vix ultra 8 cm. longa atque saepius breviore; lamina anguste lanceolata vel lanceolata in sicco fere membranacea 13–20 cm. longa 2–5 cm. lata longissime angusteque attenuata, basin versus sensim attenuata, basi ipsa acutissima, supra intense viridis, subtus pallidior, nervis primariis lateralibus utroque latere ca. 6 subremotis angulo acutissimo adscendentibus; pedunculus teres gracillimus ca. 43 cm. longus 2 mm. crassus, parte stipitiformi 3 cm. longa; spatha lanceolato-ovata viridis 10.5 cm. longa 3 cm. lata, abrupte longi-acuminata vel caudato-acuminata, basi acuta; spadix cylindricus obtusissimus 1.5 cm. longus 6–7 mm. crassus pauciflorus; sepala ca. 6 biseriata libera; stylus ovarium subaequans ultra perigonium longe exsertus atque perigonio fere duplo longior, conicus.—CANAL ZONE: Zetek Trail, Barro Colorado Island, July, 1931, *D. E. Starry 27* (Herb. Field Mus., TYPE).

Three other species of *Spathiphyllum* are known more or less definitely from Panama, and all are recorded for the Canal Zone. In general appearance, and especially in foliage, *S. Zetekianum* is most like *S. floribundum* (Lind. & André) N. E. Brown (which has been recorded for the region under the erroneous name of *S. Patini* N. E. Brown), but in the latter the style does not exceed the perianth, and the spadix is therefore even rather than tuberculate in fruit. The other two species, *S. Friedrichsthalii* Schott and *S. phryniifolium* Schott, both have exserted styles, but their leaves are large and several times as broad as those of *S. Zetekianum,* and their spadices much longer and thicker, with many times as numerous flowers in each spadix.

ERIOCAULACEAE

(H. N. Moldenke, New York)

Eriocaulon **Woodsonianum** Moldenke, spec. nov. Herba pumila; caule perbrevi; bracteis involucri hyalinis vel stramineis ovatis vel ellipticis vel obovatis obtusis; floribus dimeris; floris ♂ sepalis obovatis; floris ♀ sepalis late obovatis hyalinis valde alato-cristatis.

Dwarf plants; leaves tufted, erect or spreading, thin-membranaceous or pellucid, light-green, linear, 4–7 cm. long, 1.5–3 mm. wide at the middle, subulate at the apex, not at all revolute along the margins, glabrous, fenestrately many-nerved (the fenestrations especially conspicuous beneath); peduncles 5–21 per plant, slender, 6.5–19.5 cm. long, 3-costate, slightly twisted, glabrous; sheaths loose, 3–5 cm. long, much shorter than the leaves, glabrous, not fenestrate, deeply lobed at the apex; heads hemispheric, lightly flavescent-stramineous, 3–4.5 mm. in diameter; involucral bractlets scarious, hyaline or stramineous, varying from ovate to elliptic or obovate, about 3 mm. long, 2–2.5 mm. wide, obtuse at the apex, usually not much narrowed at the base; receptacular bractlets broadly elliptic, scarious, somewhat flavescent along the midrib and at the apex, hyaline toward the margins, about 2.4 mm. long and wide, rounded at the apex, somewhat narrowed at the base, decidedly navicular and closely imbricate; staminate florets: pedicellate (pedicels about 0.5 mm. long); sepals 2, free to the base, obovate, about 1.5 mm. long and about equally wide at the apex, hyaline, transparent, conduplicate around the corolla-tube, carinate in a median line on the back, slightly emarginate at the apex, erect, glabrous throughout; corolla-lobes 2, minute, obtuse, non-glanduliferous; stamens 4; anthers brown; pistillate florets: pedicellate (pedicels about 0.5 mm. long); sepals 2, broadly obovate, hyaline, transparent, about 1.7 mm. long and equally wide at the apex; slightly emarginate, flat (not conduplicate), with a very broad wing or crest on the median keel on the back, glabrous; petals 2, free, hyaline, spatulate, transparent, about 1.9 mm. long, about 0.7 mm. wide at the apex; ovary 2-celled.—Panamá: margin of pool in savanna along road between Panamá and Chepo, Nov. 29, 1934, *C. W. Dodge, A. A. Hunter, J. A. Steyermark & P. H. Allen 16717* (Herb. Missouri Bot. Gard., TYPE).

SYNGONANTHUS **Pittieri** Moldenke, spec. nov. Herba perennis; foliis caespitosis recurvatis vel adpressis 1–1.5 cm. longis dense strigosis; vaginis dense pilosis; pedunculis glabris; sepalis petalisque hyalinis glabris.

Dwarf plants; leaves few, tufted, recurved and usually closely appressed to the ground, membranous, olivaceous, linear, 1.0–1.5 cm. long, to 1 mm. wide at the middle, attenuate and subulate at the apex, densely strigose with whitish appressed antrorse hairs on both surfaces, not fenestrate; sheaths tightly appressed, 2–2.5 mm. long, greatly surpassing the leaves, densely pilose with irregular whitish hairs, deeply lobed at the apex; peduncles several per plant, stramineous, slender, rather obscurely costate, slightly twisted, glabrous; heads hemispheric, light-gray or ashy, 3.5–4.5 mm. wide; involucral bractlets membranous, narrowly obovate or oblanceolate, about 2 mm. long and 1 mm. wide, turning brown toward the middle, hyaline at the margins; receptacular bractlets none; staminate florets: pedicellate; pedicels about 0.5 mm. long, villous; sepals hyaline, transparent, narrow-elliptic, about 1.2 mm. long, about 0.5 mm. wide, glabrous; petal-tube hyaline, translucent, about 1.5 mm. long, 3-lobed at the apex; anthers 3, white; pistillate florets: pedicellate (pedicels about 0.7 mm. long, villous); sepals 3, free, hyaline, transparent, narrowly lanceolate, about 1.7 mm. long, about 0.5 mm. wide at the base, sharply acute or acuminate at the apex, glabrous throughout; petals narrowly oblong, hyaline and transparent, about 1 mm. long and 0.3 mm. wide, glabrous, connate by their margins above, free at the base.—CHIRIQUÍ: Sabana de El Boquete, alt. 700–1100 m., March 21, 1911, *H. Pittier 3316* (Herb. New York Bot. Gard., TYPE).

BROMELIACEAE

(L. B. Smith, Cambridge, Mass.)

THECOPHYLLUM ANGUSTUM Mez & Wercklé—COCLÉ: north rim of El Valle de Antón, alt. 600–1000 m., Feb. 12, 1939, *P. H.*

Allen 1645. Known previously only from the type, collected in Costa Rica.

Tillandsia spiculosa Griseb. var. palmana (Mez) L. B. Smith—panamá: cloud forest near summit of Cerro Campana, alt. 800–1000 m., July 1, 1939, *P. H. Allen 1878*. Previously known from Costa Rica.

Tillandsia guanacastensis Standl.—coclé: vicinity of El Valle de Antón, alt. ca. 600 m., Dec. 10, 1939, *P. H. Allen 2060*. Previously known from Costa Rica.

Guzmania dissitiflora (André) L. B. Smith—coclé: vicinity of El Valle de Antón, alt. ca. 600 m., Dec. 10, 1939, *P. H. Allen 2055*. Previously known from Costa Rica and Colombia.

LILIACEAE

Smilacina **Gigas** Woodson, sp. nov. Rhizoma cormiformis subpyriformis 5–6 cm. longa 3.0–3.5 cm. lata. Caulis ca. 3 m. altus basi ca. 1 cm. diam. glaber in sicco profunde sulcatus. Folia 10–14 adscendentia oblique oblongo-elliptica apice longiuscule subcaudato-acuminata basi late obtusa cum petiolo vix bene manifesto 25–40 cm. longa 7–9 cm. lata in sicco tenue membranacea glabra venis creberrimis distinctis venulis transversalibus haud faciliter visis. Panicula pyramidalis 25–35 cm. longa 20–25 cm. lata omnino glabra vix flexuosa; ramis multis adscendentibus inferioribus 13–15 cm. longis superioribus sensim brevioribus; pedicellis approximatis sat congestis 0.5 cm. longis; bracteis vix visis. Perianthii segmenta alba vel in sicco pallide sulphurea oblongo-ovata apice rotundata 0.35 cm. longa glabra. Stamina perianthio aequilonga exserta; antheris globosis ca. 0.05 cm. diam.; filamentis subulatis glabris. Pistillum 0.15 cm. longum glabrum; stylo ovario subduplo breviore. Bacca ignota.—chiriquí: trail from Cerro Punta to headwaters of Río Caldera, alt. 2250–2500 m., Jan. 14, 1939, *P. H. Allen 1446* (Herb. Missouri Bot. Gard., type).

This species is exceedingly distinctive, both because of its relatively enormous size and the large, fleshy, corm-like rhizomes. In the region where it was found *S. paniculata* Mart. & Gal. abounds, growing much in the same fashion as its relatives in the northern forests. I have found the latter species so uniform in the field that interpretation of *S. Gigas* as merely a variant seems out of the question.

DIOSCOREACEAE
(C. V. Morton, Washington, D. C.)

Dioscorea convolvulacea C. & S. var. glabra Uline—coclé: El Valle de Antón, Sept. 5, 1938, *P. H. Allen 739.* Previously known from Mexico to Costa Rica.

Dioscorea racemosa (Kl.) Uline—coclé: El Valle de Antón, Dec. 8, 1938, *P. H. Allen 1258;* panamá: cloud forest near summit, Cerro Campana, July 1, 1939, *P. H. Allen 1869.* Previously known from Costa Rica.

ZINGIBERACEAE

Renealmia rubro-flava K. Sch.—coclé: north rim of El Valle de Antón, alt. 600–1000 m., Feb. 12, 1939, *P. H. Allen 1654.* Previously known only from the type collection in Ecuador *(Eggers 15121,* in Hb. Berol.), which I have not yet had the opportunity to examine. Our plant checks very well with the description, except that Mr. Allen's notes merely state "flowers cream," whereas Schumann specified the calyx as red and the corolla as yellowish. This is the largest species of the genus, however, and would be hard to mistake. The leaves are at least twice as large as those of the giant *R. exaltata.*

ORCHIDACEAE
(Louis O. Williams, Cambridge, Mass.)

The collections of orchids reported here, about 120 numbers, are the most valuable that have been made in Panama in many years. The majority are from the vicinity of El Valle, Provincia de Coclé, and in Quebrada Lopez in the Canal Zone. Types of the species described are either in the Herbarium of the Missouri Botanical Garden or in the Ames Herbarium. Most of the new species and some of the old ones have been illustrated by Mr. Gordon W. Dillon.

Habenaria strictissima Rchb. f. var. odontopetala (Reichb. f.) L. O. Williams.—coclé: Nata, about 50 m. alt., flowers green, Sept. 12, 1938, *Allen 820;* PANAMÁ: Isla Taboga, 0–350 m. alt., flowers green, Dec. 16, 1938, *Allen 1280.* Previously known from Florida, the West Indies, Mexico to Costa Rica.

PRESCOTTIA STACHYODES (Sw.) Lindl.—COCLÉ: vicinity of El Valle, 600–1000 m. alt., Dec. 8, 1938, and Dec. 10, 1939, *Allen 1183* and *2064.* New to Panama. Previously recorded from Florida, Mexico to Costa Rica and the West Indies. The present specimens represent a large-leaved form. The lamina of the largest leaf is 22 cm. long and 15.5 cm. broad.

PONTHIEVA MACULATA Lindl.—CHIRIQUÍ: epiphytic, trail from Cerro Punta to headwaters of Río Caldera, 2250–2500 m. alt., flowers brown, covered with glandular hairs, Jan. 14, 1939, *Allen 1430.* Apparently not recorded from Panama previously but rather widely distributed from Mexico to Costa Rica and in northern South America.

PONTHIEVA RACEMOSA (Walt.) Mohr—COCLÉ: vicinity of El Valle, 600–1000 m. alt., flowers white, Dec. 8, 1938, *Allen 1161.* Not an uncommon plant from Virginia to Florida, the West Indies, Mexico to northern South America, but apparently not recorded from Panama previously.

STELIS **montana** L. O. Williams, sp. nov. Herbae caespitosae, epiphyticae, usque ad 33 cm. altae. Caules secundarii quam folia breviores. Folia oblanceolata, obtusa, coriacea. Inflorescentia racemosa, plusminusve secunda, quam folia longior vel aequitans. Sepala basi connata. Sepalum dorsale ovatum vel lanceolato-ovatum, acutum, apiculatum, quinquenervium. Sepala lateralia late ovata, plusminusve obliqua, acuta, apiculata, basi mentum inconspicuum formantia. Petala plusminusve orbicularia, bidentata. Labellum oblongum vel oblongo-obovatum, obscure trilobatum, basi callo magno ornatum.

Large (for the genus) caespitose epiphytic herbs up to 33 cm. tall. Secondary stems 11–13 cm. long, covered by sheathing cauline bracts, shorter than the leaves. Leaves 17–20 cm. long and 3–3.5 cm. broad, oblanceolate, obtuse, coriaceous, gradually narrowed into a short petiole. Inflorescence racemose, as long as or longer than the subtending leaf, more or less secund.

Flowers rather large for the genus, green. Sepals connate for a short distance at their bases. Dorsal sepal 6 mm. long and 3.5 mm. broad (free portion 4.5 mm. long), ovate to lanceolate-ovate, acute, apiculate, 5-nerved. Lateral sepals about 5 mm. long and 4.5 mm. broad, broadly ovate, somewhat oblique, acute, apiculate, 5-nerved, forming a short and inconspicuous mentum at the base. Petals about 1.5 mm. long and 1.5 mm. broad, nearly orbicular, with a small tooth on each side near the middle, terminal half conspicuously thickened. Lip about 2–2.25 mm. long and 0.8–1 mm. broad, oblong to oblong-obovate, obscurely 3-lobed, with a large callus which fills more than the basal half of the lip, terminal part of the lip thin and (when spread out) suborbicular, minutely puberulent dorsally. —CHIRIQUÍ: trail from Cerro Punta to headwaters of Río Caldera, 2250–2500 m. alt., Jan. 4, 1939, *Allen 1463* (Herb. Missouri Bot. Gard., TYPE).

Stelis montana is a rather distinctive species which is not closely allied to any other species known to me.

STELIS STORKII Ames—COCLÉ: epiphytic, wet north rim, vicinity of El Valle, 800–1000 m. alt., May 21, 1939, *Allen 1826*. This recently described species is new to Panama, having been found first in Costa Rica.

MASDEVALLIA **Allenii** L. O. Williams, sp. nov. (pl. 31, figs. 12–16). Herbae caespitosae, epiphyticae. Caules secundarii breves, unifoliati. Folia linearia, acuta, coriacea, semiteretia et canaliculata. Inflorescentia uniflora; pedunculus elongatus, glaber. Sepala ad basim tubo connata. Sepalum dorsale longe caudatum; lamina triangularis. Sepala lateralia plusminusve ad apicem connata, lanceolata, cum antenna laterali prope apicem, basi gibbosa. Petala oblonga, uninervia, apice rotundata, obtusa, integra. Labellum lanceolatum vel oblongo-lanceolatum, obtusum, basi bicaudatum; lamina bicallosa. Columna generis.

Small caespitose epiphytic herbs. Secondary stems very short, about 3 mm. long, covered by white chartaceous bracts, unifoliate. Leaves 10–20 mm. long, up to 2 mm. broad, linear, acute, coriaceous, subterete and canaliculate. Inflorescence 1-

flowered, subtending bract about 1 mm. long, triangular or nearly so; peduncle elongate, 3–4 cm. long, very slender, smooth. Sepals joined into a tube at the base, 3-nerved. Dorsal sepal long-caudate, free portion of the lamina triangular, about 2.5–3 mm. long and 3–3.5 mm. broad at the base; caudate termination filiform, about 10 mm. long. Lateral sepals connate to their apices or nearly so, lanceolate, 12–15 mm. long, together 4.5–5 mm. broad, gibbous at their bases, each with a lateral filiform appendage 5–6 mm. long situated about 2 mm. from its apex. Petals 1.5–2 mm. long and about 0.75 mm. broad, oblong, 1-nerved, apex rounded, obtuse, entire. Lip about 3 mm. long and 1 mm. broad, lanceolate or lanceolate-oblong, obtuse, 3-nerved, bicaudate at the base, lamina with two longitudinal calluses. Column of the genus.—COCLÉ: vicinity of El Valle, 600–1000 m. alt., Dec. 8, 1938, *Allen 1230* (Herb. Missouri Bot. Gard., TYPE).

Masdevallia Allenii is allied to *M. triaristella* Rchb. f. It differs in being a smaller plant with much smaller flowers, differently shaped petals with entire, rounded apices, and much shorter leaves.

MASDEVALLIA CHONTALENSIS Rchb. f.—COCLÉ: vicinity of El Valle, 600–1000 m. alt., flowers white with yellow-tipped spurs, Dec. 8, 1938, *Allen 1231;* epiphytic, vicinity of El Valle, north rim (wet), 800–1000 m. alt., May 21, 1939, *Allen 1826.* New to Panama. Previously recorded from Nicaragua and Costa Rica where it is not uncommon.

MASDEVALLIA ECAUDATA Schltr.—CHIRIQUÍ: valley of upper Río Chiriquí Viejo, "flowers white with three purple stripes on outer petals," Jan. 18, 1938, *White & White 81.* New to Panama but not uncommon in Costa Rica.

MASDEVALLIA SIMULA Rchb. f. (pl. 31, figs. 1–8)—CANAL ZONE: in tops of high trees, Quebrada Lopez, 30 m. alt., flowers clear, striped and barred red, Feb. 11, 1940, *Allen 2115.* New to the flora of Panama. Previously recorded from Guatemala, Honduras, Costa Rica, Colombia and Ecuador. An illustration of the species has been prepared from specimens preserved in spirits.

LEPANTHES **rotundifolia** L. O. Williams, sp. nov. (pl. 31, figs. 9–11). Herbae caespitosae, epiphyticae, parvae, usque ad 8 cm. altae. Caulis gracilis, unifoliatus. Folia orbicularia vel orbiculari-ovata, coriacea. Inflorescentia disticha, quam folia brevior, pauciflora. Sepalum dorsale suborbiculare, obtusum vel acutum, trinervium, ad basim connatum. Petala trilobata; lobus prope sepalum dorsale longior, lanceolatus, acutus, obliquus, uninervius; lobus prope sepala lateralia lanceolatus, acutus, obliquus, uninervius. Labellum bilobatum, lobis malleoliformibus. Columna generis.

Small caespitose, epiphytic herbs up to 8 cm. tall. Secondary stems slender, covered by sheaths, bearing a single leaf at their apices; sheaths glabrous except the ciliate margins. Leaves about 25 mm. long and 19–28 mm. broad, orbicular or orbicular-ovate, or even broader than long, coriaceous. Inflorescence distichous, shorter than the subtending leaf, few-flowered. Dorsal sepal about 3 mm. long and 2 mm. broad, suborbicular, abruptly acuminate, 3-nerved. Lateral sepals about 2.5 mm. long and 2 mm. broad, suborbicular, obtuse or acutish, 3-nerved, connate at their bases. Petals bipartite; lobes near the dorsal sepal longest, about 3.5 mm. long and 1 mm. broad, lanceolate, acute, oblique, 1-nerved; lobes near the lateral sepals about 2 mm. long and 0.8 mm. broad, lanceolate, acute, oblique, 1-nerved. Lip 2-lobed, about 1.5 mm. long and 2 mm. broad, each lobe malleoliform. Column about 1.5 mm. long, clavate.—COCLÉ: epiphytic, wet north rim, vicinity of El Valle, 800–1000 m. alt., May 21, 1939, *Allen 1835* (Herb. Missouri Bot. Gard., TYPE).

Lepanthes rotundifolia is somewhat allied to *L. Turialvae* Rchb. f., from which it differs in the broader leaves and shape of petals, as well as other characters.

PLEUROTHALLIS **Allenii** L. O. Williams, sp. nov. (pl. 34, figs. 5–7). Herbae epiphyticae, caespitosae, parvae, usque ad 12 cm. altae. Caulis secundarius quam folia brevior. Folia ligulata vel lineari-ligulata, obtusa vel tridentata, coriacea. Inflorescentia uniflora, saepissime fasciculo nonnullae, flores pro planta magni, quam folia breviores. Sepalum dorsale lanceolatum, longe attenuato-acuminatum, trinervium. Sepala lateralia plusminusve usque ad apicem connata, junta laminam lanceolatam, acutam formantia. Petala lanceolata, acuta vel acuminata, paulo obliqua. Labellum trilobatum; lobi laterales erecti (expansi plani), apice rotundati; lobus medius anguste triangularis, acutus, echinulatus; discus carnosus cum callo tripartito prope medium. Columna generis.

Small epiphytic, caespitose herbs up to about 12 cm. high. Secondary stems 3–5 cm. long, slender, invested at the base by one or two sheaths, shorter than the leaves. Leaves 5–8 cm. long, 3–6 mm. broad, ligulate to linear-ligulate, obtuse or tridentate, coriaceous. Inflorescence a 1–several-flowered fascicle, much exceeded by the leaves, the flowers large for the size of the plant, dull red. Dorsal sepal about 15 mm. long and 4 mm. broad, lanceolate, long attenuate-acuminate, 3-nerved. Lateral sepals connate nearly to their apices, about 15 mm. long and together 5 mm. broad, lanceolate, acute, each sepal 2-nerved. Petals about 12 mm. long and 3 mm. broad, lanceolate, acute or acuminate, 3-nerved, slightly oblique. Lip about 4 mm. long and as broad, 3-lobed; the lateral lobes erect, about 1.25 mm. long and 1 mm. broad, broadly oblong, the apices rounded; the mid-lobe about 2 mm. long and 1.5 mm. broad at the base, narrowly triangular, acute; disc (including mid-lobe) very fleshy, with a tripartite raised callus near the middle and the mid-lobe covered with echinulate protuberances. Column short, about 1.5 mm. long; column-foot small.—COCLÉ: vicinity of El Valle, alt. 600–1000 meters, flowers dull red, Dec. 8, 1938, *Allen 1240* (Herb. Missouri Bot. Gard., TYPE).

Pleurothallis Allenii is a rather handsome species which is somewhat allied to *P. Rowleei* Ames, from which it differs in several respects.

PLEUROTHALLIS CALYPTROSTELE Schltr. (pl. 33, figs. 11–15).—COCLÉ: vicinity of El Valle, 600–1000 m. alt., Dec. 8, 1938, *Allen 1233.* New to the flora of Panama, previously known from Costa Rica. There are a few minor differences between the present specimens and the usual Costa Rican material.

PLEUROTHALLIS **cobraeformis** L. O. Williams, sp. nov. (pl. 34, figs. 7–14). Herbae parvae, epiphyticae, usque ad 13 cm. altae. Caules secundarii foliis subaequales. Folia oblanceolata, obtusa vel acuta. Inflorescentia uni–pauciflora, quam folia brevior. Sepalum dorsale suborbiculare, cucullatum. Sepala lateralia connata, late ovalia. Petala elliptica, acuta, dentato-ciliata, uninervia. Labellum breviter unguiculatum; lamina apiculata, late cordata, carnosa. Columna generis.

Small caespitose, epiphytic herbs up to 13 cm. tall. Secondary stems mostly 4–6 cm. long, slender, subequal to the leaves in length or a little longer. Leaves 4–6 cm. long and 8–11 mm. broad when mature, oblanceolate, obtuse or acute, fleshy. Inflorescence a 1–several-flowered fascicle or possibly an abbreviated raceme, much exceeded by the subtending leaf. Dorsal sepal 8–10 mm. long, 7–9 mm. broad, suborbicular, subacute, strongly cucullate. Lateral sepals connate to their tips, about 6–7 mm. long and 4.5–5 mm. broad, broadly oval, 4-nerved. Petals 4–6 mm. long and 1.2–1.5 mm. broad, elliptic, acute, arcuate, dentate-ciliate, 1-nerved. Lip about 3.5 mm. long and as broad, short-clawed; lamina apiculate, broadly cordate, fleshy, sharply deflexed, the basal auricles rounded. Column about 2 mm. long; column-foot very short.—COCLÉ: epiphytic, vicinity of El Valle de Antón, ca. 600 m. alt., flower tan spotted with maroon, Dec. 19, 1939, *Allen 2057* (Herb. Ames, No. 58413, TYPE).

Pleurothallis cobraeformis is allied to *P. gonioglossa* Schltr. It may be distinguished by the very much larger flowers; broader hood-shaped dorsal sepal; broader lateral sepals; and by the comparatively narrower oblanceolate leaves.

PLEUROTHALLIS EUMECOCAULON Schltr.—COCLÉ: vicinity of El Valle, 600–1000 m. alt., flowers white, Dec. 8, 1938, *Allen 1237*. New to Panama, previously known only from Costa Rica.

PLEUROTHALLIS **hispida** L. O. Williams, sp. nov. (pl. 33, figs. 1–4). Herbae caespitosae, epiphyticae, parvae, usque ad 5 cm. altae. Caulis secundarius quam folia brevior. Folia anguste elliptica vel elliptico-ovata, obtusa, coriacea, quam caules longiora, margine hispida vel hispidula. Inflorescentia uni- vel pauciflora, saepissime fasciculata, foliis multo brevior. Sepalum dorsale cum sepalis lateralibus usque ad medium connatum, lanceolatum, acutum, dorso hispidulum. Sepala lateralia usque ad apicem connata, cucullata, carinata, extus hispidula et intus papillosa. Petala lineari-oblonga, apice oblique truncata et acuta, binervia. Labellum unguiculatum; lamina oblongo-lanceolata, tricallosa, margine anteriore integra vel denticulata; unguis ad basim biauriculatus. Columna ad apicem auriculato-alata.

Small caespitose, epiphytic herbs up to about 5 cm. tall. Secondary stems 0.5–2 mm. long, shorter than the leaves; stems invested by two or three cauline sheaths, the upper one reaching to the base of the leaf where it is subinfundibuliform, the sheaths maculated with maroon dots and hispid, at least along the angles. Leaves 1–3.5 cm. long, 0.3–1.3 cm. broad, narrowly elliptic to elliptic-oval, obtuse, coriaceous, exceeding the secondary stems in length, margins hispid or hispidulous. Inflorescence 1–few-flowered, fasciculated, much exceeded by the leaves. Flowers 7–8 mm. long, maroon. Dorsal sepal connate for half its length with the laterals, 5–6 mm. long, lanceolate, acute, 3-nerved, hispidulous dorsally. Lateral sepals about 6 mm. long and together about 6 mm. broad, connate to their tips, strongly cucullate, in natural position calceolate and resembling the lip of *Cypripedium acaule* Aiton in outline, carinate, hispidulous outside and papillose within, each sepal 3-nerved. Petals about 4 mm. long and 1 mm. broad, linear-oblong, the apex obliquely truncate and acute, 2-nerved. Lip about 3 mm. long and 1.5 mm. broad, unguiculate; lamina oblong-lanceolate, with a lamellate callus extending from each lateral angle toward the apex and with a mamillate callus at the junction of the claw and the lamina, margins toward the apex entire or denticulate; claw about 0.5 mm. long, minutely biauriculate at the base. Column about 2.5 mm. long, auriculate-winged toward the apex; column-foot bulbose, about 1 mm. long.—COCLÉ: vicinity of El Valle, 800–1000 m. alt., Sept. 5, 1939, *Allen 782* (Herb. Ames, No. 57755, TYPE); vicinity of El Valle, 600–1000 m. alt., Dec. 8, 1938, *Allen 1243*.

Pleurothallis hispida is not closely allied to any species known to me. The two collections cited differ in vegetative size but otherwise seem to be identical.

PLEUROTHALLIS HOMALANTHA Schltr.—COCLÉ: vicinity of El Valle, 600–1000 m., alt., flowers brown, Dec. 8, 1938, *Allen 1236*. New to the flora of Panama.

PLEUROTHALLIS **lepidota** L. O. Williams, sp. nov. (pl. 32, figs. 8–12). Herbae caespitosae, epiphyticae, parvae, usque ad 22 cm. altae. Caulis secundarius gracilis. Folia elliptica vel elliptico-lanceolata, breviter acuminata. Inflorescentia racemosa, pauciflora, folio brevior. Sepalum dorsale lineari-lanceolatum, acutum, trinervium, carinatum. Sepala lateralia subtriangularia, plusminusve usque ad apicem connata, acuminata, dorso carinato-alata. Petala linearia, acuta, uninervia. Labellum unguiculatum, obscure trilobatum, intus lepidotum vel lepidoto-verrucosum, callo mammillato ad unguis et laminae junctionem; lobi laterales rotundati, erecti; lobus medius oblongo-lanceolatus, acutus. Columna generis; clinandrium serrulatum.

Small caespitose, epiphytic herbs up to about 22 cm. tall. Secondary stems about 9–12 cm. long, slender, partially invested with 2–3 scarious sheaths. Leaves 7–10 cm. long, 3–3.5 cm. broad, elliptic to elliptic-lanceolate, short-acuminate. Inflorescence racemose, few-flowered, one or more from the axil of a leaf, shorter than the leaf; bract subtending the inflorescence about 1.5 mm. long, chartaceous, lanceolate; bracts of the inflorescence about 3 mm. long, ovate-lanceolate, surrounding the rachis. Dorsal sepal 13–14 mm. long and about 2 mm. broad, linear-lanceolate, acute, 3-nerved, carinate. Lateral sepals about 14 mm. long and (together) 12 mm. broad at their base, nearly triangular, connate nearly to their apices, acuminate, each 3-nerved and carinate-winged along the mid-nerve dorsally, outer surface papilliferous. Petals about 5 mm. long and 0.25 mm. broad, linear, acute, 1-nerved. Lip about 8 mm. long and 5 mm. broad, unguiculate, obscurely 3-lobed, upper surface lepidote or lepidote-verrucose, with a mammillate callus at the junction of the claw and the lamina, margins serrulate to serrate; lateral lobes 2 mm. long and as broad, rounded, erect in natural position; mid-lobe oblong-lanceolate, acute, about 4–5 mm. long, and 2 mm. broad. Column 4–5 mm. long; clinandrium serrulate.—CHIRIQUÍ: epiphytic, Llanos del Volcán, about 1300 m. alt., flowers green striped maroon, Jan. 23, 1939, *Allen 1552* (Herb. Ames, No. 57700, TYPE).

A handsome large-flowered species not closely allied to any other in Central America.

PLEUROTHALLIS **pterocaulis** L. O. Williams, sp. nov. (pl. 32, figs. 1–7). Herbae epiphyticae, repentes, usque ad 16.5 cm. altae. Caulis secundarius alatus vel angulatus, quam folia brevior. Folia elliptica vel elliptico-lanceolata, acuta, coriacea. Inflorescentia uni- vel pauciflora racemorum fasciculus, folio brevior. Sepalum dorsale oblongo-lanceolatum, obtusum vel acutum, naviculare, carinatum. Sepala lateralia usque ad medium connata, oblongo-lanceolata, plusminusve obliqua, acuta, trinervia, carinata. Petala subrhombico-obovata, uninervia, ad apicem serrulata. Labellum unguiculatum, oblongo-lanceolatum, obtusum, carinatum, bicallosum; unguis basi inconspicue biauriculatus.

Repent epiphytic herbs up to 16.5 cm. tall. Secondary stems 2.5–7 cm. long, winged or strongly angled (at least when dry), shorter than the leaves. Leaves 4–11 cm. long, 1–1.5 cm. broad, elliptic to elliptic-lanceolate, acute, coriaceous. Inflorescence a fascicle of 1–few-flowered racemes, much exceeded by the leaves. Dorsal sepal about 6 mm. long and 2–2.5 mm. broad, oblong-lanceolate, obtuse or acute, strongly navicular, carinate with the apex thickest. Lateral sepals connate for about half or more their length, 5–6 mm. long and together about 5 mm. broad; each sepal oblong-lanceolate, somewhat oblique, acute, 3-nerved, carinate, with a thicker carinate cushion toward the free margin. Petals about 2.5 mm. long and 1.7 mm. broad, subrhombic-obovate, 1-nerved, the apical margin serrulate. Lip about 4 mm. long and 1.5 mm. broad, unguiculate, oblong-lanceolate, obtuse, carinate, with two inconspicuous calluses at the junction of the claw and the lamina; the claw inconspicuously biauriculate at the base. Column about 2.5 mm. long; column-foot about 1.5 mm. long.—COCLÉ: vicinity of El Valle, 600–1000 m., alt., flowers dull red, Dec. 8, 1938, *Allen 1239* (Herb. Ames, No. 57701, TYPE).

Pleurothallis pterocaulis is allied to *P. hondurensis* Ames, from which it may be distinguished by the subrhombic-obovate, obtuse petals, instead of lanceolate, acute petals, and by other vegetative and floral details.

PLEUROTHALLIS **simulans** L. O. Williams, sp. nov. (pl. 33, figs. 8–10). Herbae epiphyticae, caespitosae, parvae, usque ad 10 cm. altae. Caules secundarii graciles, foliis subaequales vel paulo longiores. Folia ligulata vel elliptico-oblanceolata, obtusa, coriacea, submarginata. Inflorescentia uniflora vel fasciculata et pauciflora, quam folia brevior. Sepalum dorsale lanceolatum, acuminatum, trinervium. Sepala lateralia usque ad apicem connata, lanceolata, acuminata. Petala late elliptica vel subrhombica, acuta vel acuminata, uninervia, fere usque ad basim lacerato-ciliata. Labellum integrum, subcordatum, acuminatum, trinervium, margine anteriore plusminusve serrulatum; discus callo carinato ornatus.

Small epiphytic, caespitose herbs up to 10 cm. tall. Secondary stems 2.5–6 cm. long, slender, usually a little longer than the leaves, with one or two sheathing bracts at the base. Leaves 3–5 cm. long, 5–8 mm. broad, ligulate to elliptic-oblanceolate, obtuse, coriaceous, submarginate. Inflorescence 1-flowered or a few-flowered fascicle, much exceeded by the subtending leaf, subtending bract lanceolate, apiculate. Dorsal sepal about 10 mm. long and 3.5–4 mm. broad, lanceolate, acuminate, 3-nerved. Lateral sepals connate to their apices, about 10 mm. long and together 4.5–5 mm. broad, broadly lanceolate, acuminate, each half with only two prominent nerves. Petals 5–6 mm. long and 2–2.5 mm. broad, broadly elliptic to subrhombic, acute or acuminate, 1-nerved, lacerate-ciliate nearly to the base. Lip 3–3.5 mm. long and 2–2.5 mm. broad, simple, subcordate in outline, acuminate, 3-nerved, the anterior margin somewhat serrulate, the disc covered by a thick callus simulating that found in species of *Stelis,* the callus with an anterior rim, an inconspicuous depression toward its apex and sharply declined to the attachment of the lip. Column very short and dilated at the apex; stigmas apparently confluent.—COCLÉ: epiphyte, north rim of El Valle, flowers maroon, July 9, 1939, *Allen 1912* (Herb. Missouri Bot. Gard., TYPE).

Pleurothallis simulans is not allied to any other known species of Central American *Pleurothallis.* The species is particularly interesting in that the lip and the column suggest the allied genus *Stelis.* However, the species seems to belong to *Pleurothallis* as that genus is now constituted. The genera of the Pleurothallideae need critical comparative morphological study, and the present species should prove interesting when that work is done.

LIPARIS FRATRUM Schltr.—CHIRIQUÍ: creeping terrestrial, vicinity of Cerro Punta, 2000 m. alt., "roots being produced from leaf axils," flowers green, Jan. 21–24, 1939, *Allen 1528.* New to the flora of Panama. Previously recorded from Costa Rica.

EPIDENDRUM CRINIFERUM Rchb. f.—COCLÉ: epiphytic, north rim of El Valle de Antón, 600–1000 m. alt., flowers tan spotted red, Feb. 12, 1939, *Allen 1679.* New to Panama. Previously recorded from Costa Rica and Peru.

EPIDENDRUM REPENS Cogniaux—CHIRIQUÍ: pendent epiphytic plant, flowers maroon, vicinity of Cerro Punta, 2000 m. alt., Jan. 21–24, 1939, *Allen 1530.* New to Panama. Previously known from Mexico, Costa Rica, Cuba, Jamaica, and Venezuela.

EPIDENDRUM TRIANGULABIUM Ames & Schweinf.—COCLÉ: vicinity of El Valle, 600–1000 m. alt., Dec. 8, 1938, *Allen 1245.* A rare species which is new to Panama. Previously known from Costa Rica.

LAELIA **Lueddemanii** (Prill.) L. O. Williams, comb. nov. (*Schomburgkia Lueddemanii* Prill., in Jour. Soc. Imp. Hort. Paris **8**: 275. 1862; Rolfe, in Bot. Mag. **138**: *t. 8427.* 1912)—COCLÉ: mountains beyond La Pintada, 400–600 m. alt., *Hunter & Allen 509.*

MAXILLARIA **Allenii** L. O. Williams, sp. nov. (pl. 35). Herbae epiphyticae, erectae vel adscendentes, sine pseudobulbis, usque ad 3.7 dm. altae. Caules teretes vel complanati, foliosi. Folia anguste oblonga, emarginata, obtusa, coriacea, conferta, disticha. Inflorescentia florum fasciculus ex foliorum axillis. Sepalum dorsale oblongo-lanceolatum, acutum, 3–(5)-nervium, carnosum. Sepala lateralia oblongo-lanceolata, acuta, carnosa, paulo obliqua, columnae pedi adnata. Petala oblanceolata, acuta, trinervia. Labellum ovatum, trilobatum, obtusum, carnosum; lobi laterales parvi; lobus medius oblongus. Columna generis, arcuata.

Erect or assurgent epiphytic herbs without pseudobulbs, up to 3.7 dm. tall. Stems terete or flattened, up to about 1 cm. thick, covered with the persistent leaf-sheaths. Leaves 4–7 cm. long, 1.2–2 cm. broad, narrowly oblong, emarginate, obtuse, coriaceous, crowded on the stem, distichous. Inflorescence a fascicle of single flowers from the axils of leaves; rachis of each flower about 2 cm. long, covered with about three lanceolate, scarious bracts. Dorsal sepal about 9 mm. long and 2.5 mm. broad, oblong-lanceolate, acute, 3–(5)-nerved, fleshy. Lateral sepals about 8–9 mm. long and 2.5 mm. broad, oblong-lanceolate, fleshy, acute, somewhat oblique, adnate to the column-foot. Petals about 8 mm. long and 2.7 mm. broad, oblanceolate, acute, 3-nerved. Lip about 6.5 mm. long and 3–3.5 mm. broad, oval in outline, obtuse, fleshy; lateral lobes small, their points at about the middle of the lip; mid-lobe oblong, with a linear-oblong callus about 2–2.5 mm. long. Column about 3 mm. long, arcuate; column-foot 1–1.5 mm. long.—COCLÉ: epiphytic, north rim of El Valle de Antón, 600–1000 m. alt., flowers yellow, Feb. 12, 1939, *Allen 1650* (Herb. Missouri Bot. Gard., TYPE).

Maxillaria Allenii is allied to *M. dendrobioides* (Schltr.) L. Wms.,[1] a species which occurs in Costa Rica and Panama, but may be distinguished from it by the larger leaves, by a number of flowers from the axil of a leaf instead of a single flower, and by details of the flowers.

MAXILLARIA CHARTACIFOLIA Ames & Schweinf.—COCLÉ: vicinity of El Valle, 600–1000 m. alt., flowers brown, Dec. 8, 1938, *Allen 1256*. A rare species previously known only from the province of Guanacaste in Costa Rica. The present specimen is somewhat smaller than those from Costa Rica.

[1]MAXILLARIA **dendrobioides** (Schltr.) L. O. Williams, comb. nov. (*Camaridium dendrobioides* Schltr. in Beih. Bot. Centralbl. **36**, Abt. 2: 415. 1918.)

Maxillaria **Wercklei** (Schltr.) L. O. Williams, comb. nov. (*Ornithidium Wercklei* Schltr. in Fedde's Repert. Beih. **19**: 60, 244, 305. 1923).—coclé: vicinity of El Valle, 600–1000 m. alt., petals and sepals tan with brown stripes, lip brown, Dec. 8, 1938, *Allen 1253*. New to the flora of Panama, previously known from Costa Rica.—It is not unlikely that *Maxillaria Lankesteri* Ames and *Ornithidium aurantiacum* Schltr. belong here as synonyms.

Cryptocentrum gracillimum Ames & Schweinf.—coclé: epiphytic, north rim of El Valle, July 9, 1939, *Allen 1911*. *Cryptocentrum gracillimum* was originally described from "Pejivalle," Costa Rica. The type specimen was, until the present time, the only known collection of the species. The genus is new to the flora of Panama.

Cryptocentrum Standleyi Ames—coclé: north rim of El Valle de Antón, 600–1000 m. alt., flowers tan, Feb. 12, 1939, *Allen 1685*. A very rare species which was known previously only from Costa Rica.

Oncidium globuliferum HBK.—chiriquí: vine growing in the tops of the tallest trees, vicinity of Cerro Punta, 2000 m. alt., Jan. 21–24, 1939, *Allen 1567*. New to Panama and Central America, previously recorded from Colombia and Venezuela. A variety which occurs in Costa Rica, var. *costaricense* Rchb. f., may not be distinct.

Sigmatostalix **abortiva** L. O. Williams, sp. nov. (pl. 34, figs. 1–6). Herbae epiphyticae, caespitosae, parvae, usque ad 12 cm. altae. Pseudobulbi ancipites, oblongi vel ovati, unifoliati. Folia elliptica vel lanceolata, acuta, subcoriacea. Inflorescentia erecta, folia multo excedens, racemosa. Sepala lanceolata, acuta, uninervia. Petala quam sepala latiora, late lanceolata, acuta, uninervia vel basi obscure trinervia. Labellum simplex, unguiculatum; lamina suborbicularis, truncata; unguis callo cucullato ornatus. Columna generis.

Small, caespitose, epiphytic herbs up to 12 cm. tall. Pseudobulbs 1–2 cm. long, 3–10 mm. broad, oblong to ovate, ancipitous, vernicose, unifoliate at the apex, usually with one small subtending leaf on each edge of the pseudobulb. Leaves 2.5–

4 cm. long, 4–10 mm. broad, elliptic-lanceolate, acute, subcoriaceous. Inflorescence lateral, in a loose raceme much exceeding the leaves in length; bracts at the base of the pedicel sometimes bifurcate, bracts on the pedicel two, the lower one with a sterile ligule in its axil and the upper one fertile. Sepals about 3.2 mm. long and 0.8–1 mm. broad, lanceolate, acute, 1-nerved, obscurely apiculate. Petals about 3.2 mm. long and 1.3 mm. broad, broadly oblanceolate, acute, 1-nerved or obscurely 3-nerved at the base, obscurely apiculate. Lip about 5 mm. long and 3.5 mm. broad; the lamina about 3.3 mm. long, suborbicular, slightly retuse, truncate; the claw about 1.8 mm. long, slender, covered by a large cucullate callus. Column of the genus, about 3 mm. long.—CANAL ZONE: Quebrada Lopez, 30 m. alt., sepals and petals yellow, lip white, Feb. 11, 1940, *Allen 2121* (Herb. Missouri Bot. Gard., TYPE).

Sigmatostalix abortiva is more closely allied to *S. guatemalensis* Schltr. than to any other species. It is similar in habit, type of inflorescence and general structure of the flower but differs in most all floral details.

The inflorescence is an interesting one. It can be described as a raceme but on examination of the presumed pedicel of each flower two bracts are found. The lower bract has a ligule in its axil and the upper one subtends the flower. It is probable that the ligule represents an aborted flower (hence the specific name) and that the whole inflorescence is a reduced panicle; perhaps reduced from a type similar to that found in *Sigmatostalix hymenantha* Schltr. or *S. racemifera* L. Wms.

The inflorescence of *Sigmatostalix guatemalensis* Schltr. is similar to that of *S. abortiva* except for the greater number of bracts. There is no indication, on the fifteen specimens in the Ames Herbarium, that more than one flower is borne from each set of bracts. However in Rolfe's plate of *S. costaricensis* Rolfe (Bot. Mag. **145**: *t. 8825.* 1919), which is a synonym of *S. guatemalensis,* such a condition is shown.

SIGMATOSTALIX **racemifera** L. O. Williams, sp. nov. (pl. 36). Herbae epiphyticae, parvae, erectae, usque ad 15 cm. altae. Pseudobulbi ovati vel obovati, apice unifoliati et utrinque foliis suffulti. Folia erecta, elliptica vel elliptico-oblanceolata, acuta, coriacea. Inflorescentia lateralis, folia excedens; racemus paniculatus, i. e. e racemis lateralibus densifloris brevibus constans. Sepalum dorsale lanceolatum, acutum, uninervium. Sepala lateralia late lanceolata, acuta vel acuminata, uninervia, basi paulo connata. Petala anguste ovato-lanceolata, acuta, uninervia vel obscure trinervia. Labellum subquadratum, panduratum, trilobatum, callo quadrisulcato ad basim ornatum; lobus medius lobis lateralibus subaequalis. Columna gracilis, malleoliformis.

Small erect epiphytic herbs up to 15 cm. tall. Pseudobulbs 2–3.5 cm. long, 1–2 cm. broad, probably about 5 mm. thick, oval to obovate, summit unifoliate, with a subtending leaf on either margin of the pseudobulb. Leaves erect, 4–8 cm. long, 8–18 mm. broad, elliptic to elliptic-oblanceolate, acute, coriaceous. Inflorescence a paniculate raceme—with short, lateral, densely flowered branches—the inflorescence exceeding the leaves. Dorsal sepal about 3 mm. long and 0.75 mm. broad, lanceolate, acute, 1-nerved. Lateral sepals about 2.5 mm. long and 0.8 mm. broad, broadly lanceolate, acute or abruptly acuminate, connate for a short distance at their bases. Petals about 3 mm. long and 1.25 mm. broad, narrowly ovate-lanceolate, acute, 1-nerved or obscurely 3-nerved. Lip about 3 mm. long and 3.5 mm. broad, subquadrate, pandurate, 3-lobed; the mid-lobe equal in size to the two lateral lobes; with a raised subquadrate callus at the base about 1.2 mm. long and 1.1 mm. broad and having four subequal, longitudinal chambers above. Column about 5 mm. long, slender, malleoliform; the terminal portion somewhat thicker than the basal portion and with the elongated stigma on its lower side; anther decumbent.—COCLÉ: vicinity of El Valle, 600–1000 m. alt., flowers yellow, Dec. 8, 1938, *Allen 1232* (Herb. Missouri Bot. Gard., TYPE).

Sigmatostalix racemifera is closely allied to *S. hymenantha* Schltr., which it simulates in habit and in having the inflorescence made up of small lateral clusters of flowers on an elongated rachis. It differs in the shape of the lip, and in the structure of the callus and the column.

PIPERACEAE
(W. Trelease, Urbana, Ill.)

Piper **affectans** Trel., spec. nov. Arbor 10 m. alta, foliorum nervis subtus velutinis caeterumque glabra. Folia ovata subacuta profunde cordata 35 cm. lata 50 cm. longa sub parte tertia superiore pinnate nervata post exsiccationem illustria venoso-areolataque, venis utroque latere ca. 8; petiolo 17 cm. longo alato basi aliquid verrucoso. Spicae 30–50 cm. longae basi ca. 0.8 cm. diam.; pedunculo 2 cm. longo.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 865* (Herb. Univ. Illinois, TYPE).

Piper **albopunctulatissimum** Trel., spec. nov. Frutex nodosus fere glaber ca. 4 m. altus; internodiis superioribus sat brevibus gracilibusque exigue angusteque verrucosis. Folia elliptica vix acuminata cordato-auriculata latere maiore petiolum fere aequante ca. 20 cm. longa 15 cm. lata sub tertio superiore pinnate nervata nervis ca. 6 + 7, supra copiose albopunctulata subtus nervis leviter puberulis; petiolis 4.5 + 0.5 cm. longis exigue angusteque verrucosis. Spicae 17–20 cm. longae ca. 0.5 cm. crassae; pedunculo ca. 4 cm. longo.—COCLÉ: north rim of El Valle de Antón, alt. 600–1000 m., Feb. 12, 1939, *P. H. Allen 1652* (Herb. Univ. Illinois, TYPE).

Piper **Alstoni** Trel., spec. nov. Suffrutex *P. auritae* propinquus ca. 3 m. altus, ramis et petiolis et pedunculis foliisque subtus ad tempus cinereo-velutinis; internodiis sat brevibus gracilibusque. Folia rotundo-ovata sub more breviter acuminata cordato-auriculata latere maiore petiolum fere aequante 22–30 cm. longa 15–18 cm. lata pinnate nervata nervis ca. 5 + 7, molliter pubescentia subtus praecipue; petiolo 5 + 1 cm. longo glabrescente sub latere maiore alato. Spicae ca. 18 cm. longae 0.5 cm. crassae plus minusve nutantes; pedunculo 2–3 cm. longo. —COCLÉ: north rim of El Valle de Antón, Feb. 12, 1939, *A. H. G. Alston & P. H. Allen 1842* (Herb. Univ. Illinois, TYPE).

Piper **alveatum** Trel., spec. nov. Frutex ramulosus ca. 2 m. altus; internodiis breviter hirsutis mox glabrescentibus. Folia anguste lanceolata longe attenuata basi oblique obtusa 10–

12 cm. longa 2–3 cm. lata sub medio pinnate impresso-nervata, nervis 4 + 5 subtus puberulis; petiolo 0.5 cm. longo. Spicae falcatae 6 cm. longae basi ca. 0.2 cm. diam. apiculatae; pedunculo 0.5–0.6 cm. longo.—BOCAS DEL TORO: vicinity of Nievecita, alt. ca. 0–50 m., Aug. 8–19, 1938, *Woodson, Allen & Seibert 1837* (Herb. Univ. Illinois, TYPE).

Piper **amphibium** Trel., spec. nov. Frutex 2 m. altus, foliis supra glabrescentibus caeterumque puberulis; internodiis sat brevibus graciliusculisque. Folia lanceolata mucronate longeque attenuata basi inaequilateraliter acuta vel obtusa 5–16 cm. longa 3–10 cm. lata sub medio pinnate nervata, nervis utroque latere ca. 5 maturitate aliquid rufescentibus; petiolo 1 cm. longo ca. 0.1 cm. lato. Spicae 7–9 cm. longae basi ca. 0.5 cm. diam.; pedunculo 1.0–1.3 cm. longo.—COCLÉ: pools and their margins in wet llanos between Aguadulce and Antón, alt. ca. 15–50 m., July 12, 1938, *Woodson, Allen & Seibert 1222* (Herb. Univ. Illinois, TYPE).

Piper **arctilimbum** Trel., spec. nov. Frutex nodosus ramosus; internodiis florigeris brevibus sat gracilibus ad tempus longe cinereo-velutinis. Folia anguste lanceolata gradatim acuta vel subacuminata basi obliqua latere longiore rotundata 1.2–1.4 cm. longa ca. 2 cm. lata sub medio pinnate nervata nervis fere horizontalibus utroque latere 5, subtus crasse velutina; petiolo vix 0.3 + 0.2 cm. longo velutino. Spicae ca. 6 cm. longae 0.3 cm., crassae submucronatae; pedunculo vix 1 cm. longo; bracteis subpeltato-triangularibus pallidis.—COCLÉ: vicinity of El Valle, *G. S. Miller 1813* (U. S. Nat. Herb., TYPE).

Piper arctilimbum Trel., var. **Alleni** Trel., var. nov. A specie foliis maioribus (16 cm. longis 3 cm. latis), spicis arcuatis longioribus (7.5 cm. longis vel longioribus) differt.—COCLÉ: El Valle de Antón, alt. 600 m., *P. H. Allen 2003* (Herb. Univ. Illinois, TYPE).

Piper **barbirostre** Trel., spec. nov. Arbusculus nodosus ca. 6 m. altus; internodiis superioribus brevibus sat crassis hirsutis. Folia ovato- vel subelliptico-lanceolata falcate longeque acuminata basi nonnihil inaequilateralia utroque latere obtusa 12–14 cm. longa 5–6 cm. lata sub medio pinnate nervata nervis

5 + 2, supra granulo-scabra subtus nervis ferrugineo-villosis post maturitatem rugescentia; petiolo ca. 0.5 + 0.2 cm. longo hirsuto. Spicae 8–9 cm. longae ca. 0.4 cm. crassae rostro sterili pubescente; pedunculo 0.5–1.0 cm. longo; bracteis rotundo-peltatis brunneis medio crustaceo fusco.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, Jan. 6–14, 1939, *P. H. Allen 1365* (Herb. Univ. Illinois, TYPE).

PIPER **bisacuminata** Trel., spec. nov. Herba terrestris vel lignicola glabra compacte ramosa altitudine mediocri. Caulis post exsiccationem 0.2–0.3 cm. crassus. Folia 3–4-nata rhombiformia apice obtuse acuminata basi late acuta 2.5–4.0 cm. longa 1.5 cm. lata 3-nervata post exsiccationem tenuia; petiolo vix 0.5 cm. longo. Spicae et terminales et axillares 5 cm. longae basi ca. 0.1 cm. diam.; pedunculo 1 cm. longo.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 971* (Herb. Univ. Illinois, TYPE).

PIPER **casitense** Trel., spec. nov. Frutex 1–2 m. altus; internodiis superioribus brevibus crassiusculis 3-angulatis hirtellis. Folia inaequilateraliter elliptico-oblanceolata acuminata basi acuta 17–20 cm. longa 5.5–7.5 cm. lata sub medio pinnate nervata, nervis utroque latere ca. 6 subtus distinctissime manifestis aliquid hirsutis supra scabra; petiolo vix 1 cm. longo hispido. Spicae 8–10 cm. longae basi ca. 0.5 cm. diam. cuspidatae; pedunculo vix 0.5 cm. longo glabrato.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 978* (Herb. Univ. Illinois, TYPE).

PIPER **cerro-puntoense** Trel., spec. nov. Frutex ca. 2 m. altus; internodiis superioribus sat gracilibus brevibusque ad primum dense subvillosis. Folia subovato-elliptica anguste acuminata basi rotundata uno latere paulo longiore, 20 cm. longa 11 cm. lata sub tertio superiore pinnate nervata nervis 6 + 7, supra brevissime scabridula subtus nervis hirsutulis; petiolo 1.0 + 0.2 cm. longo. Spicae paulo arcuatae apiculatae 9 cm. longae ca. 0.4 cm. crassae; pedunculo 1.0–1.5 cm. longo hirtello.—CHIRIQUÍ: trail to Cerro Punta, Río Chiriquí Viejo valley, March 29, 1938, *G. White 52* (Herb. Univ. Illinois, TYPE).

Piper **colon-insulae** Trel., spec. nov. Frutex 2 m. altus, foliis supra glabris caeterumque molliter pubescens; internodiis gracilibus mox elongatis. Folia elliptica breviter acuminata basi obscure inaequilateraliterque cordulata 14–16 cm. longa 6.5–7.5 cm. lata sub medio pinnate nervata, venis utroque latere 5; petiolo 0.8 cm. longo ca. 0.2 cm. lato. Spicae 2.5–3.0 cm. longae basi ca. 0.7 cm. diam. apiculatae; pedunculo 0.8 cm. longo; baccis subquadratis, stylo brevissimo persistente.—bocas del toro: Isla de Colon, alt. ca. 25–75 m., Aug. 17–18, 1938, *Woodson, Allen & Seibert 1934* (Herb. Missouri Bot. Gard., type).

Piper **conversum** Trel., spec. nov. Frutex subarborescens glaber ca. 2 m. altus; internodiis brevibus gracillimis. Folia elliptico-lanceolata anguste caudata basi acuta uno latere paulo breviore 4–11 cm. longa 3–8 cm. lata 5-nervata nervis exterioribus 2 marginalibus leviter undulatis; petiolo vix 0.3 + 0.2 cm. longo. Spicae solitariae laterales (nostrae immaturae).—chiriquí: Llanos del Volcán, alt. 1300 m., Jan. 23, 1939, *P. H. Allen 1550* (Herb. Univ. Illinois, type).

Piper **cricamolense** Trel., spec. nov. Frutex fragilis 2–3 m. altus glaber vel mox glabrescens foliorum nervis subtus aliquid appresse arachnoideis exceptis; internodiis brevibus graciliusculis. Folia elliptica acute acuminata basi subaequilateraliter obtusa 13 cm. longa 7 cm. lata sub medio submultiplicate nervata, nervis utroque latere 4 vel 5; petiolo 0.5 cm. longo. Spicae 5–7 cm. longae 0.2–0.3 cm. diam.; pedunculo 1 cm. long.—bocas del toro: Río Cricamola between Finca St. Louis and Konkintoë, alt. ca. 10–50 m., Aug. 12–16, 1938, *Woodson, Allen & Seibert 1927* (Herb. Univ. Illinois, type).

Piper Diazanum Trel., var. **viae-kobeanae** Trel., var. nov. Frutex 2 m. altus; internodiis gracilibus breviusculis sparse pilosulis. Folia elliptica vel subovato-lanceolata gradatim acute acuminata basi inaequilateraliter subcordulata 14–16 cm. longa 5–8 cm. lata sub medio pinnate nervata, nervis subtilibus pallidis sparse molliterque pilosis; petiolo 1 cm. longo ca. 0.2 cm. lato dorso sparse molliterque pilosulo. Spicae 8 cm. longae ca. 0.2 cm. diam.; pedunculo 0.5 cm. longo piloso.—

CANAL ZONE: Fort Kobe road, July 22, 1938, *Woodson, Allen & Seibert 1412* (Herb. Univ. Illinois, TYPE).

PIPER **erubescentispica** Trel., spec. nov. Frutex 2 m. altus; internodiis breviusculis graciliusculisque evanide villosis. Folia juventate summe villosa elliptica acute acuminata oblique cordulata 10–14 cm. longa 4.0–6.5 cm. lata sub medio pinnate nervata supra albide bullata, nervis utroque latere 4 vel 5 subtus villosis; petiolo 0.5 cm. longo ca. 0.2 cm. lato juventate villosulo. Spicae saturate rubrae 3 cm. longae basi ca. 0.3 cm. diam.; pedunculo 0.5 cm. longo glabrescente.—BOCAS DEL TORO: vicinity of Nievecita, alt. ca. 0–50 m., Aug. 8–19, 1938, *Woodson, Allen & Seibert 1817* (Herb. Univ. Illinois, TYPE).

PIPER **fluvii-initii** Trel., spec. nov. Arbor monticola ca. 8 m. alta; internodiis graciliusculis breviusculusque ad primum subhirsutis. Folia elliptica acuminata basi fere aequilateraliter rotundata ca. 17 cm. longa 9 cm. lata sub medio pinnate nervata nervis maioribus ca. 6 + 5, venulis supra valde immersis, firmiter membranacea paululo illustria supra glabra subtus nervis subvillosis; petiolo 2 cm. longo. Spicae 8 cm. longae in fructu ca. 1 cm. crassae apiculatae; pedunculo crasso 2 cm. longo velutino; stigmate filiformi stylo aequilongo.—CHIRIQUÍ: trail from Cerro Punta to headwaters of Río Caldera, alt. 2250–2500 m., Jan. 14, 1939, *P. H. Allen 1445* (Herb. Univ. Illinois, TYPE).

PIPER FRIJOLESANUM Trel., var. **grandifolium** Trel., var. nov. Suffrutex ca. 3 m. altus ut videtur omnino glaber; internodiis petiolisque minute verrucosis. Folia elliptica ca. 40 cm. longa 25 cm. lata vix acuminata basi lobis impendentibus; petiolo 4–5 cm. longo. Spicae immaturae ca. 0.3 cm. crassae; pedunculo ca. 2 cm. longo.—COCLÉ: El Valle, alt. 600–1000 m., Dec. 8, 1938, *P. H. Allen 1193* (Herb. Univ. Illinois, TYPE).

PIPER GAMBOANUM Trel., var. **yapense** Trel., var. nov. Frutex ca. 2 m. altus; ramis subhirsutis vel hispidis. Folia elliptico-subovata superne sublanceolata ca. 10 cm. longa 3–4 cm. lata inferne usque 6 cm. lata rugosa supra granulo-scabra subtus nervis plus minusve hirsutis; petiolo vix 0.5 cm. longo. Spicae ca. 6 cm. longae 0.3 cm. crassae; pedunculo ca. 0.5 cm. longo.—DARIEN: vicinity of Yape, Oct. 4, 1938, *P. H. Allen 854* (Herb. Univ. Illinois, TYPE).

Piper gatunense Trel., var. **cocleanum** Trel., var. nov. Forma nodosa ca. 3 m. alta; foliis ca. 25 cm. longis 9–10 cm. latis basi acutis; spicis ca. 20 cm. longis 1 cm. crassis.—coclé: north rim of El Valle de Antón, May 14, 1939, *P. H. Allen 1784* (Herb. Univ. Illinois, type).

Piper gatunense Trel., var. **latum** Trel., var. nov. A var. *cocleano* foliis ca. 35 cm. longis 16 cm. latis basi obtusis, spicis 25 cm. longis vel longioribus differt.—coclé: north rim of El Valle de Antón, May 14, 1939, *P. H. Allen 1808* (Herb. Univ. Illinois, type).

Piper **Gigas** Trel., spec. nov. Arbor 10 m. alta, trunco ca. 30 cm. diam., ramulis obscure puberulis. Folia ovata subacuta oblique cordata sino aliquid angusto 30–45 cm. longa 20–25 cm. lata sub quarto parte superiore pinnate nervata, nervis utroque latere ca. 7 subtus puberulis; petiolo 8 cm. longo alato. Spicae 30 cm. longae basi ca. 0.8 cm. diam.; pedunculo 5 cm. longo.—chiriquí: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 846* (Herb. Univ. Illinois, type).

Apparently the largest *Piper* thus far collected in North America, and nearly, if not quite, equalling the Colombian *P. Giaccomettoi* which is reported as 12 m. tall, with a trunk 20–40 cm. thick.

Piper **heraldi** Trel., nom. nov.—*Artanthe Seemanniana* Miq. in Seem., Bot. Herald, 199. *pl. 39.* 1854, not *Piper Seemannianum* C. DC. in DC., Prodr. **16**[1]: 347. 1869; *Piper auritum* var. *Seemannianum* (Miq.) Trel., Contr. U. S. Nat. Herb. **26**: 40. 1927.

Piper heraldi Trel., var. **amplius** Trel., var. nov. Ab specie foliis longioribus (22–25 × 45–50 cm.) differt.—chiriquí: Finca Lérida to Boquete, alt. ca. 1300–1700 m., July 8–10, 1938, *Woodson, Allen & Seibert 1095* (Herb. Univ. Illinois, type).

Also referred here questionably is the following: bocas del toro: vicinity of Nievecita, alt. 0–50 m., Aug. 8–19, 1938, *Woodson, Allen & Seibert 1813.*

Piper heraldi Trel., var. **cocleanum** Trel., var. nov. Herba ut dicitur immani magnitudine ca. 3 m. alta var. *ampliori* similis, foliis subtus magis constanter cinereo-velutinis excepta. Folia ca. 45 cm. longa 30 cm. lata; petiolo 8 + 2 cm. longo. Spicae ca. 20 cm. longae ca. 0.3 cm. crassae; pedunculo 6 cm. longo.—COCLÉ: El Valle, Dec. 8, 1938, *P. H. Allen 1192* (Herb. Univ. Illinois, TYPE).

PIPER **humorigaudens** Trel., spec. nov. Frutex ramosus nodosus glaber ca. 2 m. altus; internodiis superioribus brevibus gracillimis. Folia lanceolata subacuminata basi acuta 8–13 cm. longa 2.5–3.0 cm. lata 3-nervata; petiolo vix 0.5 cm. longo. Spicae 4–5 cm. longae ca. 0.3 cm. crassae; pedunculo filiformi 1.0–1.5 cm. longo; baccis depresse ellipsoideis, stigmate parvo sessili.—COCLÉ: north rim of El Valle de Antón, May 21, 1939, *P. H. Allen 1833* (Herb. Univ. Illinois, TYPE).

PIPER **insulicolum** Trel., spec. nov. Frutex nodosus 2–3 m. altus aliquid obscure puberulus. Folia lanceolata vel oblanceolata subacuminata basi rotundata vel inaequilateraliter cordulata 17 cm. longa 5.5 cm. lata sub medio pinnate nervata, nervis utroque latere 5 vel 6; petiolo 1 cm. longo ca. 0.2 cm. lato. Spicae 7–8 cm. longae 0.3–0.5 cm. diam.; pedunculo 1 cm. longo.—PANAMÁ: Isla Taboga, June 24, 1938, *Woodson, Allen & Seibert 1527* (Herb. Univ. Illinois, TYPE).

The young spikes are minute, pointed, and borne on strikingly refracted stalks.

PIPER **konkintoense** Trel., spec. nov. Frutex 2–3 m. altus; internodiis gracilibus breviusculis aliquid laxe pubescentibus maturitate glabrescentibus. Folia elliptica acute acuminata oblique cordulata 14–16 cm. longa 6–7 cm. lata sub medio pinnate nervata, nervis utroque latere 6–7 supra granulo-scabris subtus molliter pubescentibus; petiolo 0.8 cm. longo ca. 0.2 cm. lato pubescente. Spicae refractae 11 cm. longae basi ca. 0.3 cm. diam.; pedunculo 0.5 cm. longo scabro.—BOCAS DEL TORO: between Finca St. Louis and Konkintoë, alt. 10–50 m., Aug. 12–16, 1938, *Woodson, Allen & Seibert 1894* (Herb. Univ. Illinois, TYPE).

PIPER **Margaretae** Trel., spec. nov. Frutex vix 1.5 m. altus; internodiis superioribus sat gracilibus brevibus subretrorse hispidis scabrisque. Folia rotundo- vel subovato-elliptica longi-acuminata basi inaequilateraliter acuta 8.5–15.0 cm. longa 5.5–11.0 cm. lata sub medio pinnate nervata nervis ca. 5 + 2, supra valde granulo-scabra subtus nervis molliter hirsutis; petiolo ca. 0.8 + 0.2 cm. longo hispidulo-hirsuto. Spicae ca. 9 cm. longae 0.5 cm. crassae cuspidatae; pedunculo 1 cm. longo hispido.—CHIRIQUÍ: island in upper Río Chiriquí Viejo, *P. White 158* (Herb. Univ. Illinois, TYPE).

PIPER **minute-scabiosum** Trel., spec. nov. Frutex ramosus nodosus ca. 3 m. altus; internodiis brevibus gracilibus distincte sed minute lepidotis. Folia lanceolato-elliptica vel anguste lanceolata acuminata vel caudata basi fere aequilateraliter acuta 9–13 cm. longa 3–4 cm. lata sub medio pinnate nervata nervis 4 + 5, supra minute papillata demum mature lepidota subtus nervis strigosis; petiolo 0.5 cm. longo. Spicae ca. 5 cm. longae ca. 0.2–0.3 cm. crassae rufidulae; pedunculo 1.0–1.5 cm. longo.—COCLÉ: north rim of El Valle de Antón, Feb. 12, 1939, *P. H. Allen 1639* (Herb. Univ. Illinois, TYPE).

PIPER MINUTE-SCABIOSUM Trel., var. **arborescens** Trel., var. nov. Frutex arborescens ca. 2.5 m. altus. Folia usque 15 cm. longa 4.5 cm. lata latere longiore obtusiusculo.—COCLÉ: El Valle, Dec. 8, 1938, *P. H. Allen 1185* (Herb. Univ. Illinois, TYPE).

PIPER **novae-helvetiae** Trel., spec. nov. Arbor glabra ca. 6 m. alta; internodiis graciliusculis. Folia ovata anguste acuminata basi subtruncate rotundata uno latere paulo breviore, 14–20 cm. longa 6–12 cm. lata sub medio multiplicate nervata nervis 4 + 5; petiolo 0.2–0.4 + 0.2 cm. longo haud alato. Spicae 7 cm. longae ca. 0.4 cm. crassae apiculatae zonate bracteatae; pedunculo 0.5 cm. longo.—CHIRIQUÍ: vicinity of "New Switzerland," Río Chiriquí Viejo valley, alt. 1800–2000 m., Jan. 6, 1939, *P. H. Allen 1359* (Herb. Univ. Illinois, TYPE); same data, *P. H. Allen 1416* (Herb. Univ. Illinois).

PIPER **partiticuspe** Trel., spec. nov. Suffrutex ca. 3 m. altus; internodiis graciliusculis elongatis in tempus crispe hirsutis. Folia rotundo-ovata falcatim angusteque acuminata basi inaequilateraliter cordata uno latere petiolo longiore, 20–35 cm. longa 15–22 cm. lata supra venoso-bullata cuspide quoque 2–4-

partito pilosulo in superficie minute granulo-scabridulo subtus nervis rigide subvillosis; petiolo 4 cm. longo subvilloso. Spicae ca. 15 cm. longae ca. 0.5 cm. crassae; pedunculo 2 cm. longo glabro.—COCLÉ: El Valle de Antón, Dec. 8, 1938, *P. H. Allen 1195* (Herb. Univ. Illinois, TYPE).

PIPER **paso-anchoense** Trel., spec. nov. Arbuscula ca. 2 m. alta ramosa glabra; internodiis superioribus gracilibus sat brevibus. Folia ovato-lanceolata vel lanceolata gradatim acuta basi subaequilateraliter acuta 9–13 cm. longa 4–5 cm. lata sub medio pinnate nervata nervis maioribus utroque latere ca. 3 sed nervo medio superne delicate composito; petiolo 0.5–1.0 cm. longo. Spicae 3.5 cm. longae ca. 0.2–0.3 cm. crassae obtusae; pedunculo 0.5 cm. longo.—CHIRIQUÍ: trail from Paso Ancho to Monte Lirio, upper valley of Río Chiriquí Viejo, Jan. 16, 1939, *P. H. Allen 1579* (Herb. Univ. Illinois, TYPE).

PIPER **perfugii** Trel., spec. nov. Frutex glaber ramulosus valde nodosus 1 m. altus; internodiis brevibus sursum gracilibus. Folia lanceolata longe acuteque acuminata basi late acuta 7–8 cm. longa 2.0–2.5 cm. lata sub medio pinnate nervata, nervis utroque latere 4; petiolo 0.5 cm. longo. Spicae 5 cm. longae basi ca. 0.3 cm. diam.; baccis conspicuis pallidis 3-angularibus.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 928* (Herb. Univ. Illinois, TYPE).

PIPER **Permari** Trel., spec. nov. Frutex graciliter ramosus glaber. Folia elliptica gradatim caudata basi fere aequilateraliter rotundata ca. 11 cm. longa 4.5 cm. lata per totam longitudinem pinnate nervata nervis pallidis utroque latere ca. 8 post exsiccationem fere auritis subtus fere albis; petiolo 0.5 cm. longo. Spicae ca. 2.5 cm. longae ca. 0.3 cm. crassae erectae; pedunculo 0.5 cm. longo; bracteis subpeltatis pallidis; ovario ovoideo acute attenuato, stigmatibus 3 basalibus.—BOCAS DEL TORO: upper Changuinola River, Feb., 1939, *J. H. Permar s.n.* (Herb. Missouri Bot. Gard., TYPE).

PIPER **peruligerum** Trel., spec. nov. Suffrutex parvus, ramulis et petiolis et foliis subtus juventate ferrugine subarachnoideo-villosis, internodiis brevibus graciliusculis. Folia lanceolata longe attenuata oblique cordulata 13–14 cm. longa 4–5 cm. lata sub medio pinnate nervata, nervis ca. 5 + 3, lamina inter venulas aliquid saccata; petiolo 0.3 cm. longo ca. 0.2 cm. lato pubescente. Spicae 2.5 cm. longae; pedunculo 0.3 cm. longo; ovario cum stylo brevi.—BOCAS DEL TORO: Isla de Colon, alt. ca. 25–75 m., Aug. 17–18, 1938, *Woodson, Allen & Seibert 1939* (Herb. Missouri Bot. Gard., TYPE).

PIPER **pervicax** Trel., spec. nov. Frutex 2–3 m. altus; internodiis brevibus graciliusculisque hirsuto-scabris. Folia elliptica acuminata basi rotundata vel oblique subcordulata 19–20 cm. longa 8 cm. lata sub medio pinnate nervata supra subtusque granulo-scabra, nervis 6 + 5 laxe hirtellis; petiolo 1.2–2.5 cm. longo. Spicae 9.5 cm. longae basi ca. 0.5 cm. diam. cuspidatae; pedunculo 1.5 cm. longo.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 843* (Herb. Univ. Illinois, TYPE).

PIPER **pseudo-viridicaule** Trel., spec. nov. Frutex 2 m. altus; internodiis florigeris gracilibus elongatis retrorse scabridulis tandem glabrescentibus. Folia lanceolata vel elliptica apice acute acuminata basi inaequilateraliter rotundata vel uno latere obliquissime acuta 10–12 cm. longa 3–6 cm. lata post exsiccationem tenuissima supra saturate viridia minutissime albo-scabridula subtus pallidiora ibique aliquid rugosa nervis appresse-pubescentibus sub medio pinnate nervata, nervis utroque latere ca. 4; petiolo 1.0–1.5 cm. longo basi alato retrorse scabro-hispidulo. Spicae ignotae.—CANAL ZONE: Barro Colorado Island, Gatun Lake, *Standley 31288* (U. S. Nat. Herb. No. 1,215,870, TYPE).

PIPER PSEUDO-VIRIDICAULE Trel., var. **nievecitanum** Trel., var. nov. Ab specie foliis firmioribus, spicis 9.0 cm. longis basi ca. 0.3 cm. diam., pedunculo scabridulo 0.5 cm. longo differt.—BOCAS DEL TORO: vicinity of Nievecita, alt. 0–25 m., Aug. 8–19, 1938, *Woodson, Allen & Seibert 1829* (Herb. Univ. Illinois, TYPE).

PIPER **salamancanum** Trel., spec. nov. Subarbor 2–4 m. alta glabra; internodiis brevibus gracilibusque. Folia elliptico-lanceolata obtuse subcaudato-acuminata basi late acuta 8–9 cm. longa 2.5–4.0 cm. lata sulcate 5-nervata valde venosa nitide viridia; petiolo 0.5 cm. longo. Spicae 4.0 cm. longae basi ca. 0.4 cm. diam.; pedunculo 0.7 cm. longo, baccis remotis aroideis.—CANAL ZONE: vicinity of Salamanca Hydrographic Station, Río Pequení, alt. ca. 80 m., July 28–29, 1938, *Woodson, Allen & Seibert 1590* (Herb. Univ. Illinois, TYPE).

PIPER SAN-JOSEANUM C. DC., var. **kobense** Trel., var. nov. Frutex vix 2 m. altus. Folia ovata vel subrhombo-ovata late cordata 17–20 cm. longa 13–16 cm. lata, venis supra puberulis subtus hirtellis; petiolo 3–5 cm. longo. Spicae 7 cm. longae basi ca. 0.3 cm. diam.; pedunculo nigrescente 0.5 cm. longo.—CANAL ZONE: Fort Kobe road, July 22, 1938, *Woodson, Allen & Seibert 1423* (Herb. Univ. Illinois, TYPE).

PIPER SAN-JOSEANUM C. DC., var. **panamanum** Trel., var. nov. Frutex glaber. Folia 15–19 cm. longa 10–12 cm. lata; petiolo 3–5 cm. longo. Spicae nutantes 15 cm. longae basi 0.2 cm. diam. vel maiores; pedunculo 0.5 cm. longo.—PANAMÁ: Gorgona Beach, Aug. 7, 1938, *Woodson, Allen & Seibert 1690* (Herb. Univ. Illinois, TYPE).

PIPER SAN-JOSEANUM C. DC., var. **remediosense** Trel., var. nov. Frutex glabrescens 2 m. altus. Folia subrotundo-ovata longiuscule acuminata late cordata 20 cm. longa 18 cm. lata 13-nervata nervo medio petiolum trajiciente venis supra obscure puberulis. Spicae fere rectae 10 cm. longae basi ca. 0.2 cm. diam.; pedunculo 0.5 cm. longo.—CHIRIQUÍ: Río Chiriquí to Remedios, alt. ca. 15–50 m., July 11, 1938, *Woodson, Allen & Seibert 1191* (Herb. Univ. Illinois, TYPE).

PIPER SAN-JOSEANUM C. DC., var. **tabogense** Trel., var. nov. Frutex vix 2 m. altus gracilis glaber vel foliis subtus petiolisque sparse brevissimeque pilosulis. Folia rotundo-ovata fere subcaudato-acuminata ca. 14 cm. longa 10 cm. lata; petiolo 5–7 cm. longo. Spicae 5 cm. longae basi ca. 0.2 cm. diam.; pedunculo brevissimo.—PANAMÁ: Isla Taboga, alt. 0–186 m., July 23–24, 1938, *Woodson, Allen & Seibert 1531* (Herb. Univ. Illinois, TYPE).

PIPER **seducentifolium** Trel., spec. nov. Frutex glaber nodosus 2 m. altus; internodiis brevibus graciliusculisque. Folia membranacea lanceolata vel subovata acuminata basi inaequilateraliter acuta vel fere aequilateraliter subtruncata 13 cm. longa 4.5–5.0 cm. lata prorsus pinnate nervata; petiolo 5–15 cm. longo per totam longitudinem alato. Spicae 5 cm. longae basi ca. 0.3 cm. diam.; pedunculo 1 cm. longo.—PANAMÁ: forest near Arraijan, June 22, 1938, *Woodson, Allen & Seibert 781* (Herb. Univ. Illinois, TYPE).

PIPER **tabernillanum** Trel., spec. nov. Frutex 1.5–3.0 cm. altus; internodiis florigeris elongatis gracilibus temporarie sparse molliterque pubescentibus. Folia elliptico-lanceolata acuminata basi aliquid inaequilateraliter cordulata vel subauriculata 14–17 cm. longa 4.5–6.5 cm. lata sub medio pinnate nervata, nervis utroque latere 4 vel 5 aliquid puberulis; petiolo vix 1 cm. longo ca. 0.2 cm. lato haud alato aliquid hirsuto-villoso. Spicae 8–9 cm. longae ca. 0.2–0.3 cm. crassae; pedunculo 0.5–1.5 cm. longo. Baccae obtrigonae.—CANAL ZONE: Tabernilla, *Pittier 3828* (U. S. Nat. Herb., TYPE).

PIPER TABERNILLANUM Trel., var. **anconense** Trel., var. nov. Frutex 2–3 m. altus, ramulis dense minuteque hirtellis. Folia supra hispidula subtus subvelutina. Spicae 5–6 cm. longae basi ca. 0.4 cm. diam; pedunculo 1 cm. longo.—CANAL ZONE: western slope of Ancón Hill, July 20, 1938, *Woodson, Allen & Seibert 1327* (Herb. Univ. Illinois, TYPE).

PIPER **tardans** Trel., spec. nov. Arbor parva 2–3 m. alta, trunco ca. 3 cm. diam., ramulis foliorum nervisque subtus puberulo-tomentulosis. Folia aliquid 5-gono-ovata subacuta basi late sed haud profunde cordata 28 cm. longa 15 cm. lata sub tertio superiore pinnate nervata, venis utroque latere 6; petiolo 5 cm. longo per totam longitudinem alato. Spicae 20 cm. longae basi ca. 0.5 cm. diam.; pedunculo 4 cm. longo.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 848* (Herb. Univ. Illinois, TYPE).

PIPER TUBERCULATUM Jacq., var. **Alleni** Trel., var. nov. Arbuscula ca. 4 m. alta; a specie foliis elliptico-ovatis vel sublanceolatis sat anguste acuminatis ca. 15 cm. longis 7 cm. latis, spicis ca. 12.5 cm. longis 0.2–0.5 cm. crassis cuspidatis, pedunculo 1 cm. longo differt.—COCLÉ: vicinity of El Valle de Antón, Feb. 12, 1939, *P. H. Allen 1640* (Herb. Univ. Illinois, TYPE).

PIPER **varium** Trel., spec. nov. Suffrutex caespitosus nodosus ca. 3 m. altus; internodiis superioribus brevibus sat gracilibus. Folia orbiculata breviter acuminata oblique cordata vel subauriculata ca. 17 cm. diam. sub medio submultiplicate nervata nervis ca. 6 + 7, post exsiccationem tenuia supra minute obscureque punctata; petiolo ca. 4 cm. longo sub medio anguste alato. Spicae ca. 16 cm. longae ca. 0.5 cm. crassae; pedunculo sat crasso 2 cm. longo.—CHIRIQUÍ: trail from Paso Ancho to Monte Lirio, alt. 1500–2000 m., Jan. 16, 1939, *P. H. Allen 1491* (Herb. Univ. Illinois, TYPE).

PIPER **Whiteae** Trel., spec. nov. Frutex 3–4 m. altus glaber; internodiis superioribus gracilibus. Folia subovata ut videntur auriculata sinu laterali ca. 20 cm. longa 13 cm. lata sub medio pinnate nervata nervis ca. 6 + 7; petiolo ca. 3 cm. longo alato. Spicae ca. 30 cm. longae 1.5 cm. crassae; pedunculo gracili 1.5 cm. longo.—CHIRIQUÍ: valley of the upper Río Chiriquí Viejo, near El Volcán, *P. White 177* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **albescens** Trel., spec. nov. Epiphyta subsucculenta repente subcaespitosa obscure pilosa ciliata. Folia 2–3-natave late elliptica apice basique obtusa vel subacuta 0.5–0.8 cm. longa 0.5 cm. lata post exsiccationem albescentia crassa coriacea haud manifeste nervata; petiolo 0.2–0.3 cm. longo. Spicae affixae plus minusve curvatae 1.0–1.5 cm. longae ca. 0.2 cm. diam.; pedunculo filiformi 1 cm. longo; bracteis rotundato-peltatis.—COCLÉ: vicinity of El Valle, alt. ca. 600–1000 m., Dec. 8, 1938, *P. H. Allen 1259* (Herb. Univ. Illinois, TYPE).

PEPEROMIA ANTONI Trel., var. **reducta** Trel., var. nov. Forma nana; foliis obovato-subspathulatis obtusis vel emarginatis subtus pallidioribus vix 5 cm. longis 3 cm. latis; spicis solitariis fructu vix 9 cm. longo.—COCLÉ: vicinity of El Valle, Dec. 8, 1938, *P. H. Allen 1222* (Herb. Univ. Illinois, TYPE).

PEPEROMIA ANTONI Trel., forma **fertilior** Trel., f. nov. Forma robusta; 3 spicis superioribus 12.0 cm. longis 0.3 cm. diam.;

pedicellis 3 cm. longis; pedunculo 4 cm. longo.—COCLÉ: vicinity of El Valle, Sept. 5, 1938, *P. H. Allen 760* (Herb. Univ. Illinois, TYPE).

PEPEROMIA ANTONI Trel., forma **lutea** Trel., f. nov., internodiis brevibus; foliis elliptico-obovatis subacutis vel obtusis 8–9 cm. longis 4–5 cm. latis; petiolo 2 cm. longo; spicis solitariis.—COCLÉ: vicinity of El Valle, Dec. 8, 1938, *P. H. Allen 1160* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **Appellator** Trel., spec. nov. Herba parva repento-assurgens glabra epiphytica. Caulis post exsiccationem ca. 0.1–0.2 cm. crassus porriginoso-exfolians. Folia alternata subrhombo-ovata vel elliptica apice basique acuta vel subacuta 1.5–2.0 cm. longa 0.5–1.5 cm. lata 3-nervata post exsiccationem subcoriacea; petiolo 0.5 cm. longo. Spicae terminales 3.5 cm. longae basi ca. 0.2 cm. diam.; pedunculo 1 cm. longo.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson Allen & Seibert 816* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **bifrons** Trel., spec. nov. Herba mediocris simplex erecta maturitate fere glabra. Caulis post exsiccationem 0.3–0.4 cm. crassus sulcatus, internodiis breviusculis. Folia 3–4-nata oblongo-lanceolata apice obtusa vel minutissime retusa basi anguste cuneata inaequilateraliter acuta 2.0–2.5 cm. longa 0.5 cm. lata obscure 3-nervata apicem versus minute ciliata; petiolo vix 0.3 cm. longo. Spicae terminales vel subterminales 3.5 cm. longae basi ca. 0.2 cm. diam.; pedunculo crassiusculo 1.0–1.5 cm. longo.—CHIRIQUÍ: Finca Lérida to Boquete, alt. ca. 1300–1700 m., July 8–10, 1938, *Woodson, Allen & Seibert 1132* (Herb. Missouri Bot. Gard., TYPE).

The young plants have sparsely villous stems and obovate-elliptic to subspatulate leaves 1.0–1.5 cm. long and 0.5 cm. broad, not at all resembling the adult form.

PEPEROMIA **bocasensis** Trel., spec. nov. Herba epiphytica mediocris erubescens aliquid hispidula. Caulis repento-assurgens post exsiccationem sulcatus ca. 0.2 cm. crassus. Folia 3–4-nata elliptica apice basique subobtusa 3-nervata hispidulo-ciliata post exsiccationem coriacea illustria; petiolo 0.2–0.3 cm.

longo. Spicae terminales filiformes 7–10 cm. longae, pedunculo longitudine dimidio.—BOCAS DEL TORO: vicinity of Nievecita, alt. ca. 0–50 m., Aug. 8–19, 1938, *Woodson, Allen & Seibert 1859* (Herb. Univ. Illinois, TYPE).

PEPEROMIA BREVIPEDUNCULA (C. DC.) Trel., var. **major** Trel., var. nov. Forma foliis rotundato-ovatis 9 cm. longitudine 7 cm. latitudine attingentibus, juventate minoribus ovatis vel reniformibus 3.0–5.0 cm. longis 3.5–4.5 cm. latis; petiolo gracili 5–10 cm. longo, caule pro portione gracili.—PANAMÁ: cherty rocks, Río Las Lajas, Feb., 1940, *P. H. Allen 2037* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **casitana** Trel., spec. nov. Herba epiphytica glabra majuscula. Caulis repento-assurgens paucifoliosus, internodiis brevibus post exsiccationem, ca. 0.5 cm. crassus. Folia alternata subovato-lanceolata acuminata cuneata 15–17 cm. longa 6–7 cm. lata pinnate nervata; petiolo 2–3 cm. longo canaliculato. Spicae sympodialiter terminales 12 cm. longae basi ca. 0.5 cm. diam.; pedunculo 2 cm. longo; baccis ellipsoideis scutulatis.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 952* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **cerro-puntana** Trel., spec. nov. Epiphyta montana magna sed tenuia; internodiis inferioribus radices gerentibus, superioribus vix 0.3 cm. crassis. Folia alternata rotundo-ovata anguste acuminata peltata 6.0–7.5 cm. longa 4–5 cm. lata 5-nervata post exsiccationem membranacea; petiolo gracili 5 cm. longo amplexicauli. Spicae sympodiales 7 cm. longae ca. 0.3 cm. diam.; pedunculo 2.5 cm. longo; bracteis rotundo-peltatis.—CHIRIQUÍ: trail from Cerro Punta to headwaters of Río Caldera, alt. 2250–2500 m., Jan. 14, 1939, *P. H. Allen 1451* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **chiqueroana** Trel., spec. nov. Herba majuscula laxe ramosa erecta glabra. Caulis post exsiccationem nigrescens ca. 0.1–0.3 cm. crassus. Folia 3–4-nata lanceolata apice basique acuta 5–6 cm. longa 1.5–2.0 cm. lata 3-nervata post exsiccationem tenuia; petiolo 0.5 cm. longo. Spicae terminales vel subterminales filiformes ca. 5 cm. longae; pedunculo 0.5–

1.0 cm. longo.—CHIRIQUÍ: Bajo Mona, mouth of Quebrada Chiquero, Río Caldera, alt. 1500–2000 m., July 3, 1938, *Woodson, Allen & Seibert 1025* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **cruentata** Trel., spec. nov. Herba parva repens epiphytica sparse minuteque hirsuta. Caulis filiformis. Folia alternata rotundo-obovata superne subacute lanceolata vix 0.7 cm. diam.; petiolo 0.2 cm. longo. Spicae 3–4 cm. longae basi ca. 0.1 cm. diam. rubrae vel virides ramulos breves erectos 1–3-foliatos terminantes; pedunculo 0.5 cm. longo.—BOCAS DEL TORO: Isla de Colon, alt. ca. 25–75 m., Aug. 17–18, 1938, *Woodson, Allen & Seibert 1938, 1941* (Herb. Missouri Bot. Gard., TYPE).

PEPEROMIA **digitinervia** Trel., spec. nov. Epiphyta glabra repentia; ramis 0.1–0.2 cm. crassis, nodis saepe radices gerentibus. Folia alternata ovata acuta basi subtruncata 2.5–4.0 cm. longa 2–3 cm. lata coriacea 5-nervata subtus pallidiora; petiolis 2–3 cm. longis gracilibus. Spicae 4 cm. longae 0.2 cm. diam.; pedunculo 2 cm. longo; baccis oblongoideis anguste rostratis, stigmate anteriore ad basem rostri.—COCLÉ: vicinity of El Valle, Dec. 8, 1938, *P. H. Allen 1221* (Herb. Missouri Bot. Gard., TYPE).

PEPEROMIA **diruptorum** Trel., spec. nov. Herba erecta simplex mediocris glabra. Caulis post exsiccationem ca. 0.2 cm. crassus. Folia alternata obovato-lanceolata superiora acuta inferiora valde obtusa omnia basi late acuta 2–4 cm. longa 1–2 cm. lata 5-nervata subtus olivacea nervis lateralibus exterioribus basi confluentibus; petiolo filiformi 0.5–1.0 cm. longo. Spicae terminales juventate 2 cm. longae basi ca. 0.2 cm. diam.; pedunculo 0.5–1.0 cm. longo.—CHIRIQUÍ: Bajo Mona, mouth of Quebrada Chiquero, along Río Caldera, alt. ca. 1500–2000 m., July 3, 1938, *Woodson, Allen & Seibert 1023* (Herb. Missouri Bot. Gard., TYPE).

PEPEROMIA **duricaulis** Trel., spec. nov. Epiphyta montanae glabra foliosa erecta; ramis ca. 1 m. altis 0.5 cm. crassis basi lignosis. Folia alternata elliptico-oblanceolata anguste acuminata basi cuneata 10–12 cm. longa 0.4–0.5 cm. lata pinnate nervata post exsiccationem crasse chartacea; petiolo toto alato.

Inflorescentia lateralis paniculata divaricata ampla. Spicae ca. 6 filiformes 3–5 cm. longae; pedunculo gracili 3 cm. longo.—CHIRIQUÍ: trail from Cerro Punta to headwaters of Río Caldera, alt. 2250–2500 m., Jan. 14, 1939, *P. H. Allen 1441* (Herb. Univ. Illinois, TYPE).

PEPEROMIA (?) **insueta** Trel., spec. nov. Herba mediocris acaulis terrestris omnino plus minusve molliter pubescens. Folia elliptica apice basique obtusa 3–6 cm. longa 2–4 cm. lata multiplicate nervata nervis 4 basalibus alio paulo super basem alio prope apicem; petiolo gracili 5–8 cm. longo. Spicae plures inter folia 4–5 cm. longae ca. 0.2 cm. diam.; pedunculo subaequali; bracteis rotundo-peltatis.—COCLÉ: vicinity of El Valle, Dec. 8, 1938, *P. H. Allen 1220* (Herb. Missouri Bot. Gard., TYPE).

PEPEROMIA **laesa** Trel., spec. nov. Epiphyta mediocria simplicia erecta glabra; ramis ca. 0.2 cm. crassis. Folia saepissime 3-nata elliptico-subrhombica vel lanceolata obtuse subacuminata basi acuta 2.0–2.5 cm. longa 1.0–1.5 cm. lata obscure 3-nervata post exsiccationem opaca subtus subflava; petiolo 0.5 cm. longo gracili. Spicae axillares superne aggregatae 1.5–2.0 cm. longae 0.2 cm. crassae; pedunculo 0.5 cm. longo.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. 1800–2000 m., Jan. 14, 1939, *P. H. Allen 1422* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **leridana** Trel., spec. nov. Herba epiphytica mediocris repens glabra. Caulis superne gracilis inferne post exsiccationem ca. 0.5 cm. crassus. Folia alternata elliptico-lanceolata vel elliptica breviter acuminata cordulata 10–12 cm. longa 5–7 cm. lata tenuiter pinnate nervata post exsiccationem coriacea subtus lutescentia; petiolo aequilongo. Spicae 1 vel 2 ramulos brevissimos sympodiales terminantes 15 cm. longae basi ca. 0.3 cm. diam.; pedunculo 5 cm. longo.—CHIRIQUÍ: Finca Lérida to Boquete, alt. 1300–1700 m., July 8–10, 1938, *Woodson, Allen & Seibert 1176* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **lopezensis** Trel., spec. nov. Herba terrestris sat magna rhizomatigera brevicaulis paucifolia glabra. Folia alternata elongato-lanceolata vel oblanceolata acuta cuneata

20–28 cm. longa 4.0–5.5 cm. lata tenuiter pinnate nervata nervo medio prominente; petiolo perbrevi. Spicae paniculatae ca. 0.5 cm. longae ca. 0.1 cm. crassae; pedunculo primario filiformi subterminali 6–7 cm. longo secundariis 0.3–0.5 cm. longis.—CANAL ZONE: Quebrada Lopez, Feb. 11, 1940, *P. H. Allen 2118* (Herb. Missouri Bot. Gard., TYPE).

PEPEROMIA **nievecitana** Trel., spec. nov. Herba parva epiphytica implicate repento-assurgens. Caulis tenuis post exsiccationem vix 0.1 cm. diam. minute hirtellus. Folia alternata oblongo- vel subovato-elliptica apice obtusa basi subacuta ca. 0.8 cm. longa 0.3 cm. lata opaca minutissime hirtella mox ciliato-glabrescentia; petiolo 0.1 cm. longo. Spicae terminales 2–3 cm. longae basi ca. 0.1 cm. diam.; pedunculo filiformi.—BOCAS DEL TORO: vicinity of Nievecita, alt. ca. 0–50 m., Aug. 8–19, 1938, *Woodson, Allen & Seibert 1865* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **novae-helvetiae** Trel., spec. nov. Epiphyta mediocria repento-assurgentia glabra; ramis basi ca. 0.4 cm. crassis, ramulis frondosis gracilioribus. Folia alternata elliptica obtusa superne rhombo-subobovata obtuseque acuminata 4.0–5.5 cm. longa 2.5–3.5 cm. lata 5-nervata post exsiccationem plus minusve pellucida; petiolis 1.0–1.5 cm. longis amplexicaulibus. Spicae terminales 2 cm. longae ca. 0.2 cm. crassae; pedunculo 1 cm. longo.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. 1800–2000 m., Jan. 14, 1939, *P. H. Allen 1417* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **rivi-vetusti** Trel., spec. nov. Epiphyta mediocria stolonifera vel repento-assurgentia glabra; ramis 0.2–0.3 cm. crassis. Folia alternata sed superiora subverticillate aggregata elliptica apice basique acuta vel subacuminata 4–6 cm. longa 2.5–3.0 cm. lata 3- vel 5-nervata post exsiccationem pellucida fuscentiaque; petiolis 0.5–1.0 cm. longis gracilibus. Spicae terminales 4–5 cm. longae ca. 0.3 cm. crassae; pedunculo 1 cm. longo.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, Jan. 14, 1939, *P. H. Allen 1360* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **sarcodes** Trel., spec. nov. Epiphyta monticola valida simplicia erecta carnosa; ramis plusquam 0.5 cm. crassis dense cicatricosis superne frondosis. Folia pauca oblongo-oblanceolata acuminata longe cuneata 15–16 cm. longa ca. 4 cm. lata pinnate nervata post exsiccationem tenuia translucescentia; petiolo 2 cm. longo. Spicae solitariae terminales 5–20 cm. longae ca. 0.3 cm. crassae; pedunculo ca. 1 cm. longo.—CHIRIQUÍ: trail from Cerro Punta to headwaters of the Río Caldera, alt. 2250–2500 m., Jan. 14, 1939, *P. H. Allen 1452* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **Simulatio** Trel., spec. nov. Herba epiphytica mediocris procumbens ad nodos radicans glabra. Caulis post exsiccationem vix 0.2 cm. crassus. Folia alternata 2 summis exceptis elliptica apice basique acuta inferne obovata apice obtuse acuminata 1.5–3.5 cm. longa 1–2 cm. lata obscure 3-nervia opaca supra stellate pallido-maculata subtus lutescentia; petiolo gracili 0.5–1.0 cm. longo basi implexo. Spicae terminales 4 cm. longae basi ca. 0.2 cm. diam.; pedunculo 1 cm. longo.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 895* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **tenebraegaudens** Trel., spec. nov. Herba epiphytica mediocris. Caulis repento-assurgens gracilis inferne post exsiccationem ca. 0.5 cm. crassus paucifoliatus. Folia alternata rotundo-ovata breviter acuminata super basim breviter peltata ca. 14 cm. longa 10 cm. lata tenuiter pinnate nervata post exsiccationem opaque coriacea; petiolo gracili aequilongo. Spicae 1 vel 2 ramulos breves sympodiales terminantes 7 cm. longae; pedunculo 3 cm. longo.—CHIRIQUÍ: dark wet forest, Bajo Mona, mouth of Quebrada Chiquero, along Río Caldera, alt. ca. 1500–2000 m., July 3, 1938, *Woodson, Allen & Seibert 993* (Herb. Univ. Illinois, TYPE).

PEPEROMIA **Woodsonii** Trel., spec. nov. Herba parva terrestris ramosiuscula glabra *P. hispidulae* similis. Folia alternata rhombo-ovata apice basique acutiuscula pinnate nervata; petiolo 0.5–0.7 rariusve 1.0 cm. longo. Spicae terminales graciles laxae vix 1 cm. longae; pedunculo aequilongo; baccis ellipsoideis pseudopedicello gracili, stigmate gracili stipitato.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 933* (Herb. Univ. Illinois, TYPE).

Pothomorphe **Alleni** Trel., spec. nov. Frutex 2 m. altus glabrus foliis exceptis; internodiis sat crassis elongatis. Folia subreniformia deltoidea acuminata late cordata sinu apertissimo ca. 23 cm. diam. subtus nervis nervulisque cinereo-puberulis, petiolo gracili 20 cm. longo apicem versus angustissime alato. Umbellae 2, ca. 5-spicatae; pedunculo 2 cm. longo; pedicellis 10 cm. longis. Spicae 3–7 cm. longae ca. 0.3 cm. diam.—COCLÉ: vicinity of El Valle, alt. 600–1000 m., Dec. 8, 1938, *P. H. Allen 1190* (Herb. Missouri Bot. Gard., TYPE).

Pothomorphe **almirantensis** Trel., spec. nov. Frutex glaber. Folia peltata rotundata deltoideo-acuminata basi subretusa ca. 25 cm. diam.; petiolo subaequilongo vix alato. Umbella solitaria ca. 12-spicata; pedunculo 4 cm. longo; pedicellis 1.0–1.5 cm. longis. Spicae 9–10 cm. longae ca. 0.3 cm. crassae.—BOCAS DEL TORO: Farm One, Almirante, *Cooper 170* (Herb. Field Mus., TYPE).

Pothomorphe **Baileyorum** Trel., spec. nov. Frutex glaber; internodiis brevibus lentis crassiusculis. Folia peltata rotundata basi retusa ca. 30 cm. diam.; petiolo vix aequilongo apicem versus gradatim anguste alato. Umbella solitaria ca. 7-spicata; pedunculo 7 cm. longo; pedicellis maturitate 1.0–1.5 cm. longis. Spicae 8–9 cm. longae ca. 0.2 cm. crassae.—CANAL ZONE: Barro Colorado Island, *L. H. & Ethel Zoe Bailey 414* (Herb. Univ. Illinois, TYPE).

Pothomorphe Baileyorum Trel., var. **paucispica** Trel., var. nov. Frutex graciliter ramosus. Folia 30 cm. diam. Umbella graciliter pedunculata vix 5-spicata.—CANAL ZONE: Salamanca Hydrographic Station, Río Pequeni, alt. 80 m., July 28, 1938, *Woodson, Allen & Seibert 1573* (Herb. Univ. Illinois, TYPE).

Pothomorphe **tecumensis** Trel., spec. nov. Frutex glaber ut videtur gracilis vix 2 m. altus. Folia peltata ovata acuminata basi retuse cordata ca. 22 cm. longa 20 cm. lata subtus pubescentia; petiolo aliquid breviore apicem versus alato. Umbella solitaria ca. 10-spicata; pedunculo 2.5 cm. longo; pedicellis 1.5 cm. longis. Spicae 10 cm. longae ca. 0.2 cm. crassae.—CANAL ZONE: Tecumen, *Standley 26735* (U. S. Nat. Herb., TYPE).

POTHOMORPHE TECUMENSIS Trel., var. **grandis** Trel., var. nov. Frutex molliter lignosus 1–2 m. altus, ab specie foliis grandibus 30 m. diam. differt.—PANAMÁ: vicinity of Arraijan, alt. ca. 15 m., July 21, 1938, *Woodson, Allen & Seibert 1398* (Herb. Univ. Illinois, TYPE).

LORANTHACEAE

(Phoradendron by W. Trelease, Urbana, Ill.)

PHORADENDRON **Allenii** Trel., spec. nov. *(Aequatoriales-Brevifoliae).* Rami simplices vel parum compositi subelongati cataphyllis inferioribus tantum; internodiis mediocribus 3–4 cm. longis 0.2–0.4 cm. crassis teretibus sed nodis paululo compressis; cataphyllis geminis inferioribus. Folia late elliptica lateque obtusa 4–5 cm. longa 2.5–3.0 cm. lata basi usque 1 cm. acute subpetiolata. Spicae aggregatae 1.5–2.0 cm. longae ca. 0.4 cm. crassae articulis ca. 3 subellipticis 4 + 2- vel 6-seriatum ca. 20-floris; pedunculo fere obsoleto; baccis maturis ignotis.—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, alt. ca. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 792* (Herb. Univ. Illinois, TYPE).

PHORADENDRON **herrerense** Trel., spec. nov. *(Aequatoriales-Quadrangulares).* Ramuli graciles 4-angulati valde divaricati glabri cuiusque nodo basali solum cataphyllas 2 gerente. Folia elliptica vel oblongo-elliptica apice obtusa basi acute cuneata 3.5–4.5 cm. longa 1.0–1.5 cm. lata ca. 5-nervata. Spicae solitariae laterales ca. 4 cm. longae articulis saepissime 5, 4 + 2-seriatim 12-floris; pedunculo aequilongo nudo; baccis rotundatis ca. 0.3 cm. diam. luteis, sepalis inflexis.—HERRERA: Pesé, alt. ca. 50 m., Sept. 13, 1938, *P. H. Allen 798* (Herb. Univ. Illinois, TYPE).

PHORADENDRON **novae-helvetiae** Trel., spec. nov. *(Aequatoriales-Corynarthrae).* Fruticulus epiphyticus aspectu *P. corynarthro* similis. Rami inferne furcati, ramulis sat longis gracilibusque basi cataphyllas 2 gerentibus striatis superne ancipitibus inferne teretibus; internodiis 8–9 cm. longis vel minoribus. Folia lineari-lanceolata apice basique acuta 8–10 cm. longa 0.5–1.0 cm. lata cuneate subsessilia tenuia sed opaca sat distincte 5-nervata. Spicae laterales plerumque aggregatae rubrae (?) 1–4 cm. longae apiculatae, articulis ca. 4

clavatis, floribus ca. 12, 4-seriatim positis, pedunculo brevissimo; baccis glabris rotundatis 0.3 cm. diam., sepalis valde inflexis.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. 1800–2000 m., Jan. 6–14, 1939, *P. H. Allen 1399* (Herb. Univ. Illinois, TYPE).

PHORADENDRON **pergranulatum** Trel., spec. nov. *(Aequatoriales-Percurrentes).* Epiphyta ut videntur maxima robusta; ramulis rugoso-granulatis cum foliis percurrentibus; internodiis teretibus basi cataphyllas 2 subtruncatas gerentibus. Folia elliptico-oblonga vel cultriformia late obtusa basi cuneate decurrentia 1.5–2.5 cm. lata 7–8 cm. longa opaca obscure 5-nervata. Spicae solitariae laterales ca. 3 cm. longae articulis 5, 4-seriatim 4-floris; pedunculo vix manifesto; baccis rotundatis ca. 0.5 cm. diam., sepalis erectis.—COCLÉ: vicinity of El Valle, alt. 800–1000 m., Sept. 5, 1938, *P. H. Allen 777* (Herb. Univ. Illinois, TYPE).

PHORADENDRON **sonanum** Trel., spec. nov. *(Aequatoriales-?Corynarthrae).* Rami vix furcati glabri superne 2–4-angulati; internodiis infimis cataphyllas 2 fere basales gerentibus. Folia oblonga acuta 5 cm. longa 1 cm. lata opaca fere 3-nervata basi cuneate subpetiolata. Spicae plerumque solitariae laterales 4–5 cm. longae articulis ca. 4 subcapitatis 4-seriatim 10-floris, pedunculo brevi, baccis rotundatis luteis, sepalis inflexis. —VERAGUAS: hills west of Soná, alt. ca. 500 m., Nov. 24, 1938, *P. H. Allen 1033* (Herb. Univ. Illinois, TYPE).

PHORADENDRON **Woodsonii** Trel., spec. nov. *(Aequatoriales-Panamanae*[1]*).* Rami subinde pseudodichotomi nodis omnibus cataphyllis munitis; internodiis graciliusculis 2–4 cm. longis 0.3–0.5 cm. crassis; cataphyllis geminis fere 2-divisis internodii dimidio parte inferiore ca. 4-seriatim positis. Folia elliptico-subovata apice basique acuta 3.5–5.5 cm. longa 1.5–2.5 cm. lata basi usque fere 0.5 cm. subpetiolata opaca basi obscure 3- vel 5-nervata. Spicae laterales solitariae usque 4 cm. longae 0.5 cm. latae articulis ca. 6 subclavatis androgynae 4 + 2-seri-

[1]PANAMANAE. Folia mediocria elliptico-subovata crassa, nervis pluribus inferioribus inconspicuis. Rami tereti, nodis omnibus cataphyllis munitis. Spicae breviusculae crassiusculaeque, floribus 4 + 2-seriatim positis. Baccae ovoideo-ellipsoideae laeves, sepalis connatis clausis.—Species 1 Isthmi Panamani.

atim ca. 12-floris; pedunculo vix 0.5 cm. longo nodis sterilibus basalibus ca. 1–2; baccis subovatis ca. 0.3 × 0.4 cm. subrubicundis, sepalis connatis.—COCLÉ: between Las Margaritas and El Valle, July 15, 1938, *Woodson, Allen & Seibert 1302* (Herb. Univ. Illinois, TYPE).

GAIADENDRON POASENSE Donn. Sm.—CHIRIQUÍ: vicinity of Cerro Punta, Jan. 21–24, 1939, *P. H. Allen 1518*. Previously known from Costa Rica.

PSITTACANTHUS **Allenii** Woodson & Schery, sp. nov. *(Eupsittacanthus-Ligulati)*. Frutex parasiticus omnino glaber; ramis ramulisque sat crassis teretibus ad nodos haud conspicue incrassatis continuis. Folia alternata vel approximata subsessilia obovato-elliptica apice rotundata vel obtusissima basi ca. e medio gradatim cuneata in petiolo decurrentia cum petiolo 4–7 cm. longa 2–3 cm. lata coriacea olivacea utrinque stomatifera penninervia, costa crassa utrinque elevata. Inflorescentia corymbosa 2–6-flora in axillis foliorum 2–4-fasciculata foliis ca. dimidia brevior. Flores bini aurantiaci; pedicello ca. 0.5 cm. longo; cupula patelliformi submembranacea margine integro ca. 0.2 cm. diam.; calyculo anguste campanulato ca. 0.3 cm. alto margine conspicue dilatato integro ca. 0.25 cm. diam. 0.07 cm. alto; perigonio gracili maturitate 3.5 cm. longo prope basim ca. 0.25 cm. diam., lobis 6 basi ligulatis margine minutissime hamulosis; filamentis inaequalibus 1.2–1.5 cm. longis prope medium perigonii adnatis, antheris dorsifixis oblongis 0.4 cm. longis minute apiculatis; stylo perigonium subaequante, stigmate capitato.—COCLÉ: vicinity of El Valle, alt. 600–1000 m., Dec. 8, 1938, *P. H. Allen 1223* (Herb. Missouri Bot. Gard., TYPE).

This interesting species appears to be closely related to *Ps. dilatatus* A. C. Smith, of Colombia, largely on the basis of the position of the inflorescence and expanded margin of the calyculus. The latter species, however, is somewhat larger in all respects, and the margin of the calyculus conspicuously and regularly crenulate.

PSITTACANTHUS **lateriflorus** Woodson & Schery, sp. nov. *(Eupsittacanthus-Ligulati)*. Frutex parasiticus omnino glaber; ramis ramulisque sat crassis teretibus ad nodos haud conspicue incrassatis continuis. Folia alternata approximata vel subopposita subsessilia anguste oblongo-elliptica apice rotundata vel obtusissima basi ca. e medio gradatim cuneata in petiolo decurrentia cum petiolo 4–7 cm. longa 1.5–2.5 cm. lata coriacea olivacea utrisque superficiebus stomatifera crassa, costa crassa utrinque elevata, nervi laterales penninervii et vix sensi. Inflorescentia corymbosa 2–4 flora in axillis foliorum plerumque 2-fasciculata foliis ca. dimidia brevior. Flores coccinei; pedicello ca. 0.4 cm. longo; cupula prorae simili submembranacea margine integro ca. 0.2 cm. longa 0.1 cm. lata; calyculo urceolato ca. 0.2 cm. alto margine integro haud conspicue dilatato; perigonio gracili maturitate 2.5 cm. longo prope basim ca. 0.13 cm. diam., lobis 6 basi vix ligulatis; filamentis invicem inaequalibus 0.7–1.2 cm. longis prope medium perigonii adnatis, antheris dorsifixis oblongis 0.3 cm. longis ad basim subcaudatis; stylo perigonium subaequante, stigmate capitato.—COCLÉ: vicinity of El Valle, alt. 600–1000 m., Sept. 17, 1939, *P. H. Allen 1979* (Herb. Missouri Bot. Gard., TYPE).

Closely related to *Ps. peronopetalus* Eichl., but readily distinguishable by the much smaller, cuneate leaves.

PSITTACANTHUS SCHIEDEANUS (Schlecht. & Cham.) Blume—CHIRIQUÍ: vicinity of Casita Alta, Volcán de Chiriquí, June 28–July 2, 1938, *Woodson, Allen & Seibert 915;* Río Chiriquí Viejo Valley, April 10, 1938, *Gene White 76;* trail from Cerro Punta to headwaters of Río Caldera, Jan. 14, 1939, *P. H. Allen 1444.* This species previously has been known to occur from southern Mexico to Costa Rica. An isotype in the herbarium of the Missouri Botanical Garden has flowers somewhat smaller than ours, and other small details indicate that future segregation may be necessary.

MENISPERMACEAE
(P. C. Standley, Chicago)

HYPERBAENA **Allenii** Standl., sp. nov. Arbor 8-metralis, ramulis subteretibus dense pilis brevibus sordidis subadpressis pilosis, internodiis brevibus; folia magna breviter petiolata subcoriacea, petiolo 1.5–2 cm. longo dense adpresso-pilosulo superne insigniter incrassato; lamina lanceolato-oblonga 14–

20 cm. longa 4.5–6 cm. lata acuta vel acuminata, apice ipso obtuso, basi rotundato-angustata vel obtusa atque subpeltata, supra lucida glabra, costa valde elevata, nervis venisque prominentibus, venulis arcte reticulatis, subtus paullo pallidior ubique pilis brevibus subpatentibus vel fere adpressis pilosula, pinnatinervia, costa gracili elevata, nervis lateralibus utroque latere ca. 12 angulo latiusculo adscendentibus arcuatis prominentibus prope marginem conjunctis, venulis prominentibus arcte reticulatis; inflorescentiae spiciformes axillares singulae vel fasciculatae petiolo vix longiores, spicis interruptis, floribus subverticillatim aggregatis sessilibus, rhachi dense pilis brevibus subpatentibus pilosa; sepala minuta extus sparse breviter pilosula; petala late ovalia vel rotundata vix ultra 1 mm. longa glabra; stamina ca. 1 mm. longa.—COCLÉ: north rim of Valle de Antón, alt. 600–1000 m., Feb. 12, 1939, *P. H. Allen 1656* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.).

Among all the Central American species of this genus the present plant is unique in its long and narrow, pinnately nerved, pubescent leaves. In Diels' treatment of the genus in the 'Pflanzenreich' (IV. 94: 198. 1910) the Panama plant runs at once to *H. oblongifolia* (Mart.) Chodat & Hassl., of Brazil and Paraguay, with which it could not be confused.

CRUCIFERAE

CARDAMINE OVATA Benth.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. 1800–2000 m., Jan. 6–14, 1939, *P. H. Allen 1345.* Ranging from Mexico to Venezuela and Ecuador, but apparently never before collected in Panama.

CAPPARIDACEAE

(P. C. Standley, Chicago)

CAPPARIS **mirifica** Standl., sp. nov. Arbor 6-metralis ramis gracilibus subteretibus dense molliter pilis longis stellato-pilosis; folia inter maxima sessilia tenuiter coriacea oblonga ca. 27 cm. longa atque 9 cm. lata subito acuminata vel cuspidato-acuminata, basi profunde cordata, sinu clauso, lobis posticis rotundatis, supra in statu adulto fere omnino glabra, tantum ad costam interdum stellato-tomentosa, costa prominente, nervis venisque subimpressis, subtus pallida ubique tomento laxo molli stellato dense obtecta, pilis marginis brunneis, costa gracili prominente, nervis lateralibus utroque latere ca. 11 angulo lato adscendentibus subarcuatis; pedunculus longissimus folia aequans vel longior gracillimus curvus stellato-pilosus vel glabratus; fructus ca. 20 cm. longus fere 1 cm. crassus inter semina ca. 8 paullo constrictus, basi et apice longe attenuatus, densissime minuteque stellato-tomentosus.—CANAL ZONE: vicinity of Salamanca Hydrographic Station, Río Pequení, alt. about 80 m., July 28–29, 1938, *R. E. Woodson, Jr., P. H. Allen & R. J. Seibert 1591* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.)

This is one of the most distinct and extraordinary species that the writer ever has had the opportunity of describing, and it is impossible to suggest any other species to which it may be related. It would be difficult to imagine leaves of a form more improbable in the genus *Capparis*. They are uncommonly large, sessile, deeply cordate at the base with a closed sinus, and covered beneath with a lax tomentum composed of long and soft, stellate hairs. The leaves are dark-margined, because of a border of dark brown hairs. Moreover, the long hairs of the margin appear to collect dust and dirt, thus giving them a more conspicuous margin than the fuscous hairs alone would furnish.

ROSACEAE

PRUNUS CORNIFOLIA Koehne—CHIRIQUÍ: Río Chiriquí Viejo Valley, below Cerro Punta, March 19, 1938, *Gene White 14.* Previously regarded as an endemic of Costa Rica. The leaves of Miss White's specimens attain 15 cm. in length and 6 cm. in width, but otherwise appear typical. The petals of our specimens are described as white, the calyx pale purple, and the flower fragrant.

OXALIDACEAE

OXALIS **darienensis** Woodson, sp. nov. Annua erecta. Caulis simplex 2–3 dm. altus omnino minute pilosulus. Folia alternata pinnatim 3-foliolata longe petiolata; foliola tenuissime membranacea viridia minutissime papillata margine sparse ciliolata fere rotundato-obovata saepe plus minusve obliqua margine laterali plus minusve undulata apice late rotundata ecallosa, foliolum medium 2 cm. longum 1.6 cm. latum petiolulatum, petiolulo 0.4–0.5 cm. longo, foliolis lateralibus subsessilibus plus minusve minoribus; petiolus 3.0–3.5 cm. longus gracillimus sparse minuteque pilosulus. Pedunculi praeter totam mediam et superiorem partem caulis distributi fere erecti tenues minutissime pilosuli 5–6 cm. longi apice cymam 2-ramosam 0.5–3.5 cm. longam gerentes; rami cymae 2–5-flori simplices; bracteae filiformes ca. 0.1 cm. longae. Pedicelli 0.15 cm. longi glabri. Sepala oblongo-oblanceolata breviter acuminata basi cuneata 0.4 cm. longa glabra viridia. Petala lutea oblongo-obovata rotundata apicem versus minute serrulata 0.7–0.8 cm. longa glabra. Stamina maiora 0.35 cm. longa filamentis edenticulatis minute glandulo-puberulis, minora 0.2 cm. longa glabra. Pistillum angustum 0.25 cm. longum, stylo gracili sparse minuteque glandulo-papillato, stigmate apice 2-partito. Capsula oblongo-obovoidea 0.7 cm. longa 0.4 cm. lata dense minuteque puberula (?). Semina 25 ovoidea 0.1 cm. longa castanea minute tuberculata.—DARIEN: vicinity of Boca de Cupe, alt. ca. 40 m., Oct. 5, 1938, *P. H. Allen 881* (Herb. Missouri Bot. Gard., TYPE).

In Knuth's treatment of the Oxalidaceae (in Engler's 'Pflanzenreich' IV. 130 (Heft 95). 1930) our plants key to *O. ramulosum* Knuth and *O. peruviana*. These species, however, consist of larger, branching plants with glabrous stems, and flowers about twice the size of those of *O. darienensis*. Although the simple stems of *O. darienensis* may be considered a slight character, it is quite invariable amongst the duplicates before me.

RUTACEAE

(C. L. Lundell, Ann Arbor, Mich.)

AMYRIS **barbata** Lundell, sp. nov. Arbor, 10 m. alta. Folia pinnata, petiolata, petiolo usque ad 4 cm. longo. Foliola 5 vel 7, raro 6, membranacea, ovato-oblonga vel oblongo-elliptica, 3.5–8.5 cm. longa, 2–3.5 cm. lata, apice acuminata vel acutiuscula, raro obtusiuscula, basi abrupte acutiuscula, supra glabra, subtus in axillis barbata. Inflorescentiae terminales, late paniculatae, usque ad 8 cm. longae, 8.5 cm. latae. Pedicelli ca. 1 mm. longi. Calyx quinquedenticulatus. Petala 5, glabra, ovato-oblonga, 3 mm. longa. Stamina 10. Ovarium 1-loculare.

A tree, 10 m. high; branchlets rather slender, puberulent, densely so at the nodes. Leaves alternate, pinnate, with petioles up to 4 cm. long; leaflets usually 5 or 7, sometimes 6; rachis slender, drying blackish, barbate-puberulent in axils of leaflets; petiolules of lateral leaflets up to 2.2 mm. long, petiolule of terminal leaflet (when present) up to 1.1 cm. long; blades of leaflets membranaceous, ovate-oblong or oblong-elliptic, 3.5 to 8.5 cm. long, 2 to 3.5 cm. wide, apex usually acuminate or acutish, sometimes obtusish, base rather abruptly acutish, slightly oblique, glabrous above, at first barbate beneath in the axils of the lateral veins, entirely glabrous with age. Inflorescence terminal, broadly paniculate, laxly many-flowered, up to 8 cm. long, 8.5 cm. wide, densely barbate-puberulent at the nodes, nearly glabrous otherwise. Pedicels puberulent, usually less than 1 mm. long. Hypanthium glabrous. Calyx 5-denticulate, about 2.8 mm. wide, ciliolate. Petals 5, glabrous, ovate-oblong, 3 mm. long, rather fleshy. Stamens 10, up to 2.2 mm. long. Disk large, flat, fleshy, shallowly 10-lobed, about 2.7 mm. in diam. Gynophore wanting. Ovary ovoid, glabrous, 1-celled, with 1 pendulous ovule. Stigma large, 3-lobed, sessile.—CHIRIQUÍ: Llanos del Volcán, alt. about 1300 m., Jan. 23, 1939, *P. H. Allen 1540* (Herb. Univ. Michigan, TYPE).

In aspect, *A. barbata* does not closely resemble any species of *Amyris* known to the writer.

EUPHORBIACEAE

(P. C. Standley, Chicago)

STILLINGIA **haematantha** Standl., sp. nov. Arbor 10-metralis omnino glabra, ramulis crassis teretibus pallide brunneis vel ochraceis, internodiis brevibus; stipulae minutae persistentes oblique rotundato-ovatae vix 1 mm. longae pectinato-dentatae adpressae; folia mediocria breviter petiolata alterna crasse membranacea, petiolo crassiusculo ca. 4 mm. longo apice glandulis 2 patentibus crassis obtusis onusto; lamina oblanceolato-oblonga vel obovato-oblonga 2.5–5 cm. longa 1–1.5 cm. lata acuta vel subobtusa, apice ipso obtuso, basin versus longe cuneato-angustata, in toto margine argute arcteque incurvo-glanduloso-serrata, supra viridis, costa nervisque prominulis, subtus concolor, costa gracili pallida prominente, nervis lateralibus utroque latere ca. 11 angulo semirecto adscendentibus tenerrimis pallidis prominulis; spicae terminales rubrae graciles breviter pedunculatae 4–9.5 cm. longae dense multiflorae, inferne plus minusve interruptae, rectae vel subcurvae; bracteae pauciflorae suborbiculares peltatae apice pectinato-dentatae vel integrae adpressae; flores masculi globosi brevissime pedicellati ca. 1 mm. diam.; stamina 2 breviter exserta; styli brevissimi connati.—COCLÉ: north rim of El Valle, July 9, 1939, *P. H. Allen 1915* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.).

Perhaps related to *S. zelayensis* (HBK.) Muell. Arg., which has been collected in the Province of Chiriquí, but that has altogether different foliar glands, and its leaves are broadest at the middle.

SAPINDACEAE
(P. C. Standley, Chicago)

PAULLINIA **Allenii** Standl., sp. nov. Frutex scandens cirrhifer fere glaber, ramis gracillimis obtuse pentagonis et sulcatis fere omnino glabris, internodiis elongatis; folia pinnata 5-foliolata, petiolo gracili 3.5–6 cm. longo glabro nudo, rhachi 2–4 cm. longa nuda, petiolulis 3–7 mm. longis; foliola subaequalia in sicco laete viridia lucida anguste lanceolato-oblonga 9–15 cm. longa 2.5–4 cm. lata longe angusteque acuminata, acumine ipso obtuso, basi subobtusa vel acuta, supra glabra, costa nervisque prominentibus, venis prominentibus arcte reticulatis, subtus concoloria in axillis nervorum sparse breviter barbata, aliter glabra, costa tenera prominente, nervis lateralibus utroque latere ca. 10 obliquis angulo semirecto vel paullo latiore adscendentibus subarcuatis tenerrimis prominentibus, venulis prominulis arcte reticulatis, marginibus inferne integris, apicem versus remote adpresso-serratis; flores racemosi, racemis longissime pedunculatis laxe paucifloris ca. 3.5 cm. longis, floribus pauci-fasciculatis, pedicellis sparse minute puberulis 3–4 mm. longis, bracteis minutis; sepala valde inaequalia minute ciliolata et dorso sparse minute puberula vel fere omnino glabra, extimis duplo brevioribus, interioribus ca. 3.5 mm. longis apice rotundatis.—COCLÉ: north rim of El Valle de Antón, alt. 600–1000 m., Feb. 12, 1939, *P. H. Allen 1657* (Herb. Field Mus., TYPE).

Apparently a well-differentiated species, the leaves being decidedly unlike those of any other that I have examined. The five leaflets are unusually long and narrow, almost entire, and the petiole and rachis are naked.

PAULLINIA **verecunda** Standl., sp. nov. Frutex scandens, ramis ferrugineis, vetustioribus subteretibus, junioribus obtuse angulatis et striatis densiuscule incurvo-puberulis, internodiis brevibus; folia mediocria ternato-pinnata 3–5.5 cm. longe petiolata, rhachi ca. 5.5 cm. longa anguste alata usque 4 mm. lata, pinnis infimis 2 trifoliolatis, foliolis totius folii 11; foliola sessilia integra ambitu plus minusve variabilia, terminalibus spathulato-obovatis basin versus longe angusteque attenuatis, lateralibus lanceolato-oblongis vel ovato-oblongis basi acutis et saepius inaequalibus, subito lateque acuminata, acumine ipso obtuso, in sicco laete viridia, supra sublucida glabra, costa nervisque prominentibus, venulis prominulis arcte reticulatis, subtus vix pallidiora sparse ad costam nervosque puberula vel fere glabra, venulis prominentibus arcte reticulatis; inflorescentiae axillares racemiformes brevissimae sessiles laxiuscule multiflorae vix ultra 1.5 cm. longae, pedicellis gracilibus 5–7 mm. longis breviter patulo-pilosulis, bracteis minutis subulatis; sepala ovalia tenuia apice rotundata vix ultra 1.5 mm. longa ciliata et sparse minuteque pilosula; petala glabra ciliata usque 4.5 mm. longa alba.—COCLÉ: vicinity of El Valle, alt. 600–1000 m., Dec. 8, 1938, *P. H. Allen 1224* (Herb. Missouri Bot. Gard., TYPE; fragment in Herb. Field Mus.).

In the key to species of *Paullinia* in the 'Flora of the Panama Canal Zone' this plant would run at once to *P. glomerulosa* Radlk., a species with which it has little in common except its ternate-pinnate leaves. The species appears to be a well-marked and isolated one, at least so far as Central America is concerned, distinguished by the combination of ternate-pinnate leaves, entire leaflets, and small sessile inflorescences.

SERJANIA **cissifolia** Standl., sp. nov. Frutex scandens, ramis subteretibus pluricostatis crassis densissime brunnescenti-tomentosis, internodiis elongatis; stipulae persistentes anguste triangulari-attenuatae 5–6 mm. longae obliquae; folia inter minora digitatim trifoliolata membranacea, petiolo crassiusculo 2–4.5 cm. longo dense tomentoso; foliola sessilia inaequalia, terminalia rhombica 6.5–10 cm. longa 3.5–6 cm. lata acuta, basin versus subito contracta et longe cuneato-angustata, lateralia ovalia vel late elliptico-oblonga 5–7 cm. longa 2.5–4 cm. lata, obtusa, basi subinaequilaterali obtusa vel anguste rotundata, in toto margine vel saltem supra medium grosse crenata, crenis latis subsalientibus abrupte apiculatis, utrinque dense pilis mollibus fulvidis patentibus vel subadpressis pilosa, subtus paullo pallidiora; flores majusculi in paniculas racemiformes axillares et solitarias vel terminales et paniculatas aggregati, paniculis ca. 2.5 cm. longis 2–3 cm. latis densissime multifloris crasse pedunculatis, rhachi dense ochraceo-tomentosa, pedicellis usque 6 mm. longis dense tomentosis, bracteis oblongis vel ovatis parvis extus dense tomentosis intus glabris; sepala paullo inaequalia ovalia vel late obovata apice rotundata usque 4.5 mm. longa extus dense tomentella; petala alba spathulato-obovata usque 6 mm. longa apice rotundata villoso-ciliata glabra; filamenta 4 mm. longa sparse albo-pilosa, antheris ca. 0.8 mm. longis.—VERAGUAS: hills west of Soná, alt. 500 m., Nov. 24, 1938, *P. H. Allen 1021* (Herb. Field Mus., TYPE).

A most unusual plant for this genus, because of the merely 3-foliolate, densely pubescent leaves. The foliage is strikingly like that of *Cissus rhombifolia* Vahl.

RHAMNACEAE

(C. V. Morton, Washington, D. C.)

Rhamnus capreaefolia Schl.—chiriquí: vicinity of Cerro Punta, Jan. 24, 1939, *P. H. Allen 1566*. Previously known from Mexico to Costa Rica.

TILIACEAE

(P. C. Standley, Chicago)

Sloanea **platyphylla** Standl., sp. nov. Arbor 20-metralis, ramulis crassis, internodiis brevibus dense pilis longiusculis sordido-brunnescentibus pilosis; stipulae lanceolato-ovatae subfoliaceae usque 2.5 cm. longae acuminatae utrinque dense subadpresso-pilosae; folia magna longipetiolata crasse membranacea, petiolo gracili tereti ca. 7 cm. longo dense tomentuloso atque piloso; lamina late ovalis vel latissime elliptica 25–27 cm. longa 17–19 cm. lata, apice breviter obtuseque acutata, basi late rotundata, supra in sicco fusco-brunnescens ad costam nervosque pilosa, aliter glabrata, subtus fere concolor ubique dense breviter velutino-pilosula, costa gracili elevata, nervis lateralibus utroque latere ca. 11 angulo lato interdum fere recto adscendentibus leviter arcuatis prominentibus juxta marginem arcuato-conjunctis, venis numerosis distantibus subparallelis connexis, venulis prominentibus sat arcte reticulatis; inflorescentiae axillares simplices racemosae sessiles vel subsessiles usque 6 cm. longae ca. 7-florae, pedicellis crassiusculis usque 1.5 cm. longis densissime patenti-pilosis, bracteis pedicellis duplo brevioribus vel eis fere aequilongis; sepala lineari-lanceolata inaequalia 7–9 mm. longa longe attenuata, extus breviter pilosula, intus sericea, patentia; ovarium ovoideum dense hispidulum atque breviter echinatum.—coclé: north (wet) rim, vicinity of El Valle, alt. 800–1000 m., May 21, 1939, *P. H. Allen 1810* (Herb. Field Mus., type; duplicate in Herb. Missouri Bot. Gard.).

Similar to this is *Sloanea microcephala* Standl., also of Panama, but that differs in having relatively broader, coarsely dentate, glabrate leaves, very small sepals, and an altogether different inflorescence.

MALVACEAE
(P. C. Standley, Chicago)

Hibiscus spathulatus Garcke—veraguas: hills west of Soná, alt. ca. 500 m., Nov. 24, 1938, *P. H. Allen 1019.* Apparently new to North America. Previously known from British Guiana and Brazil.

Neobrittonia acerifolia (Lag.) Hochr.—chiriquí: trail from Paso Ancho to Monte Lirio, valley of Río Chiriquí Viejo, Jan. 16, 1939, *P. H. Allen 1493.* Fairly common in Guatemala, but previously unknown from either Costa Rica or Panama.

Wercklea lutea Rolfe—chiriquí: upper valley of Río Chiriquí Viejo, near Monte Lirio, July 17, 1938, *P. White 175.* Genus new for Panama; previously unknown outside Costa Rica.

MARCGRAVIACEAE

Marcgravia **ampulligera** Woodson, sp. nov. Frutex volubilis ut dicitur giganteus omnino glaber, ramis crassiusculis subteretibus fulvis dense lenticellatis. Folia ramorum fertilium sessilia oblonga apice abrupte acuminata basi late obtusa 6–13 cm. longa 3.5–4.5 cm. lata opaca brunnescentia eglandulosa costa crassiuscula prominente utrinque enervia. Inflorescentia umbelliformis ca. 28-flora, pedicellis patulis crassiusculis lenticellatis 5.5–6.0 cm. longis, floribus paululo oblique insertis, prophyllis 2 ad basin calycis insertis deltoideis obtusis ca. 0.2 cm. longis. Bracteae steriles apulliformes clavato-tubulosae rectae 4 cm. longae, pedicello 1 cm. longo, ostio recurvato. Sepala subreniformia rotundata 0.3 cm. longa 0.5 cm. lata margine minutissime denticulata; petalorum calyptra anguste ovoidea 2 cm. longa basi 0.5 cm. diam. apice obtusa. Stamina ca. 33, filamentis filiformibus 1 cm. longis, antheris linearibus 0.6 cm. longis. Ovarium subovoideum cum stylo 1 cm. longum. —chiriquí: trail from Paso Ancho to Monte Lirio, upper valley of Río Chiriquí Viejo, alt. 1500–2000 m., Jan. 16, 1939, *P. H. Allen 1488* (Herb. Missouri Bot. Gard., type).

This species is somewhat intermediate between the subgenera *Orthothalamium* and *Plagiothalamium* of Wittmack, since, although the flowers are somewhat obliquely placed upon the pedicel, the corolline calyptra is nearly cylindrical and the number of stamens is relatively high. The shape of the nectariferous bracts is distinctive because of the recurved lip of the orifice, and the size is relatively large as well.

Marcgravia membranacea Standl.—coclé: north rim of El Valle de Antón, alt. 700 m., March 19, 1939, *P. H. Allen 1739*. Previously known only from the type collection in the highlands of Costa Rica.

Souroubea triandra Lundell.—coclé: north rim of El Valle de Antón, alt. 600–1000 m., July 9, 1939, *P. H. Allen 1914*. Previously known only from the type collection in British Honduras *(C. L. Lundell 6492)* and cotype in Guatemala. There are differences between Allen's plants and the type, being chiefly variations in petal number, length of nectary, and form of the filaments. However, in view of the limited material available, it seems better to refer our plants to *triandra,* at least for the present.

Souroubea **venosa** Schery, n. sp. Arbor glabra ut dicitur 9 m. alta, ramis rimosis. Folia alternata subsessilia late elliptica apice obtusa vel rotundata basi obtuse cuneata 7–11 cm. longa 3.5–5.5 cm. lata tenuiter coriacea utrinque opaca, venis supra immersis subtus prominentibus prope margines reticulatis. Racemus 15 cm. longus dense multiflorus, floribus congestis aureis, pedicellis ca. 0.75 cm. longis, nectariis tubularibus subsessilibus cruribus brevissimis obtusis paene aequalibus 0.6–0.8 cm. longis, ostio 0.2 cm. diam. Sepala et prophylla 7 orbiculata-reniformia 0.1 cm. longa 0.15 cm. lata. Corolla 5-lobata ca. 0.4 cm. longa. Stamina 5, filamentis linearibus vel prope basim paene dilatatis.—panamá: between Las Margaritas and El Valle de Antón, July 15–Aug. 8, 1938, *Woodson, Allen & Seibert 1289* (Herb. Missouri Bot. Gard., type).

This species is closely related to *S. exauriculata* Delp. However, the latter is generally larger than *S. venosa,* the pedicel being about 1.1 cm. long and the calyx about 0.5 cm. wide; the petals about 0.6 cm. long, the nectariferous bracts about 1.3 cm. long, the tertiary veins not prominent, the leaves oblanceolate, and the filaments broad, expanded at the base. Also in the specimens examined, the leaves of *S. exauriculata* dry gray above, tan beneath, while those of *S. venosa* dry gray to black above, dark brown beneath.

GUTTIFERAE
(P. C. Standley, Chicago)

CLUSIA **coclensis** Standl., sp. nov. Frutex 1.5 m. altus omnino glaber, ramis crassis subteretibus ferrugineis striatis, internodiis brevibus; folia parva breviter petiolata crasse coriacea, petiolo lato atque subvaginante 4–5 mm. longo subalato; lamina ovalis vel ovali-obovata 3.5–6 cm. longa 2–3.5 cm. lata apice late rotundata, basi cuneato-angustata, supra lucida, costa prominula, nervis manifestis sed vix elevatis, subtus opaca, costa angusta elevata, nervis lateralibus utroque latere ca. 15 vix prominulis interdum obsoletis angulo lato saepe fere recto abeuntibus tenerrimis fere rectis; inflorescentia terminalis ca. 1 cm. longe crasse pedunculata 1–3-flora, floribus sessilibus albis, bracteis basalibus late rotundatis 6–7 mm. longis subpatentibus; sepala rotundata late membranaceo-marginata ca. 9 mm. longa apice rotundata; petala ca. 6 atque 1.5 cm. longa apice rotundata, marginibus minute serrulatis in sicco pallidis; stamina numerosa valde inaequalia, antheris linearibus 3 mm. longis.—COCLÉ: vicinity of El Valle, alt. 800–1000 m., Sept. 5, 1938, *P. H. Allen 771* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.).

A rather well-marked species among Central American representatives of the genus, notable for the small, broad leaves, which are thick-coriaceous and broadly rounded at the apex.

LOASACEAE

LOASA GRANDIS Standl.—COCLÉ: north rim of El Valle de Antón, alt. 600–1000 m., Feb. 12, 1939, *P. H. Allen 1658*. Apparently the second collection of this giant species, originally described from Guanacaste, Costa Rica.

BEGONIACEAE
(P. C. Standley, Chicago)

BEGONIA **chiriquensis** Standl., sp. nov. Herba laxa erecta vel decumbens ca. 30 cm. alta, caule e nodis infimis radices emittente sparse ramoso primo dense ferrugineo-villoso, glabrescente, internodiis brevibus; stipulae oblique ovatae vel ovales 5–7 mm. longae obtusae virides integrae vel grosse paucidentatae; folia parva in sicco tenuia breviter petiolata, petiolo usque 9 mm. longo longivilloso; lamina lanceolato-oblonga vel oblongo-obovata plus minusve obliqua 0.5–5 cm. longa 0.8–2 cm. lata acuta vel longi-acuminata, basi obtusa et valde obliqua, latere altero bene longiore, supra viridis fere glabra vel tantum ad costam nervosque sparse villosula, subtus ubique densissime pallido-punctata ad nervos sparse ferrugineo-villosula vel fere glabra, nervis lateralibus utroque latere ca. 5 obliquis, margine grosse inaequaliter inciso-dentato interdum sublobato, dentibus setuloso-mucronatis; flores albi in cymas paucifloras ca. 2.5 cm. longe pedunculatas dispositi, pedicellis glabris fere filiformibus valde elongatis; sepala petalaque ovalia vix plus quam 4–5 mm. longa apice rotundata glabra; stamina glabra 2 mm. longa; fructus glaber 18 mm. longus 15 mm. latus viridis basi late campanulatus, parte superiore longe conica atque 1 cm. longa, angulis aliformibus divaricatis obtuse triangularibus.—CHIRIQUÍ: epiphytic, trail from Cerro Punta to headwaters of Río Caldera, alt. 2250 to 2500 m., Jan. 14, 1939, *P. H. Allen 1345* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.); stream bank in rain forest, Bajo Chorro, Boquete District, alt. 2100 m., Jan. 12, 1938, *M. E. Davidson 107.*

Referable to the subgenus *Casparya.* Two other species of this group found in Costa Rica, *Begonia Pittieri* C. DC. and *B. Torresii* Standl., differ in having glabrous stems. This group of *Begonia* is best represented in Colombia, and it may well be that the Panama plant is referable to some species described from that country, but all the Colombian species of which I have seen material seem to differ essentially.

BEGONIA **pumilio** Standl., sp. nov. Herba perennis acaulis nana, caudicibus ut videtur brevibus crassisque dense foliatis; stipulae ferrugineae tenues ovato-triangulares 5–6 mm. longae sparse longi-pilosae apice in setam 3–5 mm. longam desinentibus; folia omnia basalia longissime petiolata in vivo ut videtur carnosa, petiolo gracillimo 3–7 cm. longo sat dense pilis longis laxis plerumque patentibus ferrugineis villoso; lamina 4–5 mm. supra basin peltata ovata vel late ovata 2–4.5 cm. longa 1.5–4 cm. lata longi-acuminata, basi late rotundata ca. 8-nervia, supra sparse pilis longis laxis rufidulis villosa, subtus paullo pallidior ubique dense albo-punctata densius praesertim ad nervos villosa; flores monoeci cymosi, pedunculis gracilibus erectis 4–6 cm. longis dense longi-villosis, cymis densiuscule multifloris ca. 3 cm. altis et 4 cm. latis, ramis dense villosis, pedicellis brevibus vel aliquanto elongatis villosis, bracteis hyalinis latis villosis et ciliatis usque 5 mm. longis; sepala floris feminei suborbicularia ca. 4 mm. longa; capsula compressa suborbicularis 5 mm. longa utroque latere fere aequaliter alata, ala vix ultra 1 mm. lata.—PANAMÁ: Cerro Campana, flowers pink, growing on boulders, Dec. 31, 1939, *P. H. Allen 2089* (Herb. Field Mus., TYPE).

Easily recognized among the species of Panama and Costa Rica because of the combination of dwarf habit and peltate leaves.

CACTACEAE

(L. Cutak, St. Louis)

PSEUDORHIPSALIS HIMANTOCLADA (Roland-Gosselin) Britt. & Rose—COCLÉ: north rim of El Valle de Antón, July 9, 1939, *P. H. Allen 1897.* Previously known as an endemic of Costa Rica. This species is very difficult to distinguish from the lowland *Wittia panamensis* Britt. & Rose, at least in the dried condition.

EPIPHYLLUM PITTIERI (Weber) Britt. & Rose—BOCAS DEL TORO: Quebrada Nigua, vicinity of Almirante Bay, Oct. 21, 1938, *H. Wedel 7.* Previously known from Costa Rica.

MYRTACEAE

(P. C. Standley, Chicago)

EUGENIA **vallis** Standl., sp. nov. Arbor 8-metralis, cortice laevi ferrugineo, ramulis rigidis teretibus rimosis ferrugineis, novellis dense pilis albidis mollibus patentibus vel adscendentibus pilosis, internodiis brevibus vel elongatis; folia inter minora breviter petiolata firme membranacea, petiolo 4–7 mm.

longo dense breviter piloso; lamina oblanceolato-oblonga vel obovato-oblonga 4–7 cm. longa 1.2–2.5 cm. lata obtusa, basin versus cuneato-attenuata, supra in sicco olivacea sat dense pilis pallidis mollibus pilosa vel glabrata, dense impresso-punctata, costa nervisque vix elevatis, subtus paullo pallidior ad costam prominentem sericea, aliter molliter pilis longis pilosa vel serius glabrata, nervis lateralibus utroque latere ca. 7 teneris prominulis; flores racemoso-paniculati, paniculis axillaribus foliis vulgo multo longioribus laxis pauciramosis longi-pedunculatis, ramis patentibus dense patenti-pilosis, racemis laxe paucifloris, pedicellis usque 4 mm. longis; hypanthium ut calyx extus dense molliter pilosum vix ultra 1 mm. longum, calyce profunde lobato, lobis ad anthesin abrupte reflexis obtusis intus glabris; petala alba tenuia glabra fere 3 mm. longa; stylus filiformis glaber 4–5 mm. longus.—COCLÉ: south (dry) rim, vicinity of El Valle, alt. 600–1000 m., May 14, 1939, *P. H. Allen 1773* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.).

There is some question as to whether the present plant is properly referable to *Eugenia,* but no better place for it is apparent. If a true *Eugenia,* it is unusually distinct among the Central American species, being noteworthy chiefly for the large, openly branched, many-flowered panicles.

ONAGRACEAE
(P. A. Munz, Claremont, Calif.)

JUSSIAEA INCLINATA L. f.—VERAGUAS: floating in stream, hills west of Soná, alt. ca. 500 m., Nov. 24, 1938, *P. H. Allen 1056.* Previously thought to be confined to the Mexican states of Chiapas and Guerrero.

ARALIACEAE
(A. C. Smith, New York)

OREOPANAX **vestitum** A. C. Smith, sp. nov. Arbor 15 m. alta, trunco basin versus circiter 50 cm. diametro (ex Austin Smith), vel frutex scandens (ex Allen); ramulis gracilibus, juventute ferrugineo-tomentosis (pilis breviter cauliculatis vel subsessilibus multo-ramosis) mox glabrescentibus rugosis cinereis vel stramineis; foliis simplicibus, petiolis rectis striatis, 2–10 cm. longis juventute ut ramulis tomentellis mox glabris, laminis tenuiter coriaceis obovato-ellipticis vel elliptico-oblongis, 9–20 cm. longis, 3.5–7 cm. latis, basi acutis vel cuneatis vel rotundatis, apice breviter calloso-apiculatis vel acuminatis (acumine ad 1.5 cm. longo apiculato), margine integris et anguste revolutis, supra glabris vel parcissime (juventute plus minusve densissime) stellato-pilosis, subtus stellato-tomentellis (pilis brevissime cauliculatis vel interdum subsessilibus, 6–9-ramosis, ramulis circiter 0.2 mm. longis) demum glabrescentibus, nervis primariis 3 e basi adscendentibus, costa valida, nervis secundariis utroque 3–5 adscendentibus utrinque prominulis, venulis inconspicuis; inflorescentia mascula terminali ad 9 cm. longa et lata, ramulis, bracteis pedunculisque ferrugineo-stellato-tomentellis, bracteis lineari-oblongis acutis 1–2 mm. longis, pedunculis gracilibus, 4–9 mm. longis; capitulis subglobosis 3–5 mm. diametro, bracteolis late ovatis apiculatis circiter 1 mm. longis extus pilosis, floribus 10–15 per capitulum glabris; calyce sub anthesi cupuliformi 1–1.3 mm. diametro, limbo inconspicuo truncato vel obscure dentato; petalis 4 vel 5 ovato-deltoideis, 1.4–1.7 mm. longis, circiter 1.2 mm. latis, subacutis; filamentis maturitate filiformibus 3–3.5 mm. longis, antheris oblongis circiter 0.9 mm. longis; stylis 2 circiter 0.5 mm. longis; inflorescentia hermaphrodita quam mascula paullo minore ad 5 cm. longa et lata, pedunculis 3–5 mm. longis, floribus 5–9 per capitulum; calyce sub anthesi coriaceo subgloboso 1.3–1.7 mm. diametro; petalis subconnatis et calyptratis, circiter 1 mm. longis et latis; filamentis brevissimis; stylis 4 vel 5 e basi liberis erectis, loculis 4 vel 5; fructibus juvenilibus plerumque circiter 6 per capitulum stylis recurvatis coronatis.—COSTA RICA: ALAJUELA: San Carlos, at edge of forest near Sucre, alt. about 975 m., March 1, 1939, *Austin Smith H1167* (Herb. New York Bot. Gard., TYPE); PANAMA: CHIRIQUÍ: upper valley of Río Chiriquí Viejo, trail from Paso Ancho to Monte Lirio, alt. 1500–2000 m., Jan. 16, 1939, *P. H. Allen* (Herb. New York Bot. Gard.).

The type bears hermaphrodite, and the Panama plant staminate, inflorescences, and for this reason floral comparisons between the two are not conclusive. In foliage the two plants show some differences: the type has obovate-elliptic leaf-blades which are usually acute at base and short-apiculate at apex, while the Panama collection has somewhat longer elliptic leaf-blades which are rounded at base and comparatively long-acuminate at apex. These variations, however, are not remarkable in *Oreopanax*, where they are paralleled in other species. Austin Smith's collection is chosen as the type because the number of styles in hermaphrodite flowers appears to be an important character in the genus.

The new species is related to *O. Oerstedianum* March. and *O. Standleyi* A. C. Smith, both of which are known only from Costa Rica. *O. vestitum* is at once distinguished from *O. Oerstedianum* by its less robust habit and especially by the close indumentum of its branchlets and petioles; in Marchal's species the hairs of these parts have a remarkably stout stalk about 2 mm. long. The new species differs from *O. Standleyi* by its proportionately much narrower leaves and its fewer styles and locules, as well as by its nearly sessile rather than long-stalked hairs of the lower leaf-surface. Both staminate and hermaphrodite inflorescences of *O. vestitum* are more compact than those of its allies.

GILIBERTIA **sessiliflora** Standl. & A. C. Smith, sp. nov. Arbor ubique glabra; ramulis crassis cinereis rugosis; petiolis gracilibus rectis 3–7 cm. longis; laminis chartaceis vel tenuiter coriaceis, late ellipticis, 12–20 cm. longis, 7–13 cm. latis, basi obtusis, apice obtusis vel obtuse et breviter acuminatis, margine undulato-crenatis, pinnatinerviis, costa prominente, nervis secundariis utrinque 7–9 subrectis vel leviter arcuato-adscendentibus paullo elevatis, venulis leviter prominulis; rhachide non visa, umbellis ut videtur 10 vel ultra per inflorescentiam; pedunculis crassis striatis rugosis, 2.5–4 cm. longis, medium versus conspicue articulatis et bracteatis (bracteis coriaceis connatis 3–4 mm. longis); floribus capitatis sessilibus 5-meris 10–15 per capitulum, bracteis papyraceis deltoideis subacutis circiter 2 mm. longis subtentis; receptaculis 5–8 mm. latis;

calyce obconico vel breviter cylindrico, 2–3 mm. longo, circiter 2 mm. diametro, lobis deltoideis acutis circiter 0.7 mm. longis; petalis pallide luteis deltoideo-lanceolatis, 2.5–3 mm. longis, 1–1.5 mm. latis, apice acutis et inflexis; filamentis sub anthesi circiter 3 mm. longis, antheris subgloboso-oblongis circiter 0.7 mm. longis; stylis in columnam brevem carnosam connatis, stigmatibus plus minusve distinctis.—CHIRIQUÍ: Boquete District, near Boquete, alt. 3800 ft., June 26, 1938, *M. E. Davidson 769* (Herb. Field Mus., TYPE).

G. sessiliflora is a remarkable species, disagreeing with the other members of the genus by the character from which the specific name is derived, the sessile flowers. Superficially, it may appear that an araliaceous plant of this region with the flowers in heads should be sought in *Oreopanax* rather than in *Gilibertia.* The flowers of *Oreopanax,* however, are polygamo-dioecious or rarely polygamo-monoecious, while those of the present plant are hermaphrodite. In all its characters except the sessile flowers, moreover, *G. sessiliflora* appears correctly placed in *Gilibertia.* In its foliage and its rugose articulate peduncles with conspicuous connate bracts it bears a strong resemblance to *G. gonatopoda* Donn. Sm. The discovery of the new species makes the separation of the genera *Gilibertia* and *Oreopanax* somewhat more difficult, but nevertheless we believe that their maintenance is not seriously to be questioned.

OREOPANAX COSTARICENSIS March.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. ca. 1800–2000 m., Jan. 6–14, 1939, *P. H. Allen 1395;* Río Chiriquí Viejo valley, near El Volcán, July 17, 1938, *P. White 171;* between El Volcán and Cerro Punta, Río Chiriquí Viejo valley, March 20, 1938, *G. White.* Apparently abundant in this part of western Chiriquí, but previously unknown in Panama.

ERICACEAE

(W. H. Camp and A. C. Smith, New York)

CAVENDISHIA **stenophylla** A. C. Smith, sp. nov. Frutex gracilis epiphyticus ut videtur ubique glaber; ramulis cinereis subteretibus vel juventute leviter angulatis; petiolis subteretibus leviter striatis nigrescentibus 4–6 mm. longis; laminis chartaceis subbullatis lineari-oblongis, 8–13 cm. longis, 1.3–2 cm. latis, basi rotundatis et saepe leviter subcordatis, apice gradatim attenuatis (apice ipso obtuso), margine integris et conspicue revolutis, pinnatinerviis, costa supra impressa subtus prominente, nervis secundariis inconspicuis 5–7 (2 vel 3 prope basin orientibus adscendentibus, aliis brevibus patentibus) marginem versus anastomosantibus, supra cum venulis copiose reticulatis prominulis, subtus leviter elevatis; inflorescentiis terminalibus (semper?) racemosis 15–20-floris basi decidue bracteatis, rhachide gracili purpurascente leviter angulata 7–8 cm. longa; pedicellis gracilibus 12–16 mm. longis, bracteis inconspicuis papyraceis ovato-oblongis 2–4 mm. longis et latis subtentis, paullo infra medium bibracteolatis (bracteolis ovatis circiter 1 mm. longis et latis); calyce basi late apophysato, tubo post anthesi rugoso 2–3 mm. longo et 4–5 mm. diametro, superne constricto, limbo erecto chartaceo lobis inclusis 4–5 mm. longo, lobis deltoideis callosis acutis circiter 1.5 mm. longis et latis; corolla non visa.—PANAMÁ: in cloud forest on hills above Campana, alt. 600–800 m., July 1, 1939, *P. H. Allen 1880* (Herb. New York Bot. Gard., TYPE).

Although corollas are lacking on the available specimens, I venture to describe the plant as a new species, since the characters of the inflorescence and calyx place the plant without question in *Cavendishia,* where it can be related only to the Costa Rican *C. melastomoides* (Kl.) Hemsl. In calyx characters, which are important as indications of specific relationship in the genus, the two species are essentially similar; in inflorescence characters, *C. stenophylla* is distinguished from its ally by the smaller bracts and bracteoles and the higher position of the latter on the pedicels. The most obvious differences, however, are found in comparing the two plants as to leaf characters, the blades of the new species being nearly twice as long as those of *C. melastomoides* and about the same in breadth, with conspicuously different base and venation.

GAULTHERIA **chiriquensis** Camp, sp. nov. Frutex ad 2 m. altus, ramulis crispe pilosis eglandulosis; folia rotundo-ovata vel rectangulo-ovata, 3–5.5 cm. longa, 2–3.5 cm. lata, basi profunde cordata, apice obtusa vel abrupto-acuminata, supra minute puberulenta, subtus persistente pubescentia, pilis densis ferrugineis, margine integra vel obscure serrata, setosa, setis deciduis; racemi 2–3 cm. longi, rhachis et pedicelli (circ. 4–5 mm. longi) dense albido-puberuli et ± dense ferrugino-pilosi, eglandulosi, bracteis pubescentibus; calyx 5-lobus, lobis acuminatis, albido-puberulis, apice sparse hirsutis; corolla urceolata, circ. 5 mm. longa, purpurea, apice manifeste contracta, albido-puberulenta et crispe pilosa, pilis eglandulosis; stamina 10, circ. 4 mm. longa, filamentis dense pubescentibus; ovarium et stylus albido-pubescentes.—CHIRIQUÍ: Llanos del Volcán, alt. ca. 1300 m., Jan. 23, 1939, *P. H. Allen 1542* (New York Bot. Gard., TYPE).

G. chiriquensis strongly resembles the Mexican *G. hirtiflora* Benth. in plant size and general appearance but lacks the glandular pubescence of this species. Of the South American species, it bears considerable resemblance to the widespread *G. pichinchensis* Benth., of Colombia, Ecuador, Bolivia and perhaps Peru. It differs from the type of *G. pichinchensis* (*Hartweg 1228* from Colombia) by being slightly less hirsute, with the leaves relatively broader and more deeply cordate at the base; also, the calyx and corolla of *G. pichinchensis* lack the setae characteristic of *G. chiriquensis*.

THEOPHRASTACEAE
(C. L. Lundell, Ann Arbor, Mich.)

JACQUINIA **panamensis** Lundell, sp. nov. Arbor, 3 m. alta; ramuli puberuli. Folia coriacea, petiolata, petiolo usque ad 3 mm. longo, parce puberulo, oblanceolata vel oblanceolato-oblonga, 3.2–6.7 cm. longa, 1.4–2.5 cm. lata, apice acuta, aciculari, basi acuta vel subcuneata. Inflorescentiae terminales, racemosae, 3–13-florae, raro parce puberulae, pedunculatae. Pedicelli 8–12 mm. longi, apice incrassati. Flores aurantiaci, 9–11 mm. longi. Sepala suborbicularia, 3.5–4 mm. longa. Corolla intus ad basin minute lepidotula, lobis oblongis, ca. 5 mm. longis, staminodiis oblongo-cordatis, usque ad 4.3 mm. longis. Stamina ca. 6 mm. longa.

A tree, 3 m. high; branchlets puberulent, striate, angulate. Leaves coriaceous, short-petiolate, the petioles up to 3 mm. long, at first sparsely puberulent; leaf blades oblanceolate or oblanceolate-oblong, 3.2 to 6.7 cm. long, 1.4 to 2.5 cm. wide, apex acute, acicular, base acute or subcuneate, glabrous except along the costa, obscurely triplinerved, costa subimpressed above and puberulent at base, elevated beneath. Inflorescence terminal, at first subcorymbose, at length racemose, erect, 3- to 13-flowered, glabrous or rarely sparsely puberulent, shorter than or subequaling leaves, pedunculate. Pedicels 8 to 12 mm. long, thickened above. Bractlets ciliate. Flowers orange-colored, 9 to 11 mm. long. Sepals suborbicular, 3.5 to 4 mm. long, thick, minutely erose. Petals united to the middle, minutely lepidote within at base; the lobes oblong, about 5 mm. long, apex rounded, reflexed at anthesis; the staminodes subequaling lobes, oblong-cordate, up to 4.3 mm. long. Stamens about 6 mm. long, slightly exceeding corolla-tube; filaments sparsely lepidote; anthers about 2.5 mm. long, emarginate. Style well developed. —PANAMÁ: vicinity of Bejuco, Oct. 18, 1938, *P. H. Allen 985* (Herb. Univ. Michigan, TYPE).

Jacquinia panamensis approaches *J. axillaris* Oerst. of Mexico, but may be separated from that species by its oblanceolate rather than lanceolate leaves, costa subimpressed above, not prominulous, flowers up to 13 in a raceme compared with about 5 in *J. axillaris*, and style elongate rather than very short.

LOGANIACEAE
(C. V. Morton, Washington, D. C.)

BUDDLEJA ALPINA Oerst.—CHIRIQUÍ: Llanos del Volcán, near Paso Ancho, July 31, 1938, *P. White 202.* Previously known from Costa Rica.

GENTIANACEAE
(F. P. Jonker, Utrecht)

CURTIA TENUIFOLIA (Aubl.) Knobl.—PANAMÁ: vicinity of Pacora, Oct. 18, 1938, *P. H. Allen 994;* COCLÉ: vicinity of Natá, Sept. 12, 1938, *P. H. Allen 832.* Previously known from Brazil and the Guianas.

LISIANTHUS CONGESTUS Standl.—COCLÉ: El Valle de Antón, Sept. 5, 1938, *P. H. Allen 783.* Previously known from Guatemala.

LISIANTHUS LATIFOLIUS Sw.—COCLÉ: north rim of El Valle de Antón, trail to San Miguel, May 14, 1939, *P. H. Allen 1793.* Previously known from Jamaica.

SCHULTESIA BRACHYPTERA Cham.—COCLÉ: vicinity of Nata, Sept. 12, 1938, *P. H. Allen 831;* VERAGUAS: hills west of Soná, Nov. 24, 1938, *P. H. Allen 1069.* Previously known from Brazil, the Guianas, and Nicaragua.

SCHULTESIA PECKIANA Robinson—CHIRIQUÍ: hills near Cerro Punta, Jan., 1938, *G. & P. White 104.* Previously known from British Honduras.

APOCYNACEAE

RAUWOLFIA PURPURASCENS Standl.—CANAL ZONE: near Gorgas Memorial Laboratory, vicinity of Miraflores, June 20, 1938, *Gene White 120.* This species is noteworthy amongst the Rauwolfias of Panama because of its eglandular petioles. When first described (Field Mus. Publ. Bot. **4**: 255. 1929), only flowering material was available, and the species apparently has not been collected until the present. Miss White's specimen is in full fruit, and, although without flowers, agrees well with the type specimen in vegetative characters. The drupes are compressed-ovoid, slightly emarginate, 0.7–0.9 cm. long, equally broad, and are "green, turning to purple." The habit of the species also is known for the first time, and is described as a "tree 20–25 feet tall."

TABERNAEMONTANA **pendula** Woodson, sp. nov. Arbor 8-metralis. Rami dichotomi graciliusculi cortice luteo striato tecti. Folia opposita petiolata obovato-ovalia apice abrupte subcaudato-acuminata basi late cuneata in nodis plus minusve inaequalia 6.5–17.0 cm. longa 3–8 cm. lata membranacea opaca glabra; petiolo 1 cm. longo. Inflorescentia terminalis longissime pedunculata pluriflora pendula; pedunculo primo sterili 6–17 cm. longo fere filiformi glabro apici dichotomo, ramulis florigeris 2–6 cm. longis, bracteis minute ovatis caducis, pedicellis 0.6–0.7 cm. longis. Calycis lobi ovati 0.2 cm. longi subscariacei glabri. Corollae tubus 0.5 cm. longus basi ca. 0.1 cm. diam. extus glabrus vel minutissime papillatus prope apicem staminigerus, lobi oblique obovati 1.0–1.1 cm. longi brunnei intus basi papillati. Anthera livida 0.2 cm. longa ad medium exserta. Folliculi ignoti.—COCLÉ: north rim of El Valle de Antón, alt. 600–1000 m., March 19, 1939, *P. H. Allen 1734* (Herb. Missouri Bot. Gard., TYPE).

This species probably is most closely related to *T. amygdalifolia* Jacq., because of the conspicuously exserted anthers. However, the latter has a much shorter inflorescence, and larger, white flowers.

PRESTONIA **Allenii** Woodson, sp. nov. Frutex volubilis omnino dense luteo-pubescens. Ramuli crassiusculi tomentosi. Folia obovato-ovalia apice abrupte breviterque acuminata basi late cuneata obscureque cordata 13–19 cm. longa 5.5–11.0 cm. lata membranacea supra strigillosa subtus pallidiora dense tomentulosa; petiolo 0.5–0.7 cm. longo tomentuloso. Inflorescentia interpetiolata dense umbellata pluriflora; pedunculo 1.5 cm. longo tomentuloso; bracteis lanceolatis foliaceis 0.5–1.0 cm. longis hispidulis; pedicellis 1 cm. longis dense tomentulosis. Calycis lacinii oblongo-lanceolati acuminati 2.5 cm. longi foliacei hirtelli, squamellis dense laceratis hirtellis. Corollae subinfundibuliformis extus omnino dense hispidulae tubus 4 cm. longus basi ca. 0.5 cm. diam. tertia parte superiore staminigerus ibique conico-dilatatus, ostio ca. 0.9 cm. diametro, lobi oblique obovati 1.5 cm. longi patuli. Anthera sagittata 0.8 cm. longa glabra. Ovaria ovoidea ca. 0.2 cm. longa glabra. Nectarium conico-annulare ostio 5-lobato glabro ovarium paulo superans. Folliculi ignoti.—COCLÉ: north rim of El Valle de Antón, June 4, 1939, *P. H. Allen & A. H. G. Alston 1855* (Herb. Missouri Bot. Gard., TYPE).

Mr. Allen describes this species as follows: "Corky vine; corolla lobes green, throat of tube yellow." The subinfundibuliform corolla recalls that of *P. speciosa* Donn. Sm. and *P. remediorum* Woods., but differs from both in the unusually fleshy and pronounced lobes of the faucal annulus, and in the rather poorly manifest callous ridges which extend completely from the insertion of the stamens to the annulus. The anthers are barely included.

ASCLEPIADACEAE

Funastrum glaucum (HBK.) Schltr.—herrera: vicinity of Chitré, alt. ca. 20 m., Nov. 26, 1938, *P. H. Allen 1090.* Apparently the first record of this species from Central America.

Gonolobus **Allenii** Woodson, sp. nov. (fig. 1). Frutex volu-

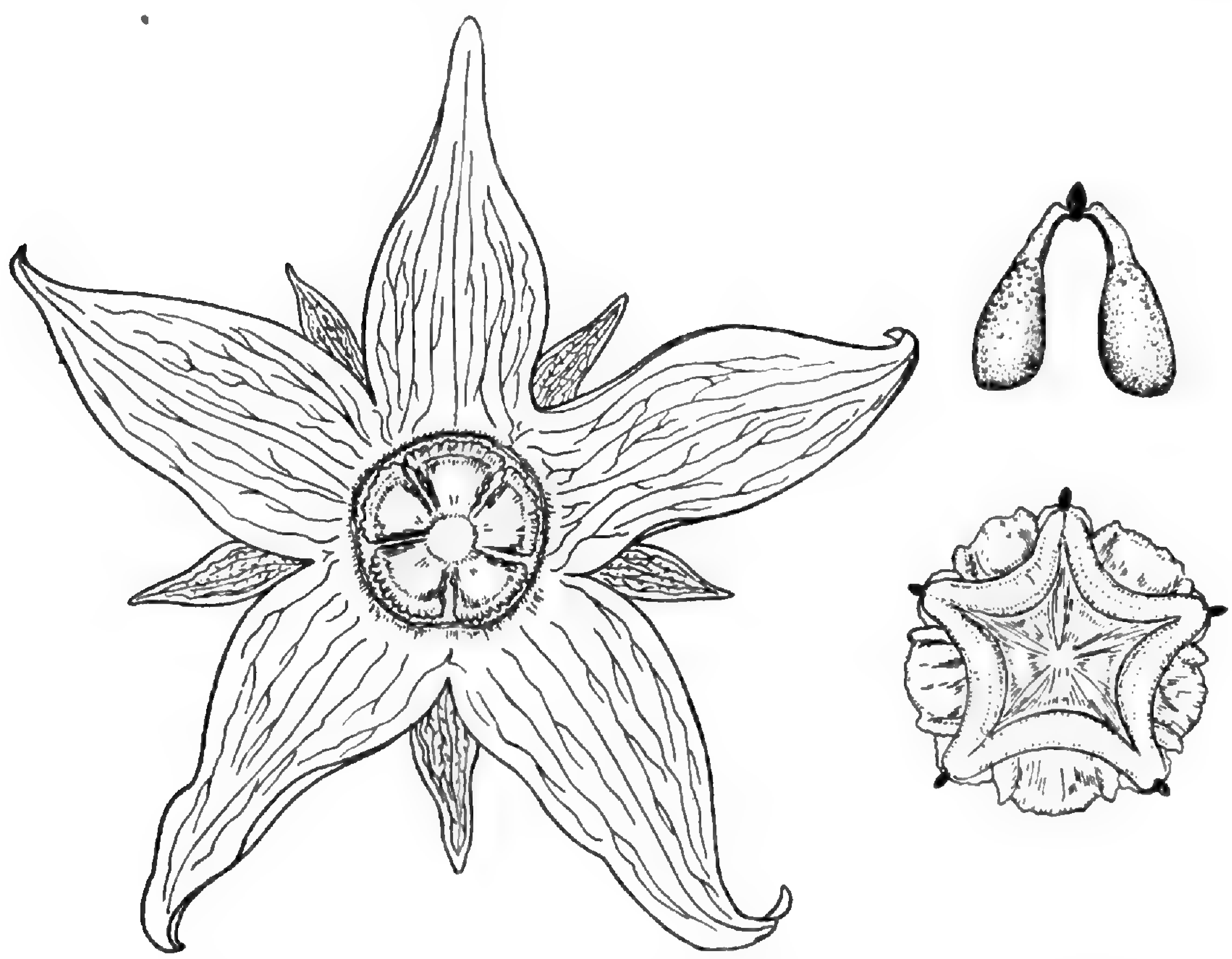

Fig. 1. *Gonolobus Allenii* Woods.: Flower, × 2; pollinia, × 10; gynostegium, × 5.

bilis. Rami gracili irregulariter pilosuli; internodiis valde variabilibus 4–20 cm. longis. Folia opposita petiolata; lamina ovato-oblonga apice super medium acute acuminata basi late rotundateque cordata, sinu ca. 1 cm. profundo lobis paulo incurvatis, 5–10 cm. longa 2–4 cm. lata membranacea viridis supra glabra, nervo medio basi 2-glanduloso subtus nervo medio venisque minute pilosulis; petiolis gracilibus 2.5–3.0 cm. longis densius minuteque pilosulis. Inflorescentia 1–3-flora; pedunculo 1.0–1.5 cm. longo sparse pilosulo; bracteis lanceolatis 0.1–0.3 cm. longis; pedicellis 2.0–2.5 cm. longis sparse pilosulis. Flores magni viridi; calycis laciniis anguste oblongo-lanceolatis sensim obtuse acuminatis 1.5 cm. longis extus sparse minutissimeque pilosulis; corolla ca. 5 cm. diam. rotata extus intusque minute papillata caeterumque glabra, lobis anguste ovato-lanceolatis super medium anguste acuminatis 2 cm. longis basi ca. 0.7 cm. latis patulis, faucibus leviter annulatis (an corona tertia?), corona exteriore breviter annulata leviter obtuseque 5-angulata integra fere glabra, interiore sub gynostegio pendente subreniformi, ca. 0.05 cm. lata, gynostegio subsessili, stigmate 5-gono plano ca. 0.5 cm. diam. Fructus ignoti.—COCLÉ: north rim of El Valle de Antón, alt. 800–1000 m., May 21, 1939, *P. H. Allen 1831* (Herb. Missouri Bot. Gard., TYPE).

Closely related to *G. uniflorus* HBK., but well marked by the somewhat larger, nearly glabrous corolla, and by structural characters of the gynostegium.

MARSDENIA TRIVIRGULATA Bartlett—HERRERA: vicinity of Chitré, alt. ca. 20 m., Nov. 26, 1938, *P. H. Allen 1092.* A most interesting addition to the flora of Panama, previously unknown south of Mexico. Allen describes the flower as pale pink, with stripes of purple, which are well preserved in our specimens. A duplicate of the type of *M. virgulata (Pringle 10,333* in Herb. Missouri Bot. Gard.) shows somewhat broader leaves than those of *Allen 1092,* and the corolla is completely glabrous within, whereas the Panama specimen, in ample flower, shows the corolla to be sparsely barbellate, particularly in the callose sinuses. In my estimation, however, these slight differences scarcely are varietal.

CONVOLVULACEAE
(P. C. Standley, Chicago)

IPOMOEA **chiriquensis** Standl., sp. nov. Volubilis herbacea fere omnino glabra, caule in sicco ochraceo, internodiis elongatis; folia majuscula integra longi-petiolata membranacea, petiolo gracili 6–14 cm. longo; lamina late ovato-cordata 10–19 cm. longa 7–11.5 cm. lata subito contracta et anguste longi-acuminata vel fere caudata, acumine angusto usque 4.5 cm.

longo, basi profunde (2–3 cm.) cordata, sinu aperto, lobis posticis rotundatis, supra glabra, subtus fusco-punctata ad costam nervosque pilis paucis inconspicuis conspersa; pedunculi petiolum aequantes vel longiores cymose 2–6-flori ca. 14 cm. longi interdum apice foliati aliquanto fistulosi, pedicellis crassiusculis usque 5 cm. longis glabris; sepala in sicco subcoriacea inaequalia glabra, exterioribus oblongo-lanceolatis acuminatis 6–7 mm. longis erectis, interioribus ovalibus vel late ovatis 12–14 mm. longis breviter mucronatis; corolla glabra alba, tubo crasso 5 cm. longo sursum sensim dilatato, fauce 2 cm. lato, limbo 8 cm. lato vel ultra; stamina medium tubi aequantia.—CHIRIQUÍ: trail from Paso Ancho to Monte Lirio, upper valley of Río Chiriquí Viejo, alt. 1500–2000 m., Jan., 16, 1939, *P. H. Allen 1512* (Herb. Missouri Bot. Gard., TYPE; fragment in Herb. Field Mus.).

The species described is not closely similar to any of the numerous *Ipomoea* species of Mexico and Central America of which I have examined specimens, and the large, white corollas are a rather unusual character. Although the technical characters do not seem to warrant reference of the plant to *Calonyction,* there is a strong suspicion that when complete material of it has been collected, it will be found really referable to that group.

HYDROPHYLLACEAE

WIGANDIA CARACASANA HBK.—CHIRIQUÍ: trail from Paso Ancho to Monte Lirio, upper valley of Río Chiriquí Viejo, alt. 1500–2000 m., Jan. 16, 1939, *P. H. Allen 1498.* Ranging from Mexico to Venezuela, but apparently not collected previously in Panama.

VERBENACEAE
(H. N. Moldenke, New York)

LIPPIA OXYPHYLLARIA (Donn. Sm.) Standl.—CHIRIQUÍ: Llanos del Volcán, alt. ca. 1300 m., Jan. 23, 1939, *P. H. Allen 1541.* Previously known from two localities in Costa Rica.

LIPPIA TORRESII Standl.—CHIRIQUÍ: vicinity of Cerro Punta, alt. 2000 m., Jan. 21–24, 1939, *P. H. Allen 1565;* trail from Paso Ancho to Monte Lirio, upper valley of Río Chiriquí Viejo, alt.

1500–2000 m., Jan. 16, 1939, *P. H. Allen 1481.* Previously known from Costa Rica.

Lippia hemisphaerica Jacq.—herrera: vicinity of Chitré, alt. ca. 20 m., Nov. 26, 1938, *P. H. Allen 1094.* Previously known from Colombia and Ecuador.

SOLANACEAE

(P. C. Standley, Chicago)

Solanum **chiriquinum** Standl., sp. nov. Arbor inermis 10–12-metralis, ramulis gracilibus teretibus ochraceis rimosis, novellis interdum plus minusve flexuosis densissime minute subadpresso-stellato-tomentulosis, internodiis brevibus; folia inter minora alterna vel interdum opposita atque valde inaequalia, breviter petiolata membranacea, petiolo 4–10 mm. longo stellato-tomentello; lamina lanceolato-oblonga 6–11 cm. longa 2–4 cm. lata sensim vel subito longe angusteque attenuato-acuminata, basi obtusa vel anguste rotundata, supra in sicco viridis sublucida, tantum ad costam sparse minute stellato-pubescens, aliter in statu adulto glabra, in statu juvenili sparse minuteque stellato-pilosula, subtus paullo pallidior ubique pilis minutis subadpressis stellato-tomentella, costa gracili prominente, nervis lateralibus utroque latere ca. 7 prominentibus obliquis angulo semirecto vel paullo latiore adscendentibus; lamina in foliis minoribus late ovata vel late elliptica 1–2 cm. tantum longa; inflorescentiae apice rami oppositifoliae pauci- vel multiflorae dichotomae 1–2.5 cm. longe pedunculatae, ramis vulgo 2 primo brevibus, serius valde elongantibus et usque 3.5 cm. longis vel ultra, ramis dense stellato-tomentulosis, pedicellis dense stellato-tomentosis usque 5 mm. longis; calyx fere 3 mm. longus extus dense minute stellato-tomentellus, lobis brevibus obtusis rotundato-ovatis erectis; corolla alba extus dense minute stellato-pilosula fere ad basin lobata, lobis patentibus acutis intus glabris ca. 4 mm. longis; antherae 2.5 mm. longae erectae oblongae apice late rotundatae.—chiriquí: Río Chiriquí Viejo, valley near El Volcán, Aug. 10, 1938, *Peggy White 224* (Herb. Field Mus., type; duplicate in Herb. Missouri Bot. Gard.).

Noteworthy for the forked inflorescences, whose branches at first are very short but during anthesis gradually elongate. Only a few flowers, apparently, are open at a time, and most of them fall, leaving behind close-set scars along the rachis.

(C. V. Morton, Washington, D. C.)

SOLANUM ENCHYLOZUM Bitter—DARIEN: vicinity of Pinogana, Oct. 6, 1938, *P. H. Allen 930.* Previously known from Costa Rica.

SOLANUM GROSSULARIA Bitter—CHIRIQUÍ: upper Río Chiriquí Viejo Valley, April 5, 1938, *G. White 68.* Previously known from Guatemala, Costa Rica, and Colombia.

SOLANDRA BRACHYCALYX Kuntze—COCLÉ: El Valle de Antón, Dec. 8, 1938, *P. H. Allen 1212.* Previously known from Costa Rica.

SOLANUM EDWARDSII Standl.—CHIRIQUÍ: Río Chiriquí Viejo Valley, April 3, 1938, *G. White 60.* Previously known from Honduras and Costa Rica.

LABIATAE

(Carl Epling, Los Angeles)

SALVIA **albopileata** sp. nov. Frutex altitudine ad 3 m. et ultra ramulis glabris purpureis tamen inter flores pilis glandulosis brevibus plus minusve viscidis; foliorum laminis ovato-lanceolatis 6–8 cm. longis, 3–4 cm. latis supra medium acuminatis, in basi angustatis, serrulatis, paginis ambabus glabris, inferiore glauca venulosa; petiolis 2–3 cm. longis; floribus 3–6 m. altis verticillastris bracteis ut videtur parvis hirtellis caducis subtentis, glomerulis inter se 5–10 mm. in spicis interruptis 8–15 cm. longis dispositis; calycibus florentibus rubris 12–13 mm. longis extus pilis brevioribus extensis mollibus glandulosis plus minusve viscidis, in maturitate paulo auctis; corollarum coccinearum tamen albopileatarum tubo 13 mm. longo, lateraliter compresso ventricoso, labia superiore 6 mm. alta.—CHIRIQUÍ: in cursus superioris fl. Chiriquí Viejo, 18. III. 1940, *P. White 321* (Herb. Univ. California, Los Angeles, TYPUS).

A member of the section *Cardinales* (species number 392a), which most nearly resembles *S. Wagneriana* of Guatemala and

Costa Rica. It is distinguished from that species by the smaller flowers, narrower leaves and finer pubescence. The corolla tubes of *S. Wagneriana* are 22–34 mm. long.

SCROPHULARIACEAE
(F. W. Pennell, Philadelphia)

Castilleja **aurantiaca** Pennell, sp. nov. Caulis laxe ramosus, cinereus; folia 2.0–2.5 cm. longa, linearia, canescentia, distaliter lobata; bracteae latiores, oblanceolatae, aurantiacae; pedicelli 3–5 mm. longi; calyx 17–19 mm. longus, postice 1 mm., antice 9–12 mm. fissus, lateraliter bilobatus; corolla 12 mm. longa, decurva, galea gracillima tubo duplo longiore, labio anteriore brevissimo; capsula 9 mm. longa.

Stem laxly and widely branched, cinereous with dense spreading hairs. Leaves 2.0–2.5 cm. long, 1.5–2.0 mm. wide, canescent, 3-ribbed, distally with 1 or 2 pairs of slender lateral lobes (2–5 mm. long). Bracts oblanceolate, 1.5–2.0 cm. long, 3–4 mm. wide, obtuse-rounded, distally orange-yellow. Pedicels 3–5 mm. long, grayish-pubescent. Calyx 17–19 mm. long, spathaceous, cleft posteriorly 1 mm., laterally less deeply into lobes (of which posterior is triangular, anterior low and angled), and anteriorly over half-length (9–12 mm.). Corolla 12 mm. long, decurved: galea very slender, dorsally pubescent, about twice length of tube; lower lip very short, 1 mm. long, deep green. Capsule 9 mm. long.—chiriquí: vicinity of Casita Alta, Volcán de Chiriquí, alt. 1500–2000 m., June 28–July 2, 1938, *Woodson, Allen & Seibert 926* (Herb. Acad. Nat. Sci. Philadelphia, type; Herb. Missouri Bot. Gard., isotype).

Castilleja **chiriquiensis** Pennell, sp. nov. Caulis laxe ramosus, cinereus; folia 1–2 cm. longa, linearia, canescentia, integra vel distaliter brevilobata; bracteae similes, rubrae; pedicelli 2–4 mm. longi; calyx 15–17 mm. longus, postice 1.5–2.5 mm., antice 10–14 mm. fissus, lateraliter fere integer; corolla 19–23 mm. longa, decurva, galea gracillima tubo multo longiore, labio anteriore brevissimo; capsula 8–9 mm. longa.

Stem laxly and widely branched, 5–10 dm. tall, cinereous with reflexed-spreading hairs. Leaves 1–2 cm. long, 1–2 mm. wide, canescent, obscurely 3-ribbed, entire or distally with a pair of short lateral lobes (1–2 mm. long). Bracts similar, entire or slightly lobed distally, 0.7–1.5 cm. long, 1–2 mm. wide, nearly wholly red. Pedicels 2–4 mm. long, grayish-pubescent. Calyx 15–17 mm. long, spathaceous, cleft posteriorly 1.5–2.5 mm., laterally scarcely or not at all, the apex unlobed or with a much smaller and shorter anterior lobe, and anteriorly ⅔ to ⅘ length (10–14 mm.). Corolla 19–23 mm. long, decurved: galea slender, dorsally with fine white pubescence, nearly thrice length of tube; lower lip very short, 1 mm. long, deep green. Capsule 8–9 mm. long.—CHIRIQUÍ: Cuesta Grande, Volcán de Chiriquí, alt. 2600–3000 m., March 11–13, 1911, *W. R. Maxon 5307* (U. S. Nat. Herb., TYPE; Herb. Acad. Nat. Sci. Philadelphia, ISOTYPE).

Several other collections from this mountain are in the U. S. Nat. Herb.: by *Carl Sapper,* in April, 1899; upper belt of mountain, alt. 3000–3374 m., *H. Pittier 3088,* March 10–13, 1911; and rocky summit, alt. 3600 m., *E. P. Killip 3600,* Feb. 27, 1918.

CASTILLEJA **Seibertii** Pennell, sp. nov. Caulis strictus, 1.5–2.5 dm. altus, glaber vel minute pubescens; folia 1–2 cm. longa, glabra puberulentave, distaliter lobata; bracteae lobatae, coccineae, superioribus flabellatis; pedicelli 2–5 mm. longi; calyx 15–16 mm. longus, postice 1–2 mm., antice 10–12 mm. fissus, lateraliter integer; corolla 20–21 mm. longa, paulum decurva, galea crassa tubo duplo longiore, labio anteriore brevissimo; capsula 8–9 mm. longa.

Stems several from the perennial root, each strict, erect, 1.5–2.5 dm. tall, glabrous or finely retrorse-pubescent, herbaceous or suffrutescent. Leaves 1–2 cm. long, 1–1.5 mm. wide, glabrous or puberulent, pale and obscurely 3-ribbed beneath, distally with 1 or 2 pairs of slender lateral lobes (3–6 mm. long). Bracts leaf-like, more deeply lobed, the upper widened and somewhat flabellate, less than 1 mm. wide, nearly wholly scarlet or scarlet-red. Pedicels 2–5 mm. long, puberulent or finely pubescent. Calyx 15–16 mm. long, spathaceous, cleft posteriorly 1–2 mm., laterally not at all (the apex rounded or nearly truncate), and anteriorly ⅔ to ¾ length (10–12 mm.). Corolla 20–21 mm. long, slightly decurved: galea stout, dorsally puberulent, nearly twice length of tube; lower lip very short, deep green, 1 mm. long, projecting. Capsule 8–9 mm. long.—CHIRIQUÍ: Loma Larga to summit, Volcán de Chiriquí, alt. above 2500 m., July 4–6, 1938, *Woodson, Allen & Seibert 1085* (Herb. Missouri Bot. Gard., TYPE; Herb. Acad. Nat. Sci. Philadelphia, ISOTYPE).

CASTILLEJA **bicolor** Pennell, sp. nov. Caulis 1.5–2 dm. altus, pubescens; folia 2.5–3.5 cm. longa, pubescentia, lobis linearibus pinnatifidis; bracteae superiores integrae, coccineae; pedicelli 3–7 mm. longi; calyx 18–19 mm. longus vel ultra, postice 1 mm., antice 14–15 mm. fissus, lateraliter integer; corolla matura non visa, forma *C. Seibertii* lata.

Stems several from the perennial root, each erect or decumbent, 1.5–2 dm. tall, pubescent with fine spreading hairs, herbaceous throughout. Leaves 2.5–3.5 cm. long, mid-blade 1–2 mm. wide, finely pubescent, obscurely or obsoletely 3-ribbed, with usually 2 pairs of linear lateral lobes (5–9 mm. long). Bracts leaf-like, the upper narrowly oblanceolate and entire, distally or nearly wholly scarlet. Pedicels 3–7 mm. long, grayish-pubescent. Calyx at least 18–19 mm. long (not seen mature), spathaceous, cleft posteriorly 1 mm., laterally not at all (the apex ovate-rounded or with slight and shorter anterior lobe), and anteriorly ¾ to ⅘ length (14–15 mm.). Corolla similar to that of *C. Seibertii,* apparently included within calyx, but not seen mature.—CHIRIQUÍ: Loma Larga to summit, Volcán de Chiriquí, July 4–6, 1938, *Woodson, Allen & Seibert 1035* (Herb. Missouri Bot. Gard., TYPE; Herb. Acad. Nat. Sci. Philadelphia, ISOTYPE).

I hesitate to describe a new species of *Castilleja* from immature material, but am induced to do so by the apparent constancy of the characters distinguishing it from *C. Seibertii.* The corolla will undoubtedly be that usual to this well-marked section of the genus. The name is suggested by the field record that the foliage is purple, thus contrasting with the scarlet bracts.

The following species of *Castilleja,* so far the only ones known from Panama, may be distinguished by the key below:

A. Calyx cleft equally posteriorly and anteriorly; pedicels less than 1 mm. long; leaf-blades entire or nearly so; root annual......1. *C. communis* Benth.

AA. Calyx cleft much more deeply anteriorly than posteriorly; pedicels becoming 3–12 mm. long; root perennial.

B. Stems widely branched, woody below, canescent-pubescent; leaves with lobes less than ¼ length of blade; bracts entire; plants taller.

C. Bracts orange-yellow, oblanceolate, wider than the upper leaves ....2. *C. aurantiaca* Penn.

CC. Bracts red, nearly linear, no wider than the upper leaves...... ....3. *C. chiriquiensis* Penn.

BB. Stems strict, little branched, herbaceous or suffrutescent, finely pubescent to glabrous; leaves with lobes more than ¼ length of blade; plants low, 1–2 dm. tall.

C. Leaves 1–2 cm. long, with short obtusely rounded lobes; bracts red, the upper triangular-obovate, lobed; leaves and stem hirtellous to glabrate, slightly glutinous, the latter suffrutescent; corolla slightly exserted......................4. *C. Seibertii* Penn.

CC. Leaves 2.5–3.5 cm. long, with slender obtuse or obtusish lobes; bracts scarlet, the upper narrowly oblanceolate, entire; leaves and stem finely cinereous-pubescent or puberulent, the latter herbaceous throughout; corolla apparently included within calyx (but perhaps not seen mature)................5. *C. bicolor* Penn.

GESNERIACEAE

(C. V. Morton, Washington, D. C.)

Besleria acropoda Donn. Sm.—coclé: north rim of El Valle de Antón, trail to San Miguel, May 21, 1939, *P. H. Allen 1829.* Previously known only from the type from Costa Rica.

LENTIBULARIACEAE

(J. H. Barnhart, New York)

Pinguicula crenatiloba DC.—coclé: moist shaded banks, vicinity of El Valle, alt. 800–1000 m., Sept. 5, 1938, *P. H. Allen 754.* Previously known from southern Mexico and Guatemala. Specimens of a larger-flowered species collected near the summit of Volcán de Chiriquí by Woodson, Allen & Seibert were destroyed in the disastrous fire of 1937.

RUBIACEAE

(P. C. Standley, Chicago)

Alibertia garapatica Schum.—panamá: Río Las Lajas, alt. 20 m., Feb. 5, 1939, *P. H. Allen 1616.* Previously known from northern Colombia and Panama, but sufficiently rare to merit recording.

Tobagoa maleolens Urban—coclé: north rim of El Valle de Antón, alt. 600–1000 m., Feb. 12, 1939, *P. H. Allen 1666*. This monotypic genus has previously been known only from Tobago and Venezuela.

Borreria **pumilio** Standl., sp. nov. Herba annua tenuis 4–6 cm. alta simplex vel superne pauciramosa, caule gracillimo sparse minute strigilloso vel fere glabro paribus ca. 4 foliorum onusto; stipulae fere 1 mm. longae multisetosae; folia linearia sessilia 3–6 mm. longa acuta basin versus paullo angustata glabra vel minute sparseque scaberula patentia; flores capitati, capitulo terminali sessili 4–5 mm. diam. paucifloro, bracteis linearibus 6–9 mm. longis patentibus vel subreflexis, floribus arcte sessilibus; capsula late subglobosa ca. 1 mm. longa glabra, sepalis linearibus viridibus erectis capsula paullo longioribus glabris vel obscure ciliolatis; corolla alba sepalis paullo longior, antheris exsertis.—coclé: Natá, alt. 50 m., Sept. 12, 1938, *P. H. Allen 822* (Herb. Field Mus., type; duplicate in Herb. Missouri Bot. Gard.).

This diminutive plant is altogether unlike any other species known previously from Central America. It is similar to several annual species of *Borreria* found in South America but differs from each of them in some important respect.

Psychotria **Allenii** Standl., sp. nov. Arbor 8-metralis, trunco usque 25 cm. diam., omnino glabra, ramulis crassis subteretibus vel obtuse tetragonis, internodiis vulgo elongatis ad nodos plus minusve incrassatis; stipulae persistentes atque basi incrassatae inferne in vaginam campanulatam ca. 4 mm. longam connatae, lobis utroque latere 2 triangularibus acutis vel acuminatis erectis vaginae aequilongis vel paullo longioribus; folia mediocria breviter petiolata crasse membranacea, petiolo 12–18 cm. longo gracili vel crassiusculo; lamina late ovata usque elliptica vel elliptico-oblonga 9–16 cm. longa 3.5–9 cm. lata abrupte breviter acuminata, acumine ipso acuto, basi obtusa vel rarius acuta, interdum fere rotundata, supra in sicco fusco-olivacea, costa nervisque subprominentibus, sublucida, subtus fere concolor, costa gracili elevata, nervis lateralibus utroque latere ca. 9 teneris arcuatis angulo lato adscendentibus, venulis prominulis laxe reticulatis; inflorescentia terminalis cymoso-paniculata 2.5–5.5 cm. longe pedunculata multiflora aperte ramosa usque 6 cm. longa atque 8 cm. lata, ramis infimis ut ceteri radiatim divaricatis crassis basi bracteatis, bracteis anguste triangulari-lanceolatis longi-attenuatis patentibus persistentibus, floribus sat dense aggregatis sessilibus vel brevissime crasseque pedicellatis albis; hypanthium crasse columnare ca. 0.7 mm. longum, calyce breviter dentato-lobulato, dentibus rotundato-ovatis vix ultra 0.3 mm. longis obtusis; corolla 5 mm. longa extus glabra in alabastro apice rotundata, lobis oblongis tubo duplo longioribus.—COCLÉ: north (wet) rim, vicinity of El Valle, alt. 600–1000 m., May 14, 1939, *P. H. Allen 1796* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.); BOCAS DEL TORO: Cricamola, region of Almirante, Jan.–March, 1928, *G. Proctor Cooper 522.*

Like the majority of *Psychotria* species, this one has no outstanding distinctive characters. It is, however, unlike any other known from Central America.

RONDELETIA **platysepala** Standl., sp. nov. Arbor 6-metralis ut videtur dense ramosa, ramis gracilibus teretibus fusco-ferrugineis, internodiis brevibus, novellis sparse vel dense strigosis; stipulae persistentes triangulares 2–3 mm. longae subulato-acuminatae erectae; folia parva breviter petiolata membranacea, petiolo gracili 3–5 mm. longo strigoso; lamina lanceolato-oblonga vel elliptico-oblonga 5–8 cm. longa 1.5–3 cm. lata longe anguste attenuato-acuminata, basi acuta vel acuminata, supra in statu adulto glabra vix lucida, subtus paullo pallidior in statu adulto tantum ad costam nervosque strigosa, in statu juvenili pilis longis mollibus albidis sat dense sericea sed cito glabrescens, costa gracili prominente, nervis lateralibus utroque latere ca. 7 prominulis valde obliquis, venis fere obsoletis; inflorescentia terminalis cymoso-paniculata sublaxe multiflora 4–7 cm. longa atque aequilata longi-pedunculata, ramis gracilibus adpresso-pilosis adscendentibus, bracteis minutis, pedicellis usque 4 mm. longis adpresso-pilosis, saepe fere nullis; hypanthium clavato-oblongum 2–2.5 mm. longum pilis albidis longis subadpressis pilosum; calyx ad basin 4-

partitus, segmentis foliaceis inaequalibus ellipticis vel late ovatis 3–4 mm. longis patentibus obtusis utrinque sparse pilosis; corolla pallide rosea extus pilis longis albidis subadpressis dense pilosa, tubo gracili 10 mm. longo sursum paullo dilatato, lobis 4 patentibus suborbicularibus 2 mm. longis intus glabris, fauce glabro.—COCLÉ: north (wet) rim, vicinity of El Valle, alt. 600–1000 m., May 14, 1939, *P. H. Allen 1791* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.).

The Panama plant is a relative of the Costa Rican *R. calycosa* Donn. Smith, which has a larger corolla and longer calyx lobes.

ALLENANTHUS Standl., gen. nov.

Arbores erectae sparse puberulae vel fere glabrae, ramulis teretibus, internodiis elongatis; stipulae latae ovatae fere liberae cuspidatae plus minusve persistentes vel deciduae; folia opposita breviter petiolata membranacea; flores parvi cymoso-corymbosi graciliter pedicellati, inflorescentia magna terminalis foliata; hypanthium truncato-obovoideum obcompressum anguste bialatum, calyce parvo 4-lobato, lobis ovato-triangularibus obtusis erectis persistentibus; corolla non visa; discus non elevatus; ovarium biloculare, ovulis in loculo solitariis ab apice loculi pendulis; fructus ut videtur siccus, loculis parvis oblongis centralibus ala marginali lata spongiosa compressa circundatis, fructu toto in ambitu elliptico-obovato apice late rotundato vel subtruncato, basi acuto; semina pendula lateraliter paullo compressa.

Type species, *Allenanthus erythrocarpus* Standl.

Allenanthus erythrocarpus Standl., sp. nov. Arbor 10-metralis, ramulis subgracilibus teretibus fusco-brunnescentibus laevibus in statu adulto glabris, novellis ut videtur bifariam puberulis, internodiis 3–4 cm. longis, infra nodos paucilenticellatis, lenticellis parvis pallidis elevatis; stipulae 5–6 mm. longae brunneae vel ferrugineae e basi late triangulari-ovata subito longiuscule cuspidatae, subpersistentes; folia breviter petiolata membranacea in sicco fusca, petiolo sat gracili 7–10 mm. longo superne anguste canaliculato atque puberulo; lamina lanceolato-oblonga vel oblongo-ovata 9–11 cm. longa 3–5 cm. lata longiuscule angusteque acuminata, basi acuta, supra glabra vel glabrata opaca, nervis venisque obscuris non elevatis, subtus concolor fere glabra sed in axibus nervorum primariorum breviter denseque albo-barbata, costa gracili elevata, nervis lateralibus utroque latere 5–6 arcuatis angulo latiusculo adscendentibus tenerrimis vix prominulis prope marginem irregulariter conjunctis, venis inconspicuis laxe reticulatis; inflorescentia terminalis dense foliata sessilis atque dense ramosa, ca 13 cm. longa et 15 cm. lata, ramulis brevibus ternatis bifariam breviter patulo-pilosis; bracteae parvae lineari-subulatae persistentes; pedicelli in statu fructifero gracillimi fere filiformes glabri plerumque 3–5 mm. longi erecti; calycis lobuli vix 1 mm. longi in statu fructifero incurvi glabri; fructus valde obcompressus ca. 8 mm. longus atque 5–6 mm. latus glaber coccineus, parte seminifera 2–2.5 mm. longa trinervia.—COCLÉ: vicinity of Valle de Antón, alt. about 600 m., Sept. 17, 1939, *P. H. Allen 1999* (Herb. Field Mus., TYPE; duplicate in Herb. Missouri Bot. Gard.).

Quite naturally, it always is a surprise, and sometimes a pleasant one, when examining a new lot of material received for determination to come suddenly upon an altogether new plant, from a region with which one is fairly familiar. It is much more of a surprise when the plant belongs to a family with which one has worked more or less intensively, at least if the plant is altogether unlike anything with which one is familiar. The plant here described is such a one. In fact, at first glance it did not recall any member of the Rubiaceae, but rather by the gross aspect of the dried specimens certain South American Polygonaceae, a resemblance that it must be confessed is soon dissipated by a second glance.

It is unfortunate that corollas are not available for examination, since they probably, although not necessarily, would facilitate a more exact reference of the plant to its proper position within the Rubiaceae. It seems to belong definitely to the tribe Chiococceae, where it may be associated with *Chiococca, Placocarpa,* and *Asemnanthe.* The texture of the leaves is considerably thinner than that of most members of this tribe, and the terminal inflorescence also is unusual in the group.

The most distinctive character of the plant is found in the peculiar fruit, which is not closely similar to that of any other genus of Rubiaceae. It is evidently obcompressed, and appears not to have been juicy in the living state, as in *Chiococca*, whose fruit dries in a rather similar manner. The central, seed-bearing part of the fruit is very small, but is surrounded by a broad, thick and rather spongy or corky wing, which *may* have been somewhat succulent in the living state. It is noteworthy that although the small fruits are exceedingly abundant in the large panicles, only a small proportion of the flowers mature, the number of withered, undeveloped or sterile flowers being much greater.

The genus is dedicated to Paul H. Allen, who has done exceptionally good and profitable collecting in Panama, over a period of several years. His carefully selected material has added many species to the recorded flora of the country.

VALERIANACEAE

(P. C. Standley, Chicago)

VALERIANA **Woodsonii** Standl., sp. nov. Herba perennis ca. 20 cm. alta caespitosa, radicibus carnosis incrassatis fasciculatis, basibus foliorum ad basin caulis persistentibus; caulis simplex scapiformis crassiusculus glaber paribus foliorum 3–4 onustus, foliis alteris ex apice radicis nascentibus; folia pinnata, radicalia usque 9 cm. longa, superiora 3.5–6 cm. longa, glabra, petiolo crasso prope basin villosulo; foliola 3–11, terminalia petiolulata ovalia vel ovali-ovata et usque 2 cm. longa, lateralia sessilia basin versus folii decrescentia late elliptica vel rotundata 3–8 mm. longa, omnia apice obtusa vel interdum rotundata, rare subacuta, inaequaliter crenato-dentata vel rare subintegra, tenuia; inflorescentia terminalis capitato-congesta dense multiflora 2 cm. lata longi-pedunculata, bracteis oblongis vel oblongo-spathulatis ciliatis obtusis vel rotundatis, exterioribus breviter lobatis; corolla pallide rosea glabra, tubo crasso 3.5 mm. longo, lobis rotundatis vix ultra 1 mm. longis; stamina exserta.—CHIRIQUÍ: Loma Larga to summit, Volcán de Chiriquí, alt. 2500–3380 m., July 4–6, 1938, *R. E. Woodson, Jr., P. H. Allen & R. J. Seibert 1043* (Herb. Field Mus., TYPE;

duplicate in Herb. Missouri Bot. Gard.); Potrero Muleto, Volcán de Chiriquí, July 18, 1938, *M. E. Davidson 1023* (Herb. Field Mus.).

Presumably this is another of the endemics restricted to the slopes of the Volcán de Chiriquí. Among the few species of *Valeriana* known from Central America it has no close relative.

CAMPANULACEAE (LOBELIOIDEAE)[1]
(Rogers McVaugh, Washington)

Lobelia Cardinalis L., subsp. **graminea** (Lamarck) comb. nov. *(L. graminea* Lam., Encyc. **3**: 583. 1791)—CHIRIQUÍ: vicinity of El Valle de Antón, *Allen 1984;* Finca Lérida to Boquete, *Woodson, Allen & Seibert 1096;* PANAMÁ: San Carlos, *Allen 1144;* Río Las Lajas, *Allen 1619;* CANAL ZONE: Miraflores Lake, *Gene White 155.*

The type locality for *Lobelia graminea* is given as "Perou," but there is no known occurrence of any indigenous cardinal flower in South America, and the type, collected by Joseph de Jussieu and now in the Muséum National d'Histoire Naturelle, Paris, exactly matches modern collections from Panama. De Jussieu is known to have left Europe in 1735, accompanying an astronomical expedition which was bound for western South America. He stopped at Martinique and Santo Domingo, then crossed the isthmus of Panama and sailed to Guayaquil (see Lamarck Encyc. **8**: 730. 1808). He spent about 35 years in South America, passing much of the time in Peru. It seems clear that the type of *Lobelia graminea* was actually collected during the trip across Panama in 1735 or 1736 and later attributed erroneously by Lamarck to Peru.

This is the commonest lobelia in Panama, ranging at least as far east as the Canal Zone, and found at various elevations, from sea-level to at least 1550 m. The plant found in Panama comprises a single well-marked variety which ranges throughout Central America to southern Mexico.

Lobelia Cardinalis of Linnaeus is confined to eastern United States and Canada. It may be designated as Lobelia Cardi-

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NALIS subsp. **Cardinalis,** nom. nov. Its western congener, ssp. *graminea,* ranges from Nebraska to California, western Texas and south throughout Mexico and Central America. The western subspecies is extremely variable and may be divided into at least four well-marked geographical varieties, as follows:

A. Plants glabrous or sparsely pubescent, never densely short-pubescent throughout; leaves mostly 8 to 14 times as long as wide, linear to linear-lanceolate or the lower oblanceolate....................................B
  B. Leaves entire or very nearly so, often subcoriaceous, the bases often broad and subauriculate; inflorescence usually ample, scarcely if at all pedunculate..1. var. *graminea*
  B. Leaves finely and evenly to coarsely and irregularly dentate, rarely subentire, not at all coriaceous, the blades plainly narrowed to the base, not at all subauriculate; inflorescence usually short, appearing pedunculate ....2. var. *pseudosplendens*
A. Plants densely pubescent to nearly glabrous; leaves mostly 5 to 8 times as long as wide, lanceolate to oblong or ovate; inflorescence usually ample, often leafy...C
  C. Plants densely short-pubescent throughout (hypanthium sometimes glabrous); leaves mostly obscurely toothed or subentire......3. var. *multiflora*
  C. Plants glabrous or sparsely pubescent; leaves usually plainly toothed.. ....4. var. *phyllostachya*

1. var. **graminea** nom. nov. A word should be inserted as to the system of nomenclature followed here by the writer. Instead of using "typica" or other similar adjectives to designate the original nomenclatorial form of the species, the specific name is used again in the subspecific category. Presumably such a name should be non-transferable, so that if a species were transferred to a new genus, the subspecific adjective would change to correspond with that of the valid specific name of the plant in that genus. In the present case, the name ssp. *graminea,* var. *graminea* indicates that the variety in question is the same as the nomenclatorial type of the subspecies, that is, typical *Lobelia graminea* Lam. The range is from Panama to Chiapas, Hidalgo and Mexico.

2. var. **pseudosplendens,** var. nov.; foliis dentatis, non coriaceis, linearibus lanceolatisve, basi angustatis; spicis brevibus, pedunculatis.—Mexico: chihuahua: 12 miles northeast of Bella Vista, Mun. de Madera, Oct. 9, 1939, *C. H. Muller 3707* (Herb. U. S. Nat. Arb., type). The range is from extreme

western Texas to California, south to Chihuahua and sparingly as far as Oaxaca.

3. var. **multiflora** (Paxt.) comb. nov. (*L. fulgens* var. *multiflora* Paxt., Paxt. Mag. **15**: 7. 1849). The type locality is unknown; the name was based upon plants of horticultural origin. This densely pubescent variety is taken to be identical with *L. fulgens* Willd. The range is from western Texas to British Honduras and Guatemala, chiefly along the eastern Sierra Madre, but very sparingly west to California.

4. var. **phyllostachya** (Engelm.) comb. nov. (*Lobelia phyllostachya* Engelm., in Wisliz. Mem. Tour North. Mex. 108. 1848). —MEXICO: "swamps between Monterey and Cerralbo," May 28, 1847, *Wislizenus 337* (Herb. Missouri Bot. Gard., TYPE). The range is from Nebraska to central and western Texas, west to Sonora and southern Nevada, south (chiefly at low elevations along the eastern coast of Mexico) to Honduras and Tabasco.

LOBELIA LAXIFLORA HBK. var. MOLLIS (Vatke) Zahlbr.—CHIRIQUÍ: valley of the Río Chiriquí Viejo, *Gene White 78;* same, near El Volcán, *Peggy White 236;* Casita Alta, Volcán de Chiriquí, *Woodson, Allen and Seibert 872;* COCLÉ: El Valle, *Allen 1779.*

L. laxiflora, which ranges almost throughout Mexico and Central America, north to southern Arizona and south to Colombia, is an exceedingly variable species. At least four varieties may be recognized, as follows:

A. Leaves linear-lanceolate, averaging 10 times as long as wide; plants glabrous or essentially so, often purplish; pedicels appressed to the stem, at least at base; a plant of the highlands of the Mexican Plateau, from Oaxaca to Baja California and Arizona....................var. ANGUSTIFOLIA A. DC.

A. Leaves broader, usually 3 to 5 times as long as wide; plants glabrous to tomentose, rarely if ever purplish; pedicels various........................B

B. Flower-bracts conspicuously smaller than the foliage-leaves; leaves broad, mostly about 3 times as long as broad; inflorescence often compact, averaging not more than 20 cm. in length; a plant of the west coast of Mexico, from Sonora to Chiapas..var. **Nelsoni** (Fern.), comb. nov. (*Lobelia Nelsoni* Fern., Proc. Amer. Acad. **36**: 503. 1901)

B. Flower-bracts as large as the foliage-leaves or nearly so, and essentially identical with them; leaves averaging 5 times as long as wide but often wider than this; inflorescence various, often long........................C

C. Pedicels lax, loosely spreading from the base; plants glabrous or sparsely pubescent; range from Guatemala and Honduras to Vera Cruz and Puebla............................var. **laxiflora** nom. nov.
(*Lobelia laxiflora* HBK., Nov. Gen. & Sp. **3**: 311 [p. 242 of folio edition]. 1819)

C. Pedicels stiff, closely and prominently appressed to the stem, at least at base; plants (rarely glabrous) slightly to densely pubescent; range from Michoacan and Jalisco throughout Central America to Colombia....var. MOLLIS (Vatke) Zahlbr., Rep. Sp. Nov. **14**:185. 1915
(*Lobelia persicaefolia* var. *mollis* Vatke, Linnaea **38**: 722. 1874)

All collections of this species from Panama seen by the writer are to be referred to var. *mollis*. *Allen 1779* is a glabrous phase of this variety, easily distinguished from var. *laxiflora* by the appressed pedicels and from var. *angustifolia* by the width of the leaves. This phase occurs sparingly throughout Central America.

LOBELIA IRASUENSIS Pl. & Oerst.—CHIRIQUÍ: valley of the upper Río Chiriquí Viejo, *Peggy White 59a;* Loma Larga to summit of Chiriquí, *Woodson, Allen & Seibert 1031.* Also collected on Volcán de Chiriquí by Pittier *(3072)* in 1911. Unknown in Panama except in the neighborhood of Chiriquí, but occurs on several high mountains in Costa Rica.

LOBELIA LONGICAULIS Brandegee *(L. urticifolia* E. Wimm.; *L. neglecta* Vatke, non R. & S.).—CHIRIQUÍ: Finca Lérida to Boquete, *Woodson, Allen & Seibert 1119.* Apparently not previously reported from Panama. Widely distributed from Morelos, Mexico, and Michoacan to Costa Rica.

CENTROPOGON GRANULOSUS Presl *(C. cuspidatus* A.DC., *C. nutans* Pl. & Oerst.)—CHIRIQUÍ: vicinity of "New Switzerland," *Allen 1420;* Casita Alta, Volcán de Chiriquí, *Woodson, Allen & Seibert 844;* El Volcán to Cerro Punta, *Gene White 13;* COCLÉ: El Valle, *Allen 1213.*

This species has not been reported heretofore from North America, all North American material having previously been referred to *C. nutans.* Examination of a large series of herbarium specimens indicates that individuals from Costa Rica and Panama are conspecific with those of a common Andean plant which ranges as far south as central Bolivia. The earliest name applied to this species is apparently *C. granulosus;* Presl's description seems to apply to the species in question, but the writer has been unable to locate the type. Wimmer (Rep. Sp. Nov. **29**: 67. 1931) refers *C. cuspidatus* to *C. granulosus*, and although the writer has not seen the type of the former, it was

Fig. 2. Distribution of *Centropogon granulosus* Presl.

examined in Paris by Dr. H. A. Gleason of the New York Botanical Garden, and his notes and tracings indicate that it represents the species here considered.

Centropogon ferrugineus (L. f.) Gleason, var. **venezuelanus** (E. Wimm.) comb. nov. *(C. affinis var. venezuelanus*

E. Wimm., Rep. Sp. Nov. **19**: 242. 1924)—CHIRIQUÍ: Casita Alta, Volcán de Chiriquí, *Woodson, Allen & Seibert 845.* New to Panama.

Typical *C. ferrugineus,* from the region of Bogotá, is a small-leaved plant with dark-tawny pubescence, the leaves usually not exceeding 2 cm. in width. In var. *venezuelanus* the leaves are typically 2 to 5 cm. wide, and the pubescence is yellow to yellow-brown and never dark-tawny; in other respects the plants appear to be identical with typical *C. ferrugineus.* The distribution of var. *venezuelanus* is from northwestern Ecuador to Panama and western Venezuela. It is not more than varietally distinct from the plant which has been known as *C. costaricanus* Pl. & Oerst., and which differs only by having more abruptly pointed leaves and by the light grey-brown rather than yellowish hairs. The latter may now be known as CENTROPOGON FERRUGINEUS var. **costaricanus** (Pl. & Oerst.) comb. nov. *(C. costaricanus* Pl. & Oerst., Kjoeb. Vidensk. Meddel. 156. 1857; *C. affinis* var. *costaricanus* A. Zahlbr., Ann. K. K. Naturh. Hofmus. Wien **6**: 437. 1891).

CENTROPOGON MACROPHYLLUS (G. Don) E. Wimm., var. **congestus** (Gleason) comb. nov. *(C. congestus* Gleason, Bull. Torr. Bot. Club **52**: 52. 1925; *C. diocleus* E. Wimm., Ann. Mo. Bot. Gard. **24**: 209. 1937)—CHIRIQUÍ: vicinity of "New Switzerland," *Allen 1393;* Bajo Mona, mouth of Quebrada Chiquero, along Río Caldera, *Woodson, Allen & Seibert 1021.*

Centropogon diocleus, previously thought to be endemic in the province of Chiriquí, turns out to be identical with *C. congestus,* which was described from the Department of Caldas, Colombia, and is relatively frequent along the Andes of Colombia at elevations of 1400 to 2200 m. The writer has not seen the type of *C. macrophyllus (Siphocampylus macrophyllus* G. Don), but follows Wimmer's interpretation of this species; the plant of Colombia and Panama here discussed as var. *congestus* differs from typical *C. macrophyllus* of Peru and Bolivia only by a somewhat greater degree of pubescence and by the slightly larger and more irregular teeth of the leaf-blades.

CENTROPOGON **radicans** (O. Ktze.) comb. nov. (*Siphocampylus radicans* O. Ktze., Rev. Gen. Pl. **2**: 381. 1891; *S. roseus* Donn. Sm., Bot. Gaz. **23**: 249. 1897, non *Centropogon roseus* Rusby, Bull. N. Y. Bot. Gard. **8**: 123. 1912; *Centropogon coccineus* auth., non *Siphocampylus coccineus* Hook.)—COCLÉ: El Valle, *Allen 1214*. This is a lowland species of Costa Rica and Panama. Kuntze's type, labelled "Costarica, 1000′," is now in the New York Botanical Garden. The species was referred in the "Flora of Costa Rica" (Field Mus. Publ. Bot. **18**[4]: 1410. 1938) to *C. coccineus*.

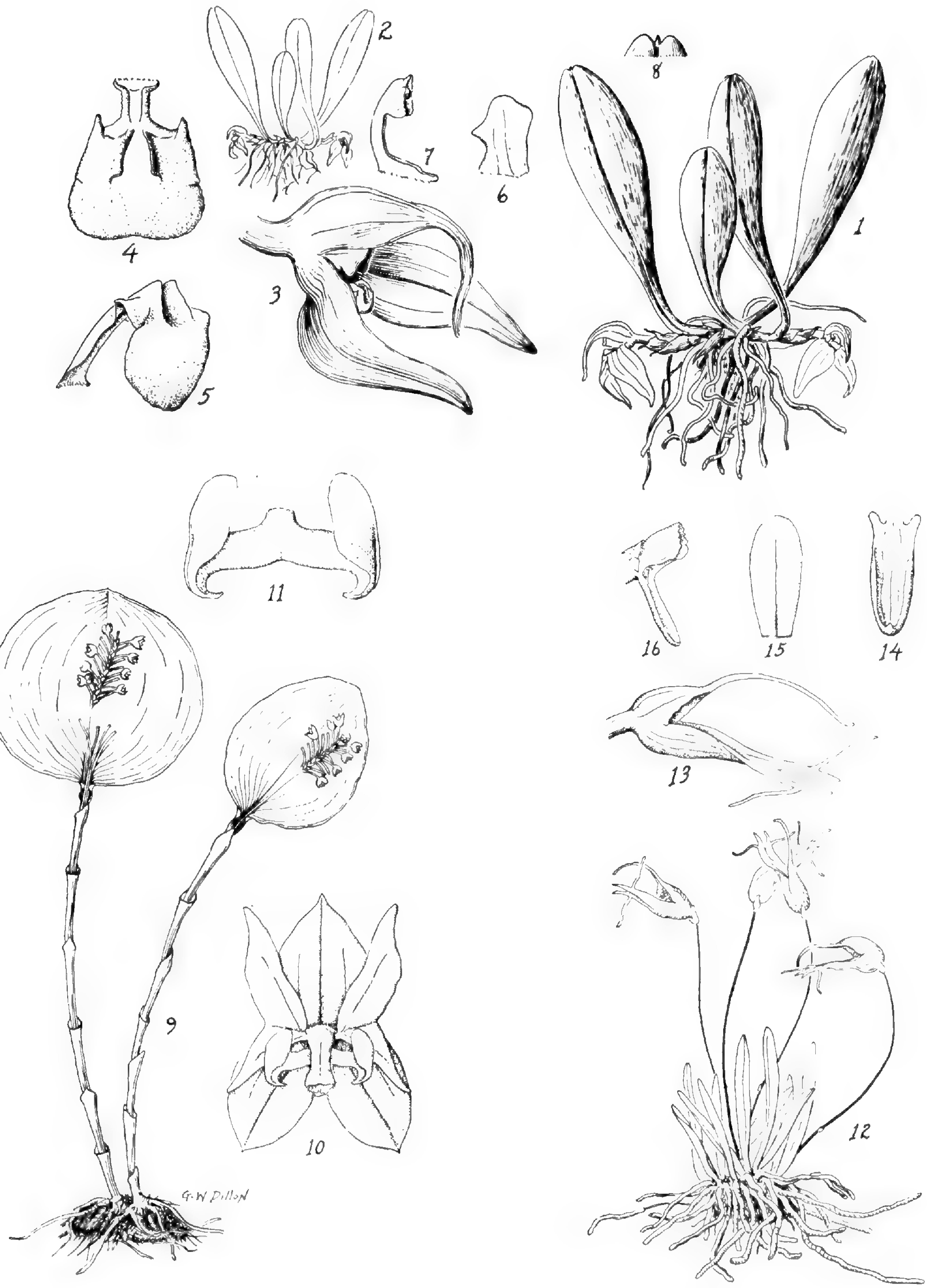
Explanation of Plate

PLATE 31

Figs. 1–8. *Masdevallia simula* Rchb. f.: fig. 1, plant, × 2; fig. 2, plant, × 1; fig. 3, flower, × 5; fig. 4, lip spread out, × 10; fig. 5, lip in natural position, × 10; fig. 6, petal, × 5; fig. 7, column and column-foot, × 5; fig. 8, apex of leaf, × 5.—Drawn from *Allen 2115*.

Figs. 9–11. *Lepanthes rotundifolia:* fig. 9, plant, × 1; fig. 10, flower, × 5; fig. 11, lip, × 10.—Drawn from the type.

Figs. 12–16. *Masdevallia Allenii:* fig. 12, plant, × 1; fig. 13, flower, from the side, × 2; fig. 14, lip, × 5; fig. 15, petals, × 10; fig. 16, column and column-foot, × 10.—Drawn from the type.



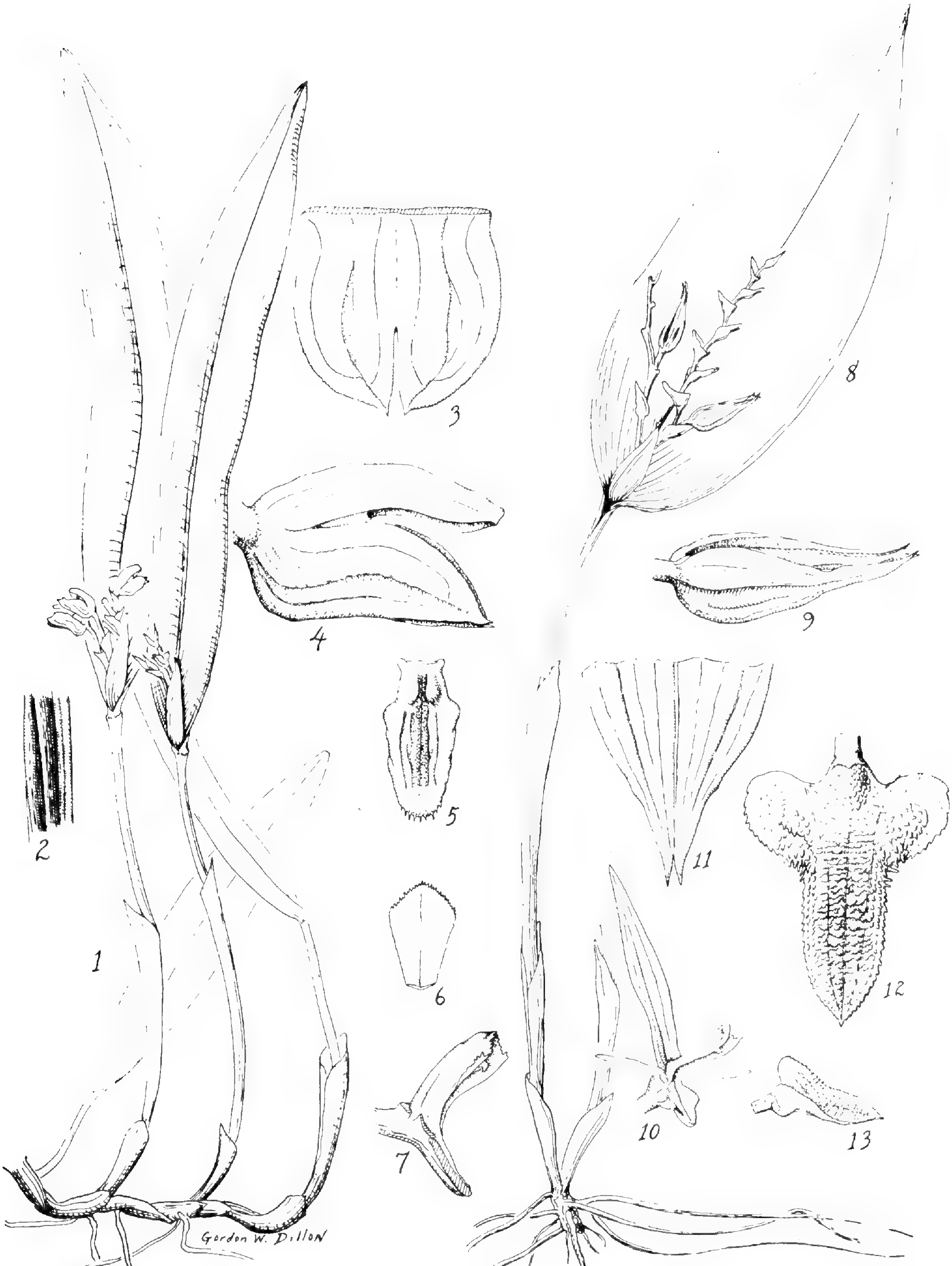
WOODSON AND SCHERY—FLORA OF PANAMA

EXPLANATION OF PLATE

PLATE 32

Figs. 1–7. *Pleurothallis pterocaulis:* fig. 1, plant, × 1; fig. 2, section of stem enlarged to show wings; fig. 3, lateral sepals, × 5; fig. 4, flower from the side, × 5; fig. 5, lip from above, × 5; fig. 6, petal, × 5; fig. 7, column and column-foot, × 5.—Drawn from the type.

Figs. 8–12. *Pleurothallis lepidota:* fig. 8, plant, × 1; fig. 9, flower from the side, × 2; fig. 10, flower to show dorsal sepal, petals, column and column-foot, × 2; fig. 11, lateral sepals, × 2; fig. 12, lip from above, × 5; fig. 13, lip from the side, × 2.—Drawn from the type.



WOODSON AND SCHERY—FLORA OF PANAMA

Explanation of Plate

PLATE 33

Figs. 1–4. *Pleurothallis hispida:* fig. 1, plant, × 1¼; fig. 2, flower from the side, × 3¾; fig. 3, lip from above, × 8¾; fig. 4, petal, × 6¼.—Drawn from the type.

Figs. 5–7. *Pleurothallis Allenii:* fig. 5, plant, × 1¼; fig. 6, flower from the front, × 2½; fig. 7, lip from above, × 10.—Drawn from the type.

Figs. 8–10. *Pleurothallis simulans:* fig. 8, plant, × 1¼; fig. 9, flower from the front, × 2½; fig. 10, lip from above, × 9½.—Drawn from the type.

Figs. 11–15. *Pleurothallis calyptrostele:* fig. 11, plant, × 3⅛; fig. 12, column, column-foot and lip from the side, × 6¼; fig. 13, dorsal sepal, × 6¼; fig. 14, lateral sepals, × 6¼; fig. 15, petal, × 6¼.—Drawn from *Allen 1237*.

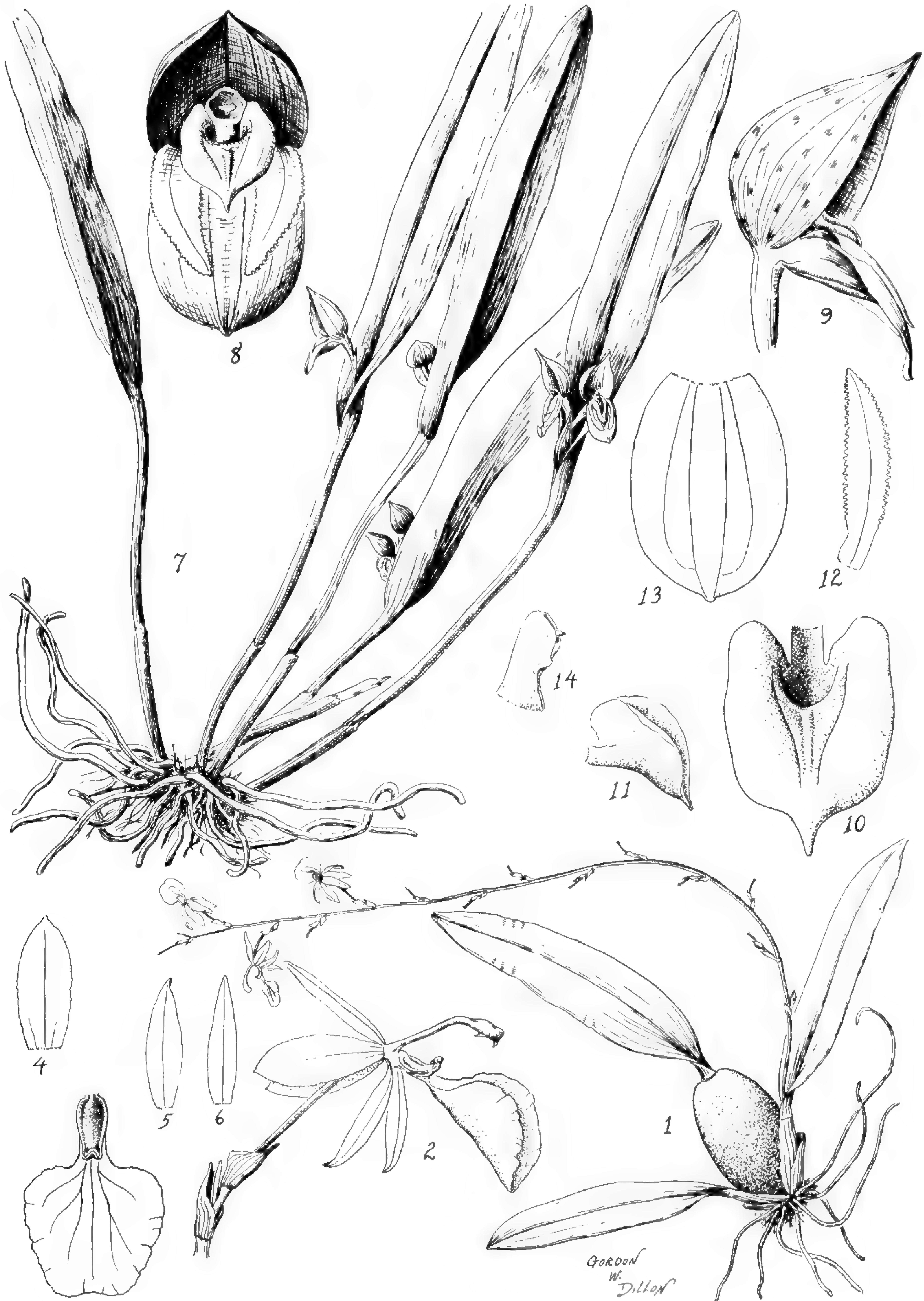
WOODSON AND SCHERY—FLORA OF PANAMA

Explanation of Plate

PLATE 34

Figs. 1–6. *Sigmatostalix abortiva:* fig. 1, plant, ×1⅛; fig. 2, flower from side, × 5½; fig. 3, lip from above, × 5½; fig. 4, petals, × 5½; fig. 5, lateral sepal, × 5½; fig. 6, dorsal sepal, × 5½.—Drawn from the type.

Figs. 7–14. *Pleurothallis cobraeformis:* fig. 7, plant, × 1⅛; fig. 8, flower from the front, natural position, × 4½; fig. 9, flower from the side, natural position, × 4½; fig. 10, lip spread out, × 9; fig. 11, lip from the side, natural position, × 5½; fig. 12, petal, × 4½; fig. 13, lateral sepals, × 4½; fig. 14, column, × 5½.—Drawn from the type.



WOODSON AND SCHERY—FLORA OF PANAMA

Explanation of Plate

PLATE 35

Maxillaria Allenii: fig. 1, plant, × ½; fig. 2, flower from the side, × 3; fig. 3, column and column-foot, × 5; fig. 4, lip, × 5; fig. 5, lateral sepal, × 3; fig. 6, petal, × 3; fig. 7, dorsal sepal, × 3.—Drawn from the type.

WOODSON AND SCHERY—FLORA OF PANAMA

Explanation of Plate

PLATE 36

Sigmatostalix racemifera: fig. 1, plant, × 1; fig. 2, flower opened out, × 5; fig. 3, lip expanded, × 5; fig. 4, lip and column from the side, enlarged; fig. 5, lateral sepals, × 5; fig. 6, dorsal sepal, × 5; fig. 7, petal, × 5.—Drawn from the type.

WOODSON AND SCHERY—FLORA OF PANAMA

AN ATTEMPT TO RECORD INTERNAL TREE-TRUNK PRESSURES

AUGUST P. BEILMANN
Arboriculturist to the Missouri Botanical Garden

The terms "internal pressure," "root pressure," "exudating pressure," have become familiar to plant physiologists. Chase[1] gives an excellent historical review of the literature and no further citations will be made in this paper.

Most, if not all, workers dealing with gas pressures in plants have attempted to measure such forces by employing water- or mercury-filled manometers. Manual readings have been taken at irregular intervals, and very few automatic timing devices have been used or continuous records obtained. The writer recognized the need of a more elaborate investigation of internal pressures when engaged in a study of pruning paints and fungicides. Trunk cavities had been made in a manner acceptable to professional tree surgeons, but instead of being filled with concrete or some other material they had been covered with heavy plate glass cut to the correct size. Less elaborate ones had been made by drilling holes in the tree trunk and inserting the proper-size watch-glass. Without exception the glasses were either broken or were forcibly ejected from their anchorage in the matrix near the bark edge. An examination showed that they were literally "blown out"—usually within twenty-four hours after installation.

It was felt that pressure measurements would furnish the information needed to devise more substantial anchorages and covers more suitable than glass. Water-filled manometers were attached either to the trunk through a bored hole, or directly to the cavity through a vent tube. A record of the internal pressure—back of a glass-front cavity—as shown by a water-filled manometer follows:

[1] Chase, W. W. The composition, quantity, and physiological significance of gases in tree stems. Univ. Minn. Agr. Exp. Sta., Tech. Bull. 99:1-51. 1934.

Sept. 24, 1932	Partly cloudy
5:00 P.M.	17 mm. plus.
Sept. 25	Cloudy
11:00 A.M.	5 mm. minus
Noon	0 mm.
1:00 P.M.	0 mm.
2:00 P.M.	1 mm. plus
Sept. 27	Cloudy—rain at noon
9:30 A.M.	4 mm. minus
10:00 A.M.	20 mm. minus
Sept. 28	Clear
11:00 A.M.	12 mm. plus
Noon	16 mm. plus
3:00 P.M.	18 mm. plus
5:00 P.M.	18 mm. plus
Sept. 29	Clear
10:30 A.M.	12 mm. plus
3:30 P.M.	13 mm. plus
5:00 P.M.	13 mm. plus
Sept. 30	Dull—some sun
Noon	12 mm. plus
1:00 P.M.	11 mm. plus
4:30 P.M.	9 mm. plus
Oct. 1	Clear
11:30 A.M.	14 mm. plus
Oct. 3	Clear
11:30 A.M.	11 mm. plus
2:00 P.M.	13 mm. plus
5:00 P.M.	13 mm. plus

The above record simply shows that on cool cloudy days no positive pressures are set up; on the contrary, minus pressures are obtained. On bright sunny days readings are as high as 18 mm. and on partly dull days the pressures are proportionally lower. The record also shows that manual readings, if not carefully taken at hourly intervals during the day and night, will not indicate the trend or rhythm of the phenomenon should they occur. Realizing the need for a continuous automatic record of internal pressure, the writer began to design and construct an instrument for the purpose. A water-filled manometer was fitted into a special case in which a self-recording thermograph had been installed. One arm of the manometer was connected to a bore hole in a tree by a length of rubber hose. The open arm supported a float resting on the water column which actuated a counterbalanced pen arm. The record of the internal pressure, along with the air temperature, was inscribed by the pen directly on the thermograph drum. When attaching the instrument to a sound tree trunk, a taper-threaded brass nipple was turned into a drilled hole 13 mm. in diameter and about 140 mm. deep and usually within two meters of the ground line. If such a hole is drilled radially toward the center of the trunk, some parts of the sapwood will be sealed off by the nipple. In actual practice it is very difficult to determine exactly what layers have been tapped. In the course of several years some hundred or more manometers have been attached to trees—some in sapwood, some in heartwood and many tapped portions of each—and none have shown a characteristic difference.

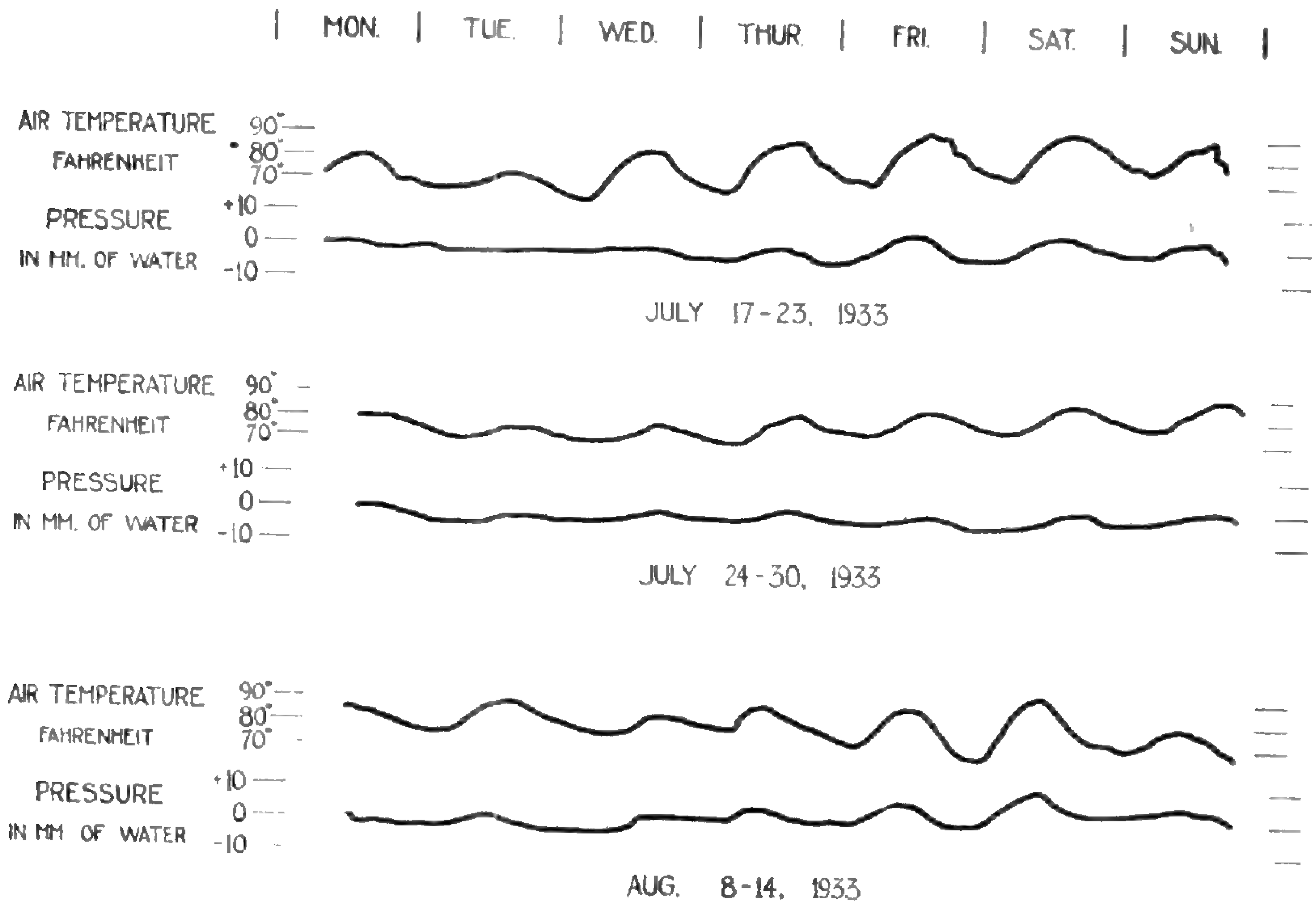


Fig. 1. Record of of internal pressure of *Quercus macrocarpa* for three typical weeks.

The graph (fig. 1) is from the record of three typical weeks, made while the instrument was attached to a Bur Oak (*Quercus macrocarpa*. Michx.). The threaded brass nipple connecting the instrument to the tree tapped both the sapwood and heartwood about one meter above the ground line. The instrument was in operation in this position for seventy weeks. The internal pressure is shown to be influenced only by changes in the volume of the confined air in the manometer and rubber tube connected with the bore hole in the tree trunk. Every fluctuation of the thermograph is duplicated by that of the internal pressure pen. For most of the year, these two records traced on the one chart appear to have been made by two pens permanently linked together. The instrument was at all times protected from the sun by a small shed built around the trunk of the tree, and only the rubber tube projected from a dust-proof metal case. The instrument was not, however, compensated for temperature changes and is therefore subject to the same criticism as any other work in which manometers were used in a similar manner.

After seventy weeks the instrument was disconnected from the trees and "connected" to a mass of ordinary glazing putty. The brass nipple was simply imbedded in the mass of putty and the charts obtained could not be distinguished from those which were produced while attached to the tree. If the tree trunks had ever been under pressures different from those outside the tree, the lag in the establishment of equilibrium between a rising or falling barometric pressure and the pressure within the tree should have been recorded. The records show no lag for any season of the year. During stormy periods, barometric pressures may fluctuate one-half inch or more very quickly, yet there is no evidence that trees are under stress even during that time.

Since trees are apparently never under pressure it was believed that if the barometric conditions of stormy periods could be simulated, perhaps the "lag" in the re-establishment of equilibrium could be measured. It would be nearly impossible to place a mature tree in a chamber capable of pressure or vacuum, but it might be possible to place a tree trunk under pressure by pumping through a bore hole, or partially evacuating the trunk, regardless of atmospheric conditions. A rapidly falling barometer should leave a tree trunk under pressure; while a rising barometer should compress the gas within the bole.

A portable vacuum-pressure unit was constructed which could be used in the field on mature trees. As a compressor the pump was capable of maintaining a pressure of forty pounds per square inch and could handle approximately three cubic feet of air per minute as a vacuum pump. The power source at first was a one-half horse-power air-cooled gasoline engine; later a six volt one-half H.P. electric motor driven by a storage battery. The suction line from the pump passed through two graduated gallon bottles; the second bottle was filled with water which passed over into the bottle nearest the pump. This served as a visual check on the pump performance and permitted a volumetric calculation of the air withdrawn from the tree trunk. In the field the unit was coupled to the tree through the same brass nipple used on the internal-pressure instrument, and water- or mercury-filled manometers were attached in the same manner.

Usually a manometer was placed about one meter below the point of evacuation and from four to six more were placed above this at intervals of one meter. When the pump was started and evacuation begun—at some point near the ground—the effect was almost immediately transmitted to the uppermost manometers. Mercury manometers of sufficient length to record the negative pressures obtained at various levels were not used because of the difficulty of installation and the care needed to avoid breakage. It was found, for instance, that the entire experiment had to be set up in a very short time—usually less than four hours—that bore holes became plugged if made too far in advance. Rarely, for the same reason, could the experiment be duplicated. Very short water-filled manometers were used and the air bubbles carried over furnished evidence of negative pressures within the tree trunk. Accurate timing in starting the pump and careful reading of the pressures became physically impossible—so rapid is the re-establishment of atmospheric pressure within a tree. For instance, after continued evacuation, about ninety seconds were required for the lowest manometer to show zero pressure in a Spanish Oak (*Quercus rubra* L.) seven meters high.

SUMMARY

The need of a better instrument for recording internal pressures was recognized. An automatic instrument of the "dash-pot" type was constructed.

The records obtained, either from back of glass-fronted cavities or from bore holes in sound tree trunks, showed clearly that so-called "internal pressures" were due to temperature changes within the instrument.

When a mass of putty replaced the tree trunk identical records were obtained.

Internal pressures—if they exist—cannot be recorded with either manometers or the instrument described. The fluctuating barometric pressures of stormy periods were simulated by applying pressure or suction forces to a tree trunk. With the equipment in use, it was found that suction forces were more easily obtained. Positive pressures are more difficult to observe.

Equilibrium, following evacuation, is so quickly re-established that accurate measurements could not be taken.

It became physically impossible to read manometers placed one meter apart from top to bottom of a mature tree.

The "lag" in the establishment of equilibrium is shown to be about ninety seconds for a certain Spanish Oak.

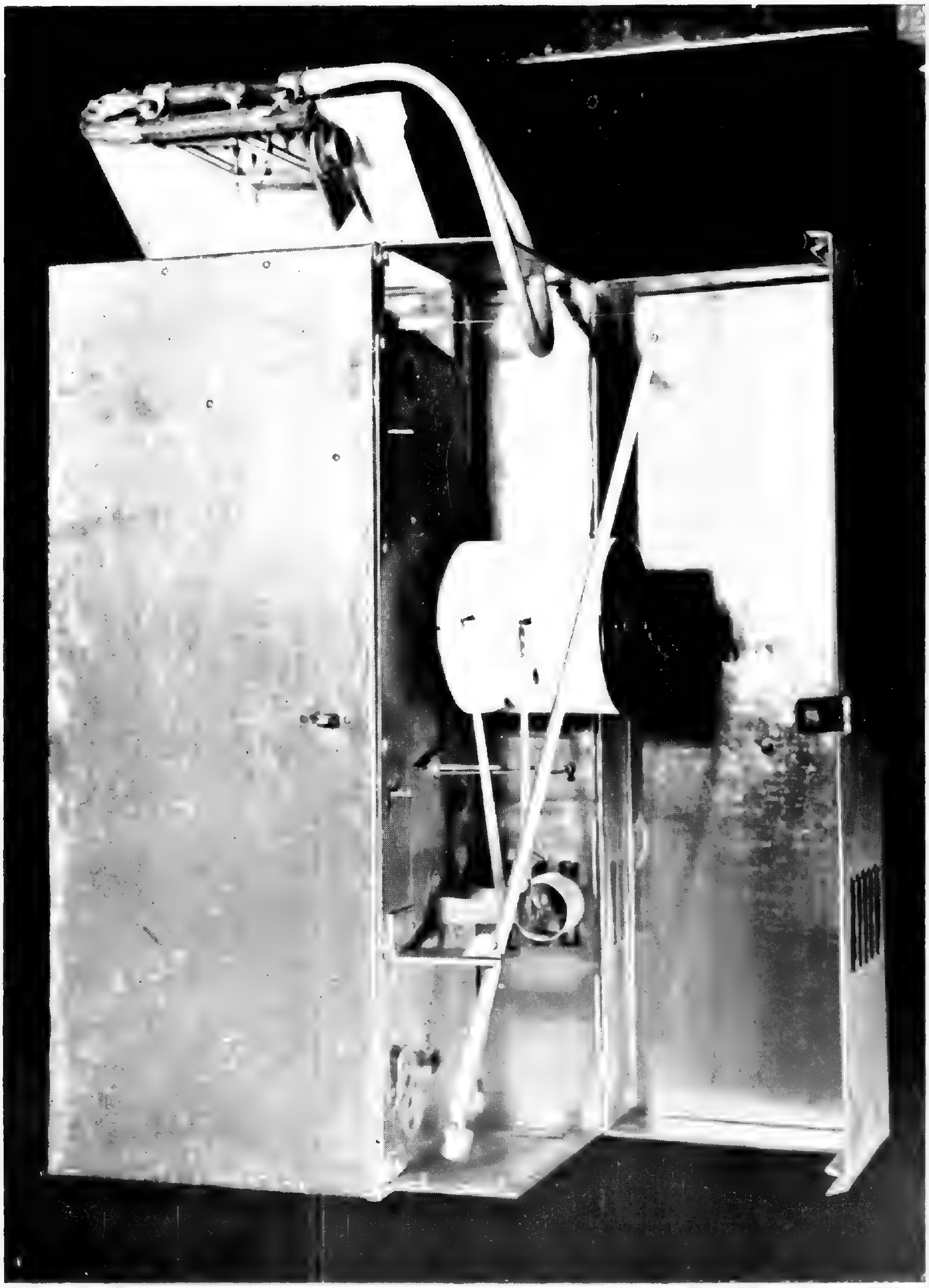
From these experiments it appears that "internal pressure" differing from atmospheric pressure does not occur in normal sound trees.

Explanation of Plate

PLATE 37

Instrument for recording internal tree-trunk pressures. See explanation in text.

BEILMANN—INTERNAL TREE-TRUNK PRESSURES



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A MONOGRAPH OF THE GENUS CALOCHORTUS[1]

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The recent development of new techniques for the study of the biological entities which we term genera and species has created a renewed interest in taxonomy as a basic plant science. Modern taxonomy no longer concerns itself primarily with merely cataloguing, with appropriate binomials and brief diagnoses, the variants which do not fit into the pre-existing "pigeon holes," but is making a sincere attempt to understand the factors which make themselves evident through variation and speciation.

The development of the monographic method of plant taxonomy is largely responsible for this change of attitude. The plant kingdom, as a whole, is so inconceivably vast, that it is only by the comparative study of a limited group of related entities that we are able to secure any understanding of the laws which must govern the entire assemblage of groups. It was with this fact in mind that the genus *Calochortus* was selected as the subject of the present study.

This genus is admirably suited to such an investigation. In

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Issued December 10, 1940.

the first place, it is a moderately small group, with a greatly restricted distribution, thus lending itself to field study. Its fifty-seven known species are found only in western North America, from southern British Columbia to Guatemala, eastward to western Nebraska and the Dakotas. Throughout this region it is quite common, often abundant, so that herbarium material of most of the species is available in quantity for comparative studies. The individual species are also often greatly restricted in distribution, sometimes occurring only locally, with the result that their areas of distribution furnish critical evidence as to their probable phylogenetic relationships. Another important consideration is the comparative ease with which the facts from cytogenetics may be made available for correlation with those from morphology and distribution. Furthermore, the genus may be successfully cultivated, and observations from the field and herbarium confirmed in the garden. Lastly, certain of the species are exceedingly variable, notoriously difficult, and have been poorly understood. This fact alone would justify the present investigation.

History

The genus *Calochortus* was proposed by Pursh[2] in 1814 to accommodate a single species, *C. elegans,* secured by Lewis and Clark "on the headwaters of the Kooskoosky," in what is now the state of Idaho. In the original publication, Pursh refers to an account of the genus in volume eleven of the 'Transactions of the Linnean Society of London,' which account appears never to have been published.

Two years later, Humboldt, Bonpland and Kunth[3] described two additional species which are now included in this genus, basing their descriptions on specimens collected in Mexico by Humboldt and Bonpland. These were placed in the genus *Fritillaria,* under the names, *F. purpurea* and *F. barbata.* The latter was questionably referred here, and in 1828, Don[4] segregated it under the generic name, *Cyclobothra.*

[2] Pursh, Fl. Am. Sept. 1: 240. 1814.

[3] Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. Pl. 1: 288. 1816.

[4] [D. Don in] Sweet, Brit. Fl. Gard. 3: *t. 273.* 1828.

During his explorations in the region of the Columbia River, Douglas rediscovered *C. elegans,* and found three additional species of the genus. Two of these, *C. macrocarpus* and *C. nitidus,* he named, described and illustrated in 1828, while the third, of which he had been unable to preserve material, he described briefly, but did not name.[5]

The following year, Schultes,[6] in a scholarly treatise, delimited the genus as it is at present understood, transferring to it *Fritillaria barbata* and *F. purpurea,* but changing their names, as was the custom at the time, to *Calochortus flavus* and *C. Bonplandianus,* respectively. At the same time, he recognized all of the previously described species, and proposed the name *C. Douglasianus* for the unnamed species which Douglas had described. He also proposed two new species from Mexico, *C. pallidus* and *C. fuscus.* In 1830, this treatment was published again in slightly emended form.[7]

On his second expedition to western North America, Douglas collected a number of additional species, which he sent to the Horticultural Society of London under the manuscript names, *C. luteus, C. splendens, C. venustus, C. pulchellus* and *C. albus.* The first of these was published by Lindley[8] in 1833, thus antedating by a year Nuttall's[9] use of the same name for another species. The remainder were published by Bentham[10] in 1834. In his paper, however, Bentham made the error of referring the latter two species to the newly established genus *Cyclobothra,* in which he also included *Calochortus elegans,* the type species of the earlier genus. Later in the same year, Lindley[11] continued Bentham's misinterpretation by transferring all of the *Calochorti* with nodding flowers to *Cyclobothra,* and added two new species, *C. paniculata* and *C. lutea.* In 1843, Kunth[12] maintained both genera, recognizing five species of *Calochortus* and twelve of *Cyclobothra.*

[5] Douglas in Trans. Hort. Soc. Lond. **7**: 275–280, *pls. 8–9.* 1828.
[6] Schultes f. in Van Hall, Vrolik & Mulder, Bijdr. Nat. Wet. **4**: 123–134. 1829.
[7] Schultes & Schultes, Syst. Veg. **7**: 1530–1536. 1830.
[8] Lindley in Bot. Reg. **19**: *t. 1567.* 1833.
[9] Nuttall in Journ. Acad. Philad. **7**: 53. 1834.
[10] Bentham in Trans. Hort. Soc. Lond. Ser. II. **1**: 411–413, *pls. 14–15.* 1834.
[11] Lindley in Bot. Reg. **20**: under *t. 1661–1663.* 1834.
[12] Kunth, Enum. Pl. **4**: 227–233. 1843.

The thirty years following the publication of Kunth's compilation added very little to our knowledge of *Calochortus*. A few new species were described, and some old ones given new names. In America, particularly, there was extreme confusion, and the literature offers little but misdeterminations. The most pretentious contribution of the period is that of Wood,[13] in which the name *Calochortus* is revived in its original sense, and twelve species of the Pacific Coast are recognized.

The first significant attempt at a long-needed revision of *Calochortus* is that of Baker[14] in 1874. Here the genus is divided into four subgenera, including a total of twenty-one species and several varieties. Baker was handicapped by a lack of material, but his revision was carefully done, and, with few exceptions, the species which he accepted stand to-day as he delimited them.

Five years later, 1879, another important contribution, that of Watson,[15] appeared. With more copious material, though still meagre as compared to that available to-day, Watson was able to correct many of Baker's errors. He divided the genus into three sections, and maintained a total of thirty-two species. This is the last attempt to treat *Calochortus* as a whole before the present one. A year later, 1880, Watson[16] again published his treatment, with the Mexican species excluded.

The period between 1880 and 1900 was characterized by intensive botanical exploration in the West and the discovery of a number of new species of *Calochortus*. In 1901, Purdy[17] presented a revision of the genus, based primarily on his own extensive experience with it, both in the field and in his garden. This treatment is remarkable in that its author had a more detailed knowledge of many of the species than any previous or subsequent writer. The taxonomy, however, is essentially that of Watson in his 'Botany of California,' brought up to date. Purdy recognized a total of forty species, exclusive of those of Mexico, most of which are accepted in the present treatment.

[13] Wood in Proc. Acad. Philad. [**20**]: 167–169. 1868.

[14] Baker in Journ. Linn. Soc. Lond. Bot. **14**: 302–310. 1874.

[15] Watson in Proc. Am. Acad. **14**: 262–268. 1879.

[16] Watson, Bot. Calif. **2**: 171–177. 1880.

[17] Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 107–158, *pls. 15–19.* 1901.

In 1911, Painter[18] published a revision of the section CYCLOBOTHRA, including therein ten Mexican species, but omitting the closely related Californian ones.

At least two more recent treatments are of importance in that they include a considerable portion of the known species. The first of these is that of Jepson,[19] in which he accepts twenty-four species in California, and the second is that of Abrams,[20] which includes forty-one species for the three Pacific Coast states.

In the present monograph, the genus is divided into three sections and twelve subsections, and a total of fifty-seven species and thirteen varieties recognized. The sectional and subsectional alliances in the genus *Calochortus*, in the order in which they are treated are as follows:

Section I. EUCALOCHORTUS	Subsection 1.	PULCHELLI
	Subsection 2.	ELEGANTI
	Subsection 3.	NUDI
	Subsection 4.	NITIDI
Section II. MARIPOSA	Subsection 5.	VENUSTI
	Subsection 6.	MACROCARPI
	Subsection 7.	NUTTALLIANI
	Subsection 8.	GUNNISONIANI
Section III. CYCLOBOTHRA	Subsection 9.	WEEDIANI
	Subsection 10.	GHIESBREGHTIANI
	Subsection 11.	BARBATI
	Subsection 12.	PURPUREI

MORPHOLOGY

The species of *Calochortus* are all more or less succulent herbs from perennial, tunicated bulbs. The genus, as a whole, presents much diversity in morphology, and the species, for the most part, are easily recognized. Some few, however, are extremely variable and difficult to delimit. The following characters have been found to be of taxonomic value:

Bulbs.—In shape, the bulbs of *Calochortus* are more or less

[18] Painter in Contrib. U. S. Nat. Herb. **13**: 343–350. 1911.

[19] Jepson, Fl. Calif. **1**: 291–302, *figs. 51–57.* 1921; Man. Fl. Pl. Calif. pp. 230–239. 1923.

[20] Abrams, Illust. Fl. Pac. States **1**: 431–446. 1923.

ovoid. Those of the sections Eucalochortus and Mariposa are membranaceous-coated, while those of Cyclobothra have fibrous-reticulate coats.

Stems.—The stems are either scapiform or leafy, and not infrequently branched. They are always glabrous and often glaucous.

Leaves.—The leaves are usually broadly to narrowly linear, attenuate and usually glabrous or glaucous. There is a single basal leaf, which in the sections Eucalochortus and Cyclobothra is often conspicuous and usually present at anthesis. In Mariposa, on the other hand, it is less conspicuous and is rarely persistent until flowering time. Due to the short lower internodes, some species of this section may appear to have several basal leaves. The cauline leaves, when present, are alternate and successively reduced upward. They are variable in outline, from linear to lanceolate, and acute to attenuate.

Bulblets.—Many of the species of the section Mariposa and two of those of Eucalochortus normally bear solitary bulblets in the axils of the lowermost cauline leaves or leaf, at or below the surface of the ground. In the section Cyclobothra the bulblets, if present, are not solitary, and are borne in the axils of the upper leaves and bracts.

Inflorescence.—The inflorescence of *Calochortus* is a more or less reduced monochasium. Certain species, for instance *C. catalinae* and its near allies, have a well-developed monochasium, but in most of the species of the section Mariposa, and all those of Eucalochortus and Cyclobothra, the internodes do not elongate, and the inflorescence appears subumbellate. This character should be of phylogenetic importance, but its fullest significance does not seem clear.

Bracts.—The bracts usually equal in number, and in all cases are opposite, the flowering pedicels which they subtend. In those species with subumbellate inflorescences, that which appears to be the lowermost bract is morphologically the uppermost cauline leaf.

Flowers.—In shape, the flowers of *Calochortus* vary from narrowly campanulate or subglobose to broadly campanulate. They are erect, spreading or nodding. In color, they are exceedingly varied, from white to yellow, red, purple, bluish, and reddish or purplish brown, often with the petals and sepals marked with contrasting colors. The perianth consists of two series of three segments each. The outermost series, being sepaloid, are, for convenience, referred to as "sepals," while the innermost, which are petaloid, are hereafter called "petals." In aestivation, the sepals are ultimately valvate and the petals convolute.

Sepals.—The sepals, in most cases, are lanceolate, obtuse to attenuate, and glabrous or rarely sparsely bearded on the inner face. In some species, there is a glandular spot near the base, similar to the gland on the petals.

Petals.—The petals are usually narrowly to broadly obovate, cuneate or clawed, and obtuse or acute. In many species in the sections EUCALOCHORTUS and CYCLOBOTHRA, they are conspicuously bearded. In MARIPOSA, however, in the subsections NUDI and NITIDI of EUCALOCHORTUS, and in the subsections GHIESBREGHTIANI and PURPUREI of CYCLOBOTHRA, they are essentially naked, except in the vicinity of the gland.

Gland.—Near the base of each petal in nearly all species of *Calochortus,* there is a unique structure known in taxonomic literature as the "gland" or "foveola." It does not seem to be always glandular, and is even less frequently foveolate, but in the absence of a better term, it is uniformly called the "gland" throughout the present treatment. The gland presents the most critical characters for the differentiation of species, and many entities can be recognized by a single petal.

Stamens.—The stamens are six in number, in two cycles of three. The filaments are more or less subulate, dilated at the base, and slightly adnate to the perianth segments. The anthers are cylindrical, oblong to linear, obtuse to long-apiculate, and prolonged as a tubular sheath below the insertion of the filaments.

Pistil.—The pistil is tricarpellary and trilocular. The ovary is oblong to linear, more or less triangular to 3-winged, abruptly contracted or tapering to a persistent, trifid stigma. A definite style is usually not evident. The ovules are numerous, in two rows in each loculus, and completely anatropous.

Fruit.—The fruit of *Calochortus* is an erect to nodding capsule, which is at first septicidally, but later often also loculicidally, dehiscent. In the section Eucalochortus and in *C. catalinae* of the section Mariposa, it is narrowly to broadly 3-winged, and from suborbicular to oblong in outline. In all other species it is at most 3-angled, and linear or nearly so.

Seeds.—The seeds are either irregular or flattened, and are usually minutely hexagonally reticulate.

Cytology

The present cytological knowledge of the genus *Calochortus* is not extensive, but is very valuable in the interpretation of morphological and geographical evidence in that it gives an indication as to the nature of the internal factors which have brought about speciation. In 1926, Newton[21] reported briefly on the number and morphology of the chromosomes in ten species, and in 1939, Beal[22] confirmed most of Newton's work, and added details for eighteen additional species. During the course of the present investigation, the writer has studied cytological material of most of the *Calochorti* indigenous to the United States. In so far as this project is not complete, however, it is proposed to defer the presentation of additional data to a subsequent paper. It should be stated, nevertheless, that all new data are in accord with the classification here outlined, and with the findings of Newton and Beal which are summarized in the following table, where the reported haploid and diploid chromosome numbers follow the name of the species as given in the present treatment.

Section I. Eucalochortus

Subsection 1. PULCHELLI	n	2n
C. amoenus	10	20
C. albus	10	20
C. amabilis	10	20

[21] Newton, W. C. F. Chromosome studies in *Tulipa* and some related genera. Journ. Linn. Soc. Lond. Bot. **47**: 339–354. 1926.

[22] Beal, J. M. Cytological studies in relation to the classification of the genus *Calochortus*. Bot. Gaz. **100**: 528–547. 1939.

Subsection 2. ELEGANTI		
C. monophyllus (Benthami)	10	20
C. Tolmiei (incl. *Maweanus)*	10	20
C. elegans	—	20
C. elegans var. *selwayensis*	—	20
C. apiculatus	10	20
Subsection 3. NUDI		
C. uniflorus	20	40
C. nudus	—	20
Subsection 4. NITIDI		
C. Douglasianus (pavonaceus)	20	40
C. nitidus	—	20
C. persistens (C. Greenei Hort., not Watson)	—	20
C. Howellii	10	20
C. Lyallii	10	20
Section II. MARIPOSA		
Subsection 5. VENUSTI		
C. catalinae	7	14
C. splendens	7	14
C. venustus	7	14, 21
C. superbus	6, 7	12, 14
C. luteus	7, 10	14, 20, 21
C. Vestae	14	28
C. Leichtlinii	—	14
Subsection 6. MACROCARPI		
C. macrocarpus	—	14
Subsection 7. NUTTALLIANI		
C. clavatus	—	16
C. Kennedyi	—	16
C. Nuttallii	—	16
C. Nuttallii var. *aureus*	—	32
Subsection 8. GUNNISONIANI		
C. Gunnisoni	—	18
Section III. CYCLOBOTHRA		
Subsection 9. WEEDIANI		
C. Plummerae	9	18

From the above table, the following facts are evident: (1) The basic chromosome number in the section EUCALOCHORTUS is ten, with two known cases of tetraploidy. (2) In the section MARIPOSA, the basic number may be six, seven, eight or nine. In the subsection VENUSTI it is usually seven, with one count of six, and two instances of triploidy and one of tetraploidy. In the subsection MACROCARPI, it is seven; in the NUTTALLIANI, eight, with one tetraploid variety; and in the GUNNISONIANI, nine. (3) In the section CYCLOBOTHRA, the basic chromosome number of the single species investigated is nine.

DISTRIBUTION

The genus *Calochortus* is restricted in its geographical distribution to western North America, from southern British Columbia, southward to Guatemala, and eastward to western Nebraska and the Dakotas. Throughout this vast region, there is rarely an area of any considerable size without one or more indigenous species. The greatest specific concentration occurs in the state of California, within the boundaries of which over one-half of the species are found.

For the most part, the species are definitely xerophytic, preferring dry, rocky slopes or desert hills as a habitat. Some, however, are more mesophytic, and a few grow in meadows which are wet for at least a part of the year. These and other ecological requirements of the various entities have apparently greatly limited them in their ability to adapt themselves to different situations. As a result, their distributional areas are usually limited, sometimes local, in extent, so that they offer valuable evidence as to probable phylogenetic relationships.

Although it is very likely that the present-day species have evolved within the areas which they now occupy, or in closely adjacent areas which are no longer suited to their requirements, an examination of the geographical aspects of the sectional and subsectional groups is both interesting and instructive. The section EUCALOCHORTUS, for instance, is widely distributed in the mountainous regions of the Northwest, from the Rocky Mountains of western Montana and Alberta, across southern British Columbia to the Cascade Range, and southward to southern California. The center of diversity is in northern California and adjacent Oregon, apparently coincident with the ancient Klamath land area. From here the lines of morphological and geographical affinity can be traced, first, northward along the Cascade Axis and inner foothills of the Oregon Coast Range, second, northeastward across the Columbian Plateau to the northern Rocky Mountains, and third, southward along the Sierra Nevada and Coast Ranges of California. Specific representatives of three subsections of EUCALOCHORTUS are to be found within this Klamath area, while the fourth, the PULCHELLI, are found only to the south of it. From this center, the ELEGANTI are distributed in all directions, the NITIDI to the east and northeast, and the NUDI principally to the south.

The center of diversity of the section MARIPOSA is not so well defined as that of EUCALOCHORTUS, but seems to be located somewhere in the mountains or deserts of southern California, perhaps in the San Gabriel Mountains. From here the lines of affinity can be traced northward along the Coast Ranges and Sierra Nevada, southward in the mountains along the coast, and eastward or northeastward across the deserts to the Rocky Mountains and the northern Great Plains. The subsection VENUSTI is almost entirely confined to California, whereas the subsection NUTTALLIANI is widespread from southern California eastward to the Rocky Mountains, and northeastward to the Dakotas. Of the two species of the subsection GUNNISONIANI, one is found in the desert regions of New Mexico and Arizona, while the other occurs in the Rocky Mountains from New Mexico northward to Montana. The single species assigned to the subsection MACROCARPI has a Columbian Plateau distribution similar to the subsection NITIDI of the section EUCALOCHORTUS.

With the exception of the subsection WEEDIANI, the exact distributional areas of the various entities of the section CYCLOBOTHRA are too poorly known for comparison with those of the other sections. The subsection WEEDIANI is closely limited to its center of diversity, which is essentially similar to that of the section MARIPOSA. The remaining three subsections of the section CYCLOBOTHRA are distributed entirely to the south of any other representatives of the genus. Their center of diversity seems to be on the southern part of the Mexican Plateau, whence they appear to have dispersed, both to the north and to the south.

The geographical evidence presented above strongly supports that from morphology and cytology, and indicates that the three sections herein recognized are natural groups of long standing.

Generic Relationship

Calochortus, as a genus, differs considerably in its morphology and cytology from all other genera in the subfamily Lilioideae and tribe Tulipeae of the family Liliaceae, in which it has been placed by most recent authors. From these it may be distinguished by its sepaloid outer perianth segments, short or obsolete style, septicidal capsule, and its varying chromosome base number, which is never twelve, the usual number of all other genera of this alliance. Although these differences are significant, they do not seem to justify segregating *Calochortus* as a monotypic family, the Calochortaceae, as has been done by some recent American botanists. In general appearance, some species are not unlike certain representatives of the genus *Fritillaria,* but the relationship of the genus as a whole, although remote, is probably rather with the genus *Tulipa.*

Specific Concept[23]

In the present treatment, every effort has been made to delimit the species as morphologically different natural populations. It is the contention of the author that such entities, although at times perplexingly variable, are the only satisfactory basis for the application of taxonomic names. Natural populations are defined by barriers, either external or internal, which, when once established, allow divergent evolution in the two or more groups so separated, and effectively prevent genetic intermingling between them. All factors which prevent genetically compatible populations from interbreeding are included as external barriers. These may be geographical where the areas of distribution of the entities are not continuous, ecological where the entities occupy different habitats within the

[23] See also Clausen, Jens, David D. Keck and William M. Hiesey. The concept of species based on experiment. Am. Journ. Bot. **26**: 103–106. 1939, and the references there cited.

same area, or seasonal where the entities grow together, but flower at different seasons of the year. As internal barriers are included those changes in the germ-plasm which in themselves cause incompatibility. Such cytological phenomena as polyploidy, inversions and translocations fall into the second class.

Where the barrier is weak, or has been broken down, more or less hybridization may occur. These cases present special difficulties, but in *Calochortus,* fortunately, they are rare. If the hybrid is partially or completely sterile, or the area of hybridization limited, particularly if both parent entities occur outside of this area in pure or nearly pure condition, it seems best to recognize both as of specific rank (cf. *C. nudus* and *C. minimus; C. luteus* and *C. superbus.* If, on the other hand, hybridization has completely submerged either or both parents, so that its or their existence becomes more or less hypothetical, then the population is probably better considered as a single, variable entity. *C. venustus* is a possible example in *Calochortus.*

Another factor which has given rise to variable species is incomplete isolation, which allows local or regional populations to diverge, but prevents their complete separation by allowing occasional genetic intermingling. This is a frequent phenomenon in *Calochortus.* Such species as *C. Nuttallii, C. Tolmiei, C. barbatus, C. purpureus, C. albus,* and many others are broken up into numerous local or regional facies. In many genera such variants have been given taxonomic rank as subspecies, but in *Calochortus* they are so frequent and so poorly defined that recognition, even in subspecific rank, would lead to confusion. In some instances, however, it has seemed necessary to designate outstanding variants of either this or other categories. In these cases, the noncommittal status "variety" has been employed.

Phylogeny

The evidence from the standpoints of morphology, geographical distribution and cytology, presented in the present paper, seems to justify the following conclusions as to the phylogeny of the genus *Calochortus*.

1. The genus is one of long standing. This point is supported by the lack of close generic relatives, its great morphological and cytological variation and its well-marked sections, subsections and species, each with a characteristic geographical range.

2. The evolutionary pattern has been essentially dendroid. Reticulate relationships between the species are apparently of recent origin, and have not affected the evolutionary pattern as a whole. There is no evidence for linear or orthogenetic development.

3. Speciation has been brought about by the combined action of competition and natural selection on independently varying natural populations, limited by internal or external barriers. In this way, evolution has been able to proceed in different directions within two closely related populations.

4. Primitive and advanced characters occur at random throughout the genus, and are of little value in the determination of the relative position of a given entity. For this reason, the sequence of sections, subsections, and species in the following treatment is admittedly artifical. Every effort, however, has been made to group related entities together.

Economic Importance

The bulbs of *Calochortus* are edible, and were used as food by the American Indians. They are crisp and starchy, and taste not unlike an ordinary potato tuber. Most of the species have been cultivated as ornamental garden plants, but have never been very popular in this country, due, no doubt, to the fact that they soon die out if not properly cared for, especially during the summer months.

Acknowledgments

The writer takes this opportunity to acknowledge and express his appreciation for the efforts of those who have made possible this investigation or have assisted in its completion.

He is indebted to Dr. George T. Moore for the necessary library, herbarium and horticultural facilities; to Dr. J. M. Greenman, under whose direction the investigation was carried on, for his interest and helpful advice; to Dr. Edgar Anderson for useful suggestions as to cytology and genetics; and to Dr. J. M. Beal for a copy of the results of his cytological investigations, long before they were published. The writer is also deeply indebted to the curators of the several herbaria, who have generously loaned the material in their charge, and to his many friends and correspondents who have sent either living or herbarium material for study. He is under special obligations to his wife, Ruth Peck Ownbey, whose conscientious efforts in behalf of the problem have been almost as great as his own.

Abbreviations

The herbaria from which material has been available for study and from which specimens are cited in this treatment are indicated by the following abbreviations:

CA—California Academy of Sciences Herbarium.
Clokey—Personal Herbarium of Ira W. Clokey.
D—Dudley Herbarium of Stanford University.
F—Field Museum of Natural History Herbarium.
G—Gray Herbarium of Harvard University.
Kew—Herbarium of the Royal Botanic Gardens, Kew.
M—Missouri Botanical Garden Herbarium.
NY—New York Botanical Garden Herbarium.
O—Personal Herbarium of the author.
P—Pomona College Herbarium.
PA—Herbarium of the Academy of Natural Sciences of Philadelphia.
RM—Rocky Mountain Herbarium of the University of Wyoming.
UC—University of California Herbarium, Berkeley.
UCLA—University of California Herbarium, Los Angeles.
UM—Montana State University Herbarium.
UO—University of Oregon Herbarium.
US—United States National Herbarium.
WS—State College of Washington Herbarium.
WU—Willamette University Herbarium.

Taxonomy

Calochortus Pursh, Fl. Am. Sept. **1**: 240. 1814; Douglas in Trans. Hort. Soc. Lond. **7**: 275–280, *pls. 8–9.* 1828; Schultes f.

in Van Hall, Vrolik & Mulder, Bijdr. Nat. Wet. **4**: 123–134. 1829; Schultes & Schultes, Syst. Veg. **7**: 1530–1536. 1830; Bentham in Trans. Hort. Soc. Lond. Ser. II. **1**: 411–412, *pl. 15, figs. 1, 3.* 1834; Kunth, Enum. Pl. **4**: 231–233. 1843; Wood in Proc. Acad. Philad. [**20**]: 167–169. 1868; Baker in Journ. Linn. Soc. Lond. Bot. **14**: 302–310. 1874; Watson in Proc. Am. Acad. **14**: 262–268. 1879; Bot. Calif. **2**: 171–177. 1880; Bentham & Hooker, Gen. Pl. **3**: 820. 1883; Hemsley, Biol. Centr.-Am. Bot. **3**: 379–380. 1885; Engler in Engler & Prantl, Nat. Pflanzenf. $\mathbf{2}^5$: 63. 1887; Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 107–158, *pls. 15–19.* 1901; Piper in Contrib. U. S. Nat. Herb. **11** [Fl. Wash.]: 193–195. 1906; Nelson in Coulter & Nelson, New Man. Bot. Centr. Rocky Mts. pp. 116–117. 1909; Painter in Contrib. U. S. Nat. Herb. **13**: 343–350. 1911; Purdy & Bailey in Bailey, Stand. Cyclop. Hort. **2**: 631–635. 1914; Wooton & Standley in Contrib. U. S. Nat. Herb. **19** [Fl. N. Mex.]: 127–128. 1915; Rydberg, Fl. Rocky Mts. & Adj. Plains, pp. 171–172. 1917; Jepson, Fl. Calif. **1**: 291–302, *figs. 51–57.* 1921; Man. Fl. Pl. Calif. pp. 230–239. 1923; Abrams, Illust. Fl. Pac. States **1**: 431–446. 1923; Tidestrom in Contrib. U. S. Nat. Herb. **25** [Fl. Utah & Nev.]: 124–125. 1925; Krause in Engler & Prantl, Nat. Pflanzenf. 2. aufl. **15a**: 337–338. 1930; Wehrhahn, Gartenstaud. **1**: 141–147. 1931; Rydberg, Fl. Prairies & Plains Centr. N. Am. pp. 223–224. 1932; Munz, Man. So. Calif. Bot. pp. 91–95. 1935.

Cyclobothra [D. Don in] Sweet, Brit. Fl. Gard. **3**: *t. 273.* 1828; Bentham in Trans. Hort. Soc. Lond. Ser. II. **1**: 412–413, *pl. 14, figs. 1, 3.* 1834; Lindley in Bot. Reg. **20**: *t. 1661–1663.* 1834; Kunth, Enum. Pl. **4**: 227–231. 1843.

Glabrous herbs from perennial, tunicated bulbs, with membranaceous or fibrous-reticulate coats; stems scapiform or leafy, often branched, frequently bulbiferous either in the axils of the lower cauline leaves, at or beneath the surface of the ground, or in the axils of the upper leaves and bracts; leaves usually linear, the solitary basal ones often conspicuous, the cauline ones successively reduced upward; inflorescences monochasial or subumbellate through the failure of the internodes to elongate, the bracts usually equalling the flowering pedicels in number and opposite them; flowers conspicuous, erect or nodding, globose to broadly campanulate, white, yellow, red, purple, bluish or brownish, often marked with contrasting colors; outer perianth segments (sepals) three, ultimately valvate in aestivation, more or less sepaloid, oblong to lanceolate, obtuse to attenuate, usually naked; inner perianth segments (petals) three, convolute in aestivation, obovate to lanceolate, cuneate to clawed, usually more or less bearded on the inner face, and characteristically with a unique depression or glandular spot (the gland) near the base; stamens six, in two series, anthers oblong to linear, obtuse to long-apiculate, the base prolonged below the insertion of the filaments as a tubular sheath, filaments subulate, basally dilated, slightly adherent at the base to the perianth segments; pistils tricarpellary, trilocular, ovaries triangular to 3-winged, abruptly contracted or tapering to a persistent, trifid stigma; ovules anatropous, in two rows in each loculus; fruits orbicular to linear, 3-angled to 3-winged, erect or nodding, septicidally dehiscent; seeds irregular or flattened, usually with inconspicuously hexagonally reticulate coats.

TYPE SPECIES: **Calochortus elegans** Pursh.

KEY TO THE SECTIONS

A. Fruits orbicular to oblong, 3-winged; inflorescences subumbellate........ ....Section I. EUCALOCHORTUS

AA. Fruits oblong to linear, usually 3-angled; if winged, inflorescences monochasial.

B. Bulb-coats membranaceous........................Section II. MARIPOSA

BB. Bulb-coats fibrous-reticulate..................Section III. CYCLOBOTHRA

KEY TO THE SUBSECTIONS, SPECIES AND VARIETIES

Section I. EUCALOCHORTUS

a. Fruits usually nodding; if erect, stems scapiform *(C. nudus)*.

b. Flowers globose to narrowly campanulate, nodding.................. ....Subsection 1. PULCHELLI

c. Flowers white to purple; petals not conspicuously fringed; glands traversed by several broad membranes.

d. Lower membranes of glands extending entirely across the base of the petals and decurrent along the margins.............*1. C. amoenus*

dd. Lower membranes extending only ⅓ to ⅔ the breadth of the petals..*2. C. albus*

cc. Flowers yellow; petals conspicuously fringed; gland-membranes lacking.
d. Surface of the petals sparsely clothed to the tip with short hairs. .... *3. C. pulchellus*
dd. Surface of the petals nearly naked, occasionally with a few hairs near the gland.................................... *4. C. amabilis*
bb. Flowers broadly campanulate, erect or spreading.
c. Petals clawed, ciliate and more or less densely bearded.............. .... Subsection 2. ELEGANTI
d. Petals yellow.................................. *5. C. monophyllus*
dd. Petals white, cream-colored, or variously marked or shaded with purple or rose.
e. Stems usually branched, or at least with a bract-like cauline leaf. .... *6. C. Tolmiei*
ee. Stems scapiform, rarely branched.
f. Glands lunate, ½ to nearly as broad as the claw.
g. Petals conspicuously fringed, inner face not papillose.
h. Anthers large, oblong, acute................. *7. C. coeruleus*
hh. Anthers smaller, lanceolate, acute to apiculate.
i. Petals ciliate to the apex......... *7a. C. coeruleus* var. *nanus*
ii. Petals ciliate laterally only..... *7b. C. coeruleus* var. *Westoni*
gg. Petals less conspicuously fringed, inner face minutely papillose.
h. Upper gland-membranes lacking; sepals without a basal, glandular spot.
i. Gland-membranes deeply fringed.
j. Glands strongly arched upward............. *8. C. elegans*
jj. Glands straight or only slightly arched............ .... *8a. C. elegans* var. *selwayensis*
ii. Gland-membranes erose to crenate.................... .... *8b. C. elegans* var. *oreophilus*
hh. Upper gland-membranes present; sepals with a basal, glandular spot............................... *9. C. Lobbii*
ff. Glands short, nearly circular.................... *10. C. apiculatus*
cc. Petals cuneate, not ciliate, glabrous or nearly so....... Subsection 3. NUDI
d. Stems leafy, the lower internodes sometimes very short.
e. Internodes elongate; stems branched, usually not bulbiferous.... .... *11. C. umbellatus*
ee. Internodes very short; pedicels elongate; stems usually unbranched, bulbiferous............................ *12. C. uniflorus*
dd. Stems scapiform.
e. Fruits nodding; petals acute....................... *13. C. minimus*
ee. Fruits erect; petals rounded.......................... *14. C. nudus*
aa. Fruits usually erect; if nodding, stems not scapiform *(C. persistens)*..... .... Subsection 4. NITIDI
b. Fruits erect; anthers obtuse to short-apiculate.
c. Petals obovate, cuneate at the base.
d. Hairs on face of petals long and flexuous, sometimes sparse; gland-processes usually papillose, but not branched.
e. Lower internodes very short; stems bulbiferous..*15. C. longebarbatus*

ee. Lower internodes elongate; stems not bulbiferous.
f. Glands triangular-lunate, slightly depressed.
g. Petals purplish, with a basal crescent-shaped spot........ ....16. *C. Douglasianus*
gg. Petals white or purplish, with a central purple blotch...... ....17. *C. nitidus*
ff. Glands lunate, deeply depressed; petals purplish, with a basal crescent-shaped spot..............................18. *C. Greenei*
dd. Hairs on face of petals short; gland-processes branched..19. *C. Howellii*
cc. Petals triangular-lanceolate, conspicuously clawed..........20. *C. Lyallii*
bb. Fruits nodding; anthers apiculate........................21. *C. persistens*

Section II. MARIPOSA
a. Glands not depressed (or rarely slightly so), never surrounded with a membrane..Subsection 5. VENUSTI
b. Inflorescences distinctly monochasial, the internodes sometimes short, but evident.
c. Capsules oblong, narrowly 3-winged, obtuse..............22. *C. catalinae*
cc. Capsules lanceolate or linear, 3-angled, acute.
d. Capsules lanceolate; stems usually flexuous-twining....23. *C. flexuosus*
dd. Capsules linear, stems erect.
e. Gland-processes linear or subclavate.
f. Gland-processes linear; petals with a reddish brown spot above the gland...................................... 24. *C. Dunnii*
ff. Gland-processes subclavate; petals without a spot above the gland..25. *C. Palmeri*
ee. Gland processes enlarged and fungoid distally.......26. *C. splendens*
bb. Inflorescences obscurely monochasial, subumbellate.
c. Anthers not sagittate at the base.
d. Gland oblong, with long, slender gland-processes.
e. Petals conspicuously striate, not spotted..............27. *C. striatus*
ee. Petals not striate, with a conspicuous, dark red spot above the gland..28. *C. monanthus*
dd. Glands not oblong, with shorter thicker processes.
e. Glands quadrate................................29. *C. venustus*
ee. Glands Λ-shaped.................................30. *C. superbus*
eee. Glands doubly lunate..............................31. *C. Vestae*
eeee. Glands simply lunate; petals yellow..................32. *C. luteus*
cc. Anthers more or less sagittate at the base..............33. *C. Leichtlinii*
aa. Glands more or less depressed, surrounded with a membrane.
b. Sepals usually greatly exceeding the petals; anthers linear............ ....Subsection 6. MACROCARPI
c. Petals purple, with or without a spot above the gland...34. *C. macrocarpus*
cc. Petals white, with a reddish purple crescent above the gland........ ....34a. *C. macrocarpus* var. *maculosus*
bb. Sepals rarely exceeding the petals; anthers oblong to lanceolate.
c. Glands circular; membrane broad, usually continuous; hairs on face of petals not branched........................Subsection 7. NUTTALLIANI
d. Flowers white to purplish.

e. Petals with a conspicuous, reddish brown or purple spot or band above the gland.
f. Face of petals sparsely bearded near the gland with slender hairs; petals usually without a median, longitudinal, green stripe..*35. C. Nuttallii*
ff. Face of petals glabrous, or with a few short hairs near the gland; petals with a median, longitudinal, green stripe........
.............................*35a. C. Nuttallii* var. *bruneaunis*
ee. Petals without a spot above the gland.
f. Basal leaves withering before anthesis; plants of dry slopes.
g. Flowers large; petals broadly obovate; Panamint Mountains, Inyo County, California....*35b. C. Nuttallii* var. *panamintensis*
gg. Flowers usually smaller; petals narrower; southern Sierra Nevada and South Coast Ranges, to southern California....
....*36. C. invenustus*
ff. Basal leaves persistent at anthesis; plants of moist meadows, Inyo County, California........................*37. C. excavatus*
dd. Flowers yellow to vermillion.
e. Hairs on face of petal not enlarged distally.
f. Stems low, usually bulbiferous; desert regions of northwestern New Mexico, northeastern Arizona and southern Utah......
.................................*35c. C. Nuttallii* var. *aureus*
ff. Stems taller, rarely bulbiferous; mountains of southern California, southward...............................*38. C. concolor*
ee. Hairs on face of petals distally enlarged or subclavate.
f. Hairs on face of petals merely thickened distally; flowers yellow to vermillion................................*39. C. Kennedyi*
ff. Hairs on face of petals subclavate; flowers yellow.
g. Stems slender; flowers small; San Gabriel Mountains.....
..............................*40a. C. clavatus* var. *gracilis*
gg. Stems stout; flowers large; Los Angeles County, northward to central California..........................*40. C. clavatus*
cc. Glands transversely more or less oblong; membrane narrow and discontinuous; hairs on face of petals branched and gland-tipped......
.....................................Subsection 8. GUNNISONIANI
d. Glands short, transverse; anthers usually obtuse.......*41. C. ambiguus*
dd. Glands transversely oblong; anthers acute to apiculate.
e. Petals white or purplish..........................*42. C. Gunnisoni*
ee. Petals pale yellow.................*42a. C. Gunnisoni* var. *perpulcher*

Section III. CYCLOBOTHRA
a. Flowers erect.
b. Petals conspicuously bearded; glands always circular, slightly depressed, surrounded with a dense ring of hair-like processes..Subsection 9. WEEDIANI
c. Petals obovate, cuneate, little, if any, shorter than the sepals.
d. Petals rarely fimbriate, glabrous at the apex.
e. Petals pinkish or purplish.......................*43. C. Plummerae*
ee. Petals pale yellow..................*44b. C. Weedii* var. *peninsularis*
dd. Petals minutely dentate to conspicuously fimbriate, bearded nearly or quite to the apex.

e. Petals orange-yellow .... *44. C. Weedii*
ee. Petals purplish .... *44c. C. Weedii* var. *intermedius*
eee. Petals reddish brown .... *44a. C. Weedii* var. *vestus*
cc. Petals oblong, greatly reduced, half as long as the sepals .. *45. C. obispoensis*
bb. Petals inconspicuously bearded; glands, when present, variable in outline, not depressed, not surrounded with a hairy ring, often absent .... Subsection 10. GHIESBREGHTIANI
c. No glands on sepals, those on petals inconspicuous or absent.
d. Flowers white to yellow.
e. Petals yellow; basal leaves about equalling the stems; capsules linear-oblong .... *46. C. venustulus*
ee. Petals white or yellowish; basal leaves exceeding the stems; capsules narrowly lanceolate .... *47. C. exilis*
dd. Flowers brown or brownish .... *48. C. Hintoni*
cc. Glands present and conspicuous on both petals and sepals .... *49. C. Ghiesbreghtii*
aa. Flowers nodding.
b. Petals conspicuously bearded on the inner face ...... Subsection 11. BARBATI
c. Flowers yellow, brownish or purplish.
d. Petals obovate, densely bearded to below the gland ...... *50. C. barbatus*
dd. Petals narrowly elliptic to spatulate, bearded above the gland only. .... *51. C. fuscus*
cc. Flowers very dark red or reddish brown.
d. Petals ciliate laterally; flowers apparently reddish brown .... *52. C. Pringlei*
dd. Petals not ciliate; flowers drying black .... *53. C. nigrescens*
bb. Petals very sparingly bearded on the inner face .... Subsection 12. PURPUREI
c. Flowers purplish brown; stems moderately leafy.
d. Inner surface of the petals sparsely covered with short hairs.
e. Petals conspicuously ciliate; cauline leaves linear-lanceolate .... *54. C. cernuus*
ee. Petals inconspicuously ciliate; cauline leaves lanceolate .... *55. C. purpureus*
dd. Inner surface of the petals glabrous or nearly so; hairs, if present, restricted to midvein and margin .... *56. C. Hartwegi*
cc. Flowers apparently bluish; stems very leafy .... *57. C. foliosus*

Section I. Eucalochortus

Eucalochortus Lemaire in Fl. des Serres et Jardins **5**: 430b. 1849, name only; Watson in Proc. Am. Acad. **14**: 262. 1879; Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 116. 1901, as section.

Calochortidea Wood in Proc. Acad. Philad. [**20**]: 168. 1868, as section.

Macrodenus Baker in Journ. Linn. Soc. Lond. Bot. **14**: 303. 1874, as subgenus.

Platycarpus Baker, *l. c.* 305, in part, as subgenus.

Bulbs ovoid, with membranaceous coats; stems scapiform or leafy, branched in some species, rarely bulbiferous in the axils of the lower cauline leaves; basal leaves conspicuous, often exceeding the stems; inflorescences subumbellate, the flowers globose to broadly campanulate, erect or nodding; sepals elliptic to lanceolate, acute to acuminate, usually glabrous; petals obovate to lanceolate, cuneate or clawed, usually more or less fringed laterally and bearded above the gland; glands more or less depressed, usually bordered below with an erose to deeply fringed membrane; anthers oblong to lanceolate, obtuse to long-apiculate; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruits orbicular to oblong, 3-winged, erect or nodding; seeds irregular, usually with hexagonally reticulate coats. (Spp. 1–21).

Type Species: **Calochortus elegans** Pursh.

The section Eucalochortus is a very natural group of species which are not closely related to the remaining two sections of *Calochortus.* Morphologically, it is is distinguished by its short, 3-winged capsules, membranaceous bulb-coats, and conspicuous, persistent basal leaves. Cytologically, all species which have been investigated show ten as the basic number of chromosomes, a base number otherwise unknown within the genus.

In contrast to this cytological uniformity, the species of Eucalochortus show great morphological variation. They may be grouped, however, into four well-marked subsections, which on morphological, cytological and geographical grounds appear to represent four ancient stocks from which have been differentiated the present-day species and species groups.

In comparison with that of the other two sections, the distribution of the section Eucalochortus is entirely northern. A single species reaches southern California, but the great center of diversity is in the Northwest. From the distributional areas of the various entities, the Klamath Region of northern California and adjacent Oregon seems to present a likely center of dispersal for the entire section.

Subsection 1. PULCHELLI.[24]

Flowers narrowly campanulate to globose, usually nodding; stems leafy, usually branched; ultimate branches and the stems, each terminated by a pair of large, opposite bracts, sub-

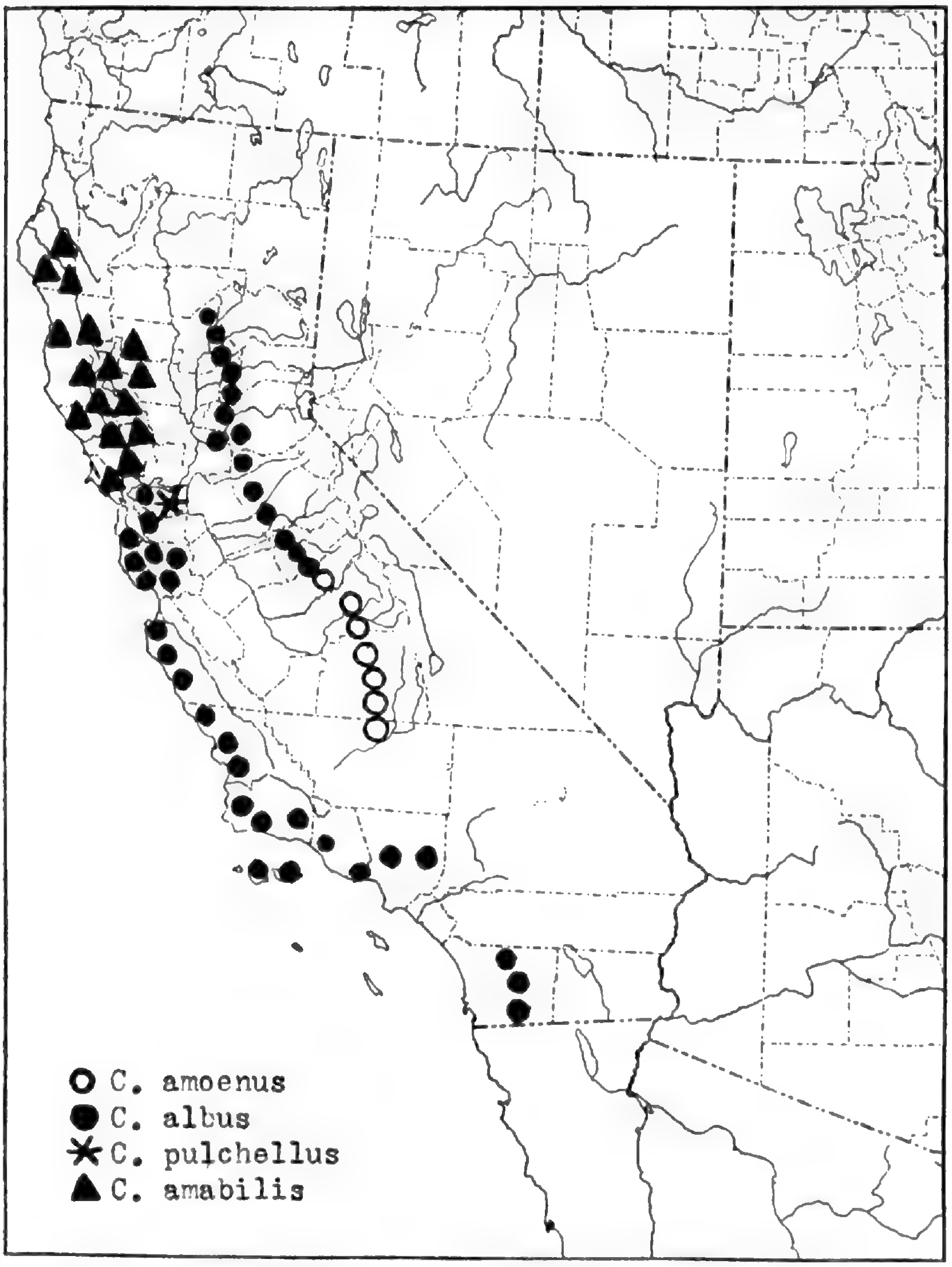
- ....Subsection 1. PULCHELLI.....
  - .....
    - ....*C. amoenus*
    - ....*C. albus*
  - .....
    - ....*C. pulchellus*
    - ....*C. amabilis*
- ....Subsection 2. ELEGANTI......
  - ....*C. monophyllus*
  - .....
    - ....*C. Tolmiei*
    - ....*C. coeruleus*
    - ....*C. coeruleus* var. *nanus*
    - ....*C. coeruleus* var. *Westoni*
    - ....*C. elegans* var. *oreophilus*
    - ....*C. elegans*
    - ....*C. elegans* var. *selwayensis*
  - ....*C. Lobbii*
  - ....*C. apiculatus*
- ....Subsection 3. NUDI..........
  - .....
    - ....*C. umbellatus*
    - ....*C. uniflorus*
  - .....
    - ....*C. minimus*
    - ....*C. nudus*
- ....Subsection 4. NITIDI.........
  - .....
    - ....*C. longebarbatus*
    - ....*C. Douglasianus*
    - ....*C. nitidus*
    - ....*C. Greenei*
  - ....*C. Howellii*
  - ....*C. Lyallii*
  - ....*C. persistens*

Fig. 1. Diagram showing morphological relationships of the subsections, species and varieties of the section EUCALOCHORTUS.

tending a pair of flowering pedicels; fruits oblong, 3-winged, nodding.

The four species included under this subsection fall into two

[24] PULCHELLI subsect. nov., floribus anguste campanulatis vel globosis plerumque cernuis; caulibus foliatis plerumque ramosis; ramis ultimis et caulibus bracteis duobus magnis oppositis terminatis, bracteis pedicellis duobus florentibus subtendentibus; capsulis oblongis 3-alatis cernis.



Map 1. Distribution of the species of the subsection PULCHELLI.

natural groups. The first of these includes *C. amoenus* and *C. albus,* which are distinguished by their white to purplish flowers and several transverse gland-membranes. The second group is characterized by yellow flowers and the absence of gland-membranes. Here are placed *C. pulchellus* and *C. amabilis.* These distinctions are of fundamental importance, and it may be that the similarities in branching and flower shape which hold the subsection together are the result of parallel development rather than evidence of phylogenetic relationship.

In distribution, the PULCHELLI are restricted to California, occurring in the Coast Ranges from Humboldt County to San Diego County, and on the western slope of the Sierra Nevada from Butte County to Kern County (Map 1).

1. **Calochortus amoenus** Greene, Pittonia **2**: 71. 1890.

Calochortus elegans var. *amoenus* Hort. in Gard. Chron. Ser. III. **15**: 810, *fig. 104.* 1894.

Calochortus albus var. *amoenus* Hort. ex Purdy & Bailey in Bailey & Miller, Cyclop. Am. Hort. **1**: 219. 1900.

Bulb ovoid, with membranaceous coats; stem slender, erect, more or less flexuous, 2–5 dm. tall, branched, each of the ultimate branches, and the stem, terminated by a pair of large, opposite, lanceolate, acuminate bracts subtending a pair of flowering pedicels; basal leaf 2–5 dm. long, 5–25 mm. broad, tapering toward both ends, usually exceeding the stem; cauline leaves 2 to 5, lanceolate, acuminate, 5–15 cm. long, reduced upward; flowers deep rose, drying purple, narrowly campanulate, erect to reflexed on slender pedicels; sepals shorter than the petals, lanceolate, acute, glabrous; petals elliptic-obovate, obtuse and rounded to acute, sparsely ciliate laterally and sparingly invested on the inner face above the gland with long, slender hairs; gland broad, slightly depressed, traversed by four or five broad, deeply fringed membranes, the lower of which extends entirely across the base of the petal, and is decurrent along the margins, upper membranes successively shorter, fringes of the membranes densely beset with long, slender papillae; anthers oblong, obtuse, about equalling the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit oblong, obtuse or acute, narrowly 3-winged, nodding; seeds irregular, with dark brown, hexagonally reticulate coats.

Calochortus amoenus is closely related only to *C. albus,* from which it is easily distinguished by the shape and color of the flower and characters of the gland.

Distribution. California: western foothills of the Sierra Nevada, from Madera County southward to the Greenhorn Mountains in Kern County.

California. madera co.: decomposed granite, Coarsegold, 600 m. alt., May 14, 1932, *Benson 3575* (D), *3576* (D, UC); North Fork, 1050 m. alt., May 5, 1913, *Dudley* (D); Coarsegold, May 4, 1938, *Eastwood & Howell 5374* (CA); sandy loam, dense woodland, S. 33, T. 8 S., R. 22 E., 600 m. alt., May 2, 1933, *Hormay H-132* (UC). fresno co.: near Prather, April 19, 1923, *DeGraw* (CA); Base Camp, junction of North and South Forks of Kings River, April 10, 1923, *Duncan 83* (D); Big Sandy Valley, east base of Black Mt., May 17, 1938, *Hoover 3471* (O); Big Sandy Creek, May, 1916, *McDonald* (CA); Samson Flats, June, 1901, *Newhall* (UC); moist, shady, north-facing slope along Grants Park Road, above Dunlap Valley, 690 m. alt., May 11, 1929, *Quibell 1258* (P); Shore Lake Road, above Fall House, 900 m. alt., May 12, 1933, *Winblad* (F). tulare co.: 2 mi. below Alder Creek, March 25, 1925, *Abrams 10823* (D, P); at Mr. Sweets' Canyon Ranch on the Mineral King Road, 900 m. alt., April 23, 1925, *Bacigalupi 1206* (D, G, NY, P, UC); on Mineral King Road, 1 mi. below Oak Grove, 750 m. alt., April 22, 1925, *Bacigalupi 1219* (D, P); North Fork of the Tule River, 1 mi. s. of Milo, 6 mi. n. of Springville, 420 m. alt., April 16, 1938, *Constance & Mason 2125* (O); near Milo, April 5, 1900, *Dudley* (CA, D, G, UC); Kaweah, April 27, 1895, *Eastwood* (G); from Lindsay to Springville, May 1, 1927, *Harter* (CA, P); road to Mineral King, about 10 mi. from the General's Highway, May 23, 1933, *Holman* (UC); Kaweah River Basin, May 3, 1901, *Hopping 107* (UC); Deer Creek, 5 mi. n. of California Hot Springs, on road to Porterville, May 16, 1935, *Keck & Stockwell 3331* (D, P, UC); Tule Indian Reservation, May 1, 1920, *Kelley* (CA); Pine Flat, near California Hot Springs, June 19, 1917, *Moxley 557* (UC); near Exeter, April 19, 1923, *Thew* (CA). kern co.: hills near Glenville, Greenhorn Range, 960 m. alt., May 15, 1930, *Howell 5121* (CA); hills s. e. of Glenville, Greenhorn Range, 1050 m. alt., May 15, 1930, *Peirson 8876* (UC); Greenhorn Mt., May 31, 1931, *Van Dyke* (CA); below pine belt, Greenhorn Mts., May 20, 1926, *Weston 134* (CA); Greenhorn Mts., near Glenville, April 24, 1927, *Weston 640* (CA).

2. Calochortus albus Douglas ex Bentham in Trans. Hort. Soc. Lond. Ser. II. **1**: 413, *pl. 14, fig. 3.* 1834.

Cyclobothra alba Bentham, *l. c.*

Cyclobothra paniculata Lindley in Bot. Reg. **20**: under *t. 1662.* 1834.

Calochortus albus var. *paniculata* Baker in Journ. Linn. Soc. Lond. Bot. **14**: 304. 1874.

Calochortus albus var. *rubellus* Greene in Erythea **1**: 152. 1893.

Calochortus Englerianus Hort. in Notizblatt Bot. Gart. Mus. Berl. **2**: 318. 1899; Ascherson & Graebner, Syn. Mittel-europ. Fl. **3**: 218. 1905.

Calochortus lanternus Davidson in Bull. So. Calif. Acad. Sci. **23**: 126. 1924.

Bulb ovoid, with membranaceous coats; stem usually stout, erect, 2–8 dm. tall, branched, each of the ultimate branches, and the stem, terminated by a pair (sometimes three) of large, opposite, lanceolate, attenuate bracts subtending an equal number of flowering pedicels; basal leaf 3–7 dm. long, 1–5 cm. broad, tapering toward both ends, usually not exceeding the stem except in short plants; cauline leaves 2–6, lanceolate to linear, attenuate, 5–25 cm. long, reduced upward; flowers white to rose-colored, globose to globose-campanulate at anthesis, nodding on rather slender pedicels; sepals ½ to ⅔ as long as the petals, ovate to lanceolate, acuminate, glabrous; petals elliptic-obovate to elliptic-lanceolate, acute or obtuse, ciliate laterally and moderately invested above the gland with slender, tapering hairs; gland ⅓ to ⅔ the width of the petal, depressed, traversed by four or five (sometimes more) broad, deeply fringed membranes, which become successively shorter upward, fringes of the membranes sparingly papillose; anthers oblong, acute or obtuse, about equalling the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit oblong, obtuse or acute, 3-winged, nodding; seeds irregular, with dark brown, hexagonally reticulate coats and terminal, netted crests.

In a species with a large and discontinuous distribution, it is to be expected that geographical variations of the nature of races or incipient species will be found. This is true, to a certain extent, in *Calochortus albus,* but the morphological differences which are shown by the different races do not seem to justify taxonomic recognition. In general, the Sierran plants of this species, and those from San Diego County, tend to have smaller flowers, which are more nearly campanulate at anthesis, with the gland less deeply depressed, than do the plants of the Coast Ranges. In these characters they somewhat approach *C. amoenus,* but are easily distinguished from that species by the color of the petals and the nature of the gland. In the Coast Range plants there is a tendency for the petals to be flushed with rose. This tendency finds its extreme expression in the variety *rubellus* of Greene, which, because of the numerous intermediates, cannot be maintained as taxonomically distinct.

DISTRIBUTION. California: western foothills of the Sierra Nevada from Butte County southward to Madera County, and in the Coast Ranges from the vicinity of San Francisco Bay southward to the San Gabriel and Santa Monica mountains of Los Angeles County; also in the Cuyamaca Mountains in the interior of San Diego County and on Santa Cruz and Santa Rosa islands.

CALIFORNIA. BUTTE CO.: Butte Creek, June, 1896, *Austin 30* (M, UC); near Clear Creek, 55 m. alt., April 15–30, 1897, *Brown 190* (D, F, M, NY, PA, RM); Butte Creek, May, 1897, *Bruce 2118* (P); Butte Creek, May, 1898, *Bruce 2119* (NY); Midas Mine, near Enterprise, South Fork of the Feather River, 390 m. alt., May 22, 1937, *Hedges* (UC); plateau above Clear Creek, on the Paradise Road, May 8, 1914, *Heller 11375* (CA, Clokey, D, F, G, M, NY, PA, UC); Berry Canyon, near Clear Creek, May 7, 1902, *Heller & Brown 5484* (D, F, G, M, NY, P, PA, RM); Durham, May 30, 1932, *Morrison* (P); Durham, June 5, 1932, *Morrison* (CA); Oroville, *Purdy* (G); near Magalia, May 5, 1918, *Van Eseltine 1741* (G, NY). YUBA CO.: Los Vergils, May 22, 1921, *Eastwood 10558* (CA, RM). NEVADA CO.: Bear River, 390 m. alt., June 6, 1916, *Hall 10151* (D, G, UC); 22 mi. e. of Marysville, May 11, 1911, *Jones 50* (G). PLACER CO.: foothills, North American River, *Bolander 4530* (G); near Auburn, on road to Grass Valley, May 8, 1937, *Eastwood & Howell 4336* (CA); between Auburn and Newcastle, May 17, 1891, *Sonne 7* (UC); near Auburn, 1892, *Sonne* (RM). ELDORADO CO.: Simpson's Ranch, Sweetwater Creek, May 18, 1907, *Brandegee* (NY, UC); 3 mi. s. of Coloma, 480 m. alt., April 30, 1938, *Constance & Morrison 2170* (O, WS); Placerville, May, 1918, *Hannibal* (D); Placerville, May, 1923, *King* (CA); Marshall Monument, Coloma, April 14, 1928, *Peers* (CA); rather shady hill-slope, near Placerville, May 21, 1917, *Ramaley 11300* (UC); Nashville, April 29, 1900, *Rixford* (RM); Coloma, May 16, 1928, *Vortriede* (CA). SACRAMENTO CO.: rocky places near American River, near Folsom, April 22, 1928, *Copeland 173* (P); Folsom, April 26, 1938, *Copeland* (O). AMADOR CO.: Agricultural Station, 600 m. alt., May, 1891, *Hansen 46* (D); same locality, May, 1893, *Hansen 46* (M); New York Falls, 450 m., alt., May 25, 1893, *Hansen 46* (P); Caminetti Ranch, near Jackson, 480 m. alt., June 1–20, 1904, *Mulliken 102* (D, P, RM, UC); Sutter Creek, May 10, 1918, *Wood* (D). CALAVERAS CO.: Altaville, May 19, 1927, *Becker* (CA); Mokelumne Hill, *Blaisdell* (CA, Clokey); Murphys, May 17, 1887, *Smith* (PA); meadows and moist hillsides, near limestone quarry, Calaveras Cement Works, near San Andreas, 150 m. alt., May 7, 1927, *Stanford 262* (P); Fourth Crossing, between Valley Spring and San Andreas, May 21, 1923, *Steinbeck* (CA). TUOLUMNE CO.: Jamestown, May, 1900, *Bioletti* (UC, UO); shaded slopes, Spring Gulch, near Bear Creek, 300 m. alt., May 2, 1919, *Williamson 22* (Clokey), *28* (CA, D, NY, P). MARIPOSA CO.: Mariposa, May 10, 1893, *Congdon* (D); Cathey Valley, April 19, 1915, *Eastwood 4338* (CA); foothills near Mariposa, May 5, 1933, *Nelson & Nelson 527* (D, M, RM); above Coulterville, May, 1932, *Seale* (CA, D, P). MADERA CO.: Coarsegold, 450 m. alt., May 14, 1932, *Benson 3591* (D, UC). CONTRA COSTA CO.: s. e. of Mt. Diablo, May 24, 1862, *Brewer 1157* (UC). ALAMEDA CO.: Lake Chabot, San Leandro, May 6, 1900, *Carruth* (CA); Niles Canyon, May 1, 1891, *Chesnut & Drew* (UC). SAN MATEO CO.: Woodside, May, 1901, *Abrams 1571* (D); Page Mill Creek, above Stanford University, April 8, 1895, *Applegate 727*

(D); San Francisquito Creek, near and above Stanford University, May 8, 1895, *Applegate 727a* (D); near Burlingame, May, 1904, *Baker* (UC); San Mateo, June 23, 1893, *Blasdale* (UC); side of hill near San Mateo Ravine, April 21, 1894, *Dudley* (D); San Mateo, May, 1903, *Elmer 4846* (CA, D, M, NY, P, UC, UO, WS); above Woodside, on La Honda Road, east slope of Santa Cruz Mts., May 13, 1932, *Keck 1778* (UCLA, UM); San Bruno, June 10, 1868, *Kellogg & Harford 991* (CA, G, M, NY); shady slope, Jasper Ridge, May, 1907, *McGregor* (M); Redwood Grove in Portola Valley, June 8, 1907, *Randall 219* (D); shady canyons, 9 mi. w. of Stanford University, June 11, 1935, *Rose 35214* (F, M, NY); Crystal Springs, June, July, *Schmidt* (UC); Woodside, June 9, 1919, *Walther* (CA, M); Woodside, May 9, 1920, *Walther* (CA). SANTA CLARA CO.: Stanford University, April, 1900, *Atkinson* (D); foothills near Stanford University, April 14, 1902, *Baker 622* (P); hill above Palo Alto Stock Farm, April 24, 1895, *Burnham* (P); near Stock Farm, Stanford University, May, 1895, *Dudley* (D); along Coyote Creek, May 31, 1895, *Dudley 4143* (D); near Stanford University, April 28, 1902, *Dudley* (P); foothills w. of Los Gatos, May 7, 1904, *Heller 7395* (D, F, G, M, NY, PA, RM, UC); back of Alum Rock Park, April 27, 1907, *Heller 8476* (D, F, G, M, NY, PA); between Alma and Los Gatos, May 9, 1920, *Hichborn* (M); Coyote Creek, 3 mi. e. of Madrone, May 20, 1937, *Howell 12989* (CA, NY); Los Gatos, April 16, 1888, *Leeds* (F); along San Francisquito Creek, near St. Michaels Church, May 13, 1894, *Leithold* (D); foothills, Stanford University, April 22, 1896, *Leithold* (D); Alum Rock Spring, near San Jose, May, *Lemmon* (F, M, UC); Permanente Creek, April 21, 1907, *Mason 124* (F); Raymond's Ranch, Los Gatos, 420 m. alt., June 20, 1914, *Newell* (CA); Smith Creek, 645 m. alt., May 30, 1907, *Pendleton 797* (UC); eastern side of Mt. Hamilton, 1140 m. alt., May 7, 1934, *Sharsmith 1049* (O); heavily wooded, northeastern slope of Seeboy Ridge, Mt. Hamilton Range, 675 m. alt., May 26, 1935, *Sharsmith 3216* (WS); Olson Ranch, Loma Prieta, June 7, 1902, *Thompson* (D). SANTA CRUZ CO.: Santa Cruz, May 27, 1929, *Canby 239* (P); Glenwood, 1914, *Davis* (CA, G, M); Flat Rock Camp, Big Basin, June 5, 1897, *Dudley* (D); Santa Cruz, June 28, 1881, *Jones* (P); railroad near Big Trees, April 5, 1914, *Stinchfield 147* (D). MONTEREY CO.: between Posts and Rancho los Pesares, May 14, 1920, *Abrams 7466* (D, P); Tularcitos Ranch, Carmel Valley, May 15, 1924, *Bacigalupi* (D); burro trail, eastward slope, Santa Lucia Mts., June 9, 10, 1909, *Brandegee* (G, M, NY, RM, UC); Guadalupe Ranch, Palo Escrito Hills, May 11, 1861, *Brewer 592* (CA, G, M, UC, WS); sandy loam, Pajaro Hills, June, July, 1899, *Chandler 376* (UC); "Nova California" (locality uncertain, but probably near Monterey), 1833, *Douglas* (G, Kew TYPE, NY); gorge of San Antonio Creek, near Jolon, May 13, 1895, *Dudley* (D); Cypress Point, Monterey, May 28, 1912, *Eastwood 93* (CA, Clokey, G); Tassajara Hot Springs, June, 1901, *Elmer 3222* (D, M, UO); Carmel Highlands, 200 m. alt., June 21, 1925, *Epling 8382* (M, UCLA); Santa Lucia Mts., near Lucia, June 9, 1915, *Hall 10001* (UC); Monterey, *Hartweg 1984* (NY); pine woods, Pacific Grove, May 14, 1903, *Heller 6728* (D, F, G, M, NY, P, PA, RM, UC, UO); shaded grassy places in the pine forest at Pacific Grove, June 25, 1927, *Heller 14398* (F, M, PA); Rancho del Monte, Carmel River, May 7, 1921, *Mason* (D); Palo Colorado Canyon, near Big Sur, June 21, 1921, *Parish 20038* (G); Pacific Grove, June 12, 1907, *Patterson & Wiltz* (D, UC); Cypress Point, near Pacific Grove, June 21, 1907, *Patterson & Wiltz* (D); Santa Lucia Mts., May, 1898, *Plaskett 139* (NY, RM); between Point Lobos and Ocean Home, Carmel-by-the-Sea, April 17, 1910, *Randall* (D); between 17-Mile Drive and Carmel-by-the-Sea, April 30, 1910, *Randall 420* (D); Carmel-by-the-Sea, May 3, 1910, *Randall 444* (D); near Pacific Grove, June 9, 1901, *Setchell* (UC); 17-Mile Drive, about 4 mi. n. w. of Carmel, June 26, 1937, *Youngberg 193* (P). SAN LUIS OBISPO CO.: Santa Lucia Mts., May 1, 1900, *Barber* (UC); Cambria, May, 1908, *Cobb 76* (D, F, G, M, NY, P, PA, RM, UC, UO); Pettit Canyon, San Luis Obispo, June 4, 1910, *Condit* (UC); Cambria Road, Santa Rosa Creek, June 13, 1911, *Condit* (UC); Cambria, April 28, 1926, *Eastwood 13582* (CA); Cambria, June 14, 1938, *Eastwood & Howell 5946* (CA); Arroyo Grande, May, 1895, *King* (UC); San Simeon, near Cayucos, May, 1923, *McKenzie* (CA); Santa Lucia Mts., May, 1885, *Summers* (PA, UC). SANTA BARBARA CO.: Santa Inez Mts., near Santa Barbara, 1888, *Brandegee* (D, UC); Adelaide District, near Lompoc, June 20, 1930, *Sinseheimer* (CA); on north slope in chaparral, s. of Buelton, 2 mi. n. of Las Cruces, May 10, 1926, *Wiggins 2094* (D). SANTA CRUZ ISLAND: without exact locality, April, 1888, *Brandegee* (D, UC); wooded slope, Dix Canyon, 100 m. alt., May 26, 1930, *Clokey 4882* (Clokey, NY, P, UC); wooded hillside, Pelican Bay, 75 m. alt., May 23, 1930, *Clokey 4883* (Clokey, F, M, NY); grassy hillside, Friars Canyon, 30 m. alt., April 18, 1931, *Clokey 5168* (Clokey, NY); ravine w. of Pelican Bay, 40 m. alt., April 20, 1931, *Clokey 5169* (Clokey, G, NY, RM, UM, WS); ridge w. of Marine Garden, 90 m. alt., May 25, 1930, *Clokey 7481* (Clokey); without exact locality, May 12–15, 1929, *Ellison* (UCLA); near Pelican Harbor, June 14, 1930, *Hoffmann* (D, P); without exact locality, May 24, 1918, *Miller* (CA, Clokey). SANTA ROSA ISLAND: without exact locality, June, 1888, *Brandegee* (UC); without exact locality, May 15, 1932, *Dunn* (UCLA); without exact locality, April 15, 1935, *Sweet* (P). VENTURA CO.: Foster Park, April 14, 1916, *Eastwood 4975* (CA); Casitas Pass, 180 m. alt., May, 1902, *Hall 3213* (UC). LOS ANGELES CO.: Little Santa Anita Canyon, San Gabriel Mts., July 1, 1902, *Abrams 2620* (D, G, M, NY, P, PA); shaded side of ravine, Fulkerson's Ranch, Claremont, 720 m. alt., May 24, 1897, *Chandler* (UC); open slope, San Dimas Canyon, May 9, 1935, *Clokey & Anderson 6544* (Clokey); Los Alisos Canyon, Santa Monica Mts., April 18, 1931, *Epling* (UCLA); Eaton Canyon, near Pasadena, 450 m. alt., June 2, 1907, *Grinnell* (F); Topanga Canyon, Santa Monica Mts., May 17, 1933, *Hilend & Reis* (UCLA); San Dimas Canyon, San Gabriel Mts., May 10, 1928, *Hitchcock* (P); at the end of the public road, West Fork of San Dimas Canyon, San Gabriel Mts., May 9, 1931, *Mathias 857* (M); Claremont, June 1, 1909, *Metz 53* (P); damp, shaded slope, Topanga Canyon, Santa Monica Mts., 90 m. alt., May 17, 1920, *Munz & Harwood 3977* (P, RM); hillside, Malibu Road, Santa Monica Mts., May 11, 1935, *Purer 6577* (M); Johnson's pastures, near Claremont, April 29, 1916, *Robinson* (P); mouth of Live Oak Canyon, near Claremont, May 3, 1916, *Robinson* (P); Malibu Ranch, May, 1926, *Scott* (UCLA); Palmers Canyon, Claremont, May 3, 1901, *Williams 14* (P). SAN DIEGO CO.: Middle Peak, Cuyamaca Mts., June 24, 1903, *Abrams 3861* (D, G, M, NY, P, PA); Cuyamacas, July, 1932, *Clayton 83* (UC); Cuyamaca, June 25, 1919, *Eastwood 9137* (CA); Palomar Mt., June 24, 1932, *Epling, Darsie, Knox & Robison 1078* (UCLA); Cuyamaca Mts., 1200 m. alt., May, 1899, *Hall* (UC); near the Hutcut, Palomar, 900 m. alt., May 17–June 1, 1901, *Hall 1937* (UC); Cuyamaca Lake, May 30, 1926, *Jones* (D, P); Cuyamaca Lake, June 11, 1932, *Jones* (UC); burn in chaparral, Potrero Grade, May 10, 1924, *Munz 8055* (P); shaded north slope, Cuyamaca Lake, 1380 m. alt., June 27, 1923, *Munz & Harwood 7233* (NY, P);

Cuyamaca Mts., July 12, 1875, *Palmer 376* (F, M); Stonewall Mine, Cuyamaca Mts., 1380 m. alt., June 5–7, 1897, *Parish 4422* (F, G, M, NY); Julian Canyon, June, 1880, *Parish & Parish 357* (D, F); hillside, Palomar, June 6, 1937, *Purer 7269* (M); in open woods, Pine Hills, May 28, 1917, *Spencer 494* (G, NY, P); Talley's Ranch, 1800 m. alt., July, 1895, *Stokes* (D); Julian, June, 1880, *Vasey 632* (PA).

3. Calochortus pulchellus Douglas ex Bentham in Trans. Hort. Soc. Lond. Ser. II. **1**: 412, *pl. 14, fig. 1.* 1834.

Cyclobothra pulchella Bentham, *l. c.*

Bulb ovoid, with membranaceous coats; stem usually stout, erect, 1–3 dm. tall, often branched, each of the ultimate branches, and the stem, terminated by a pair of large, opposite, lanceolate, attenuate bracts subtending a pair of flowering pedicels; basal leaf 1–4 dm. long, 1–3 cm. broad, tapering toward both ends, often exceeding the stem; cauline leaves 2 or 3, lanceolate to linear, attenuate, 5–25 cm. long, reduced upward; flowers lemon-yellow, globose, nodding on rather slender pedicels; sepals slightly shorter than the petals, ovate to lanceolate, acuminate, glabrous; petals lanceolate, obtuse, clawed, conspicuously fringed with rather short, thick hairs, inner face sparsely invested to the tip above the claw with similar hairs; gland deeply depressed, bounded above with a narrow, transverse band of long, slender processes, which are more or less coalescent and directed downward, covering the upper portion of the claw; anthers oblong, obtuse or acute, shorter than the basally dilated filaments; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit oblong, obtuse, broadly 3-winged, nodding; seeds irregular, with dark brown, hexagonally reticulate coats.

This species is closely related to *C. amabilis,* but can be distinguished by its larger, more nearly globose flowers, which are of a lighter shade of yellow, and its longer-fringed petals, which are sparsely hairy to the tip.

DISTRIBUTION. California: endemic in the Mount Diablo Region, Contra Costa County. Similar plants from the North Coast Ranges belong to the closely related, but distinct, *C. amabilis.*

CALIFORNIA. CONTRA COSTA CO.: at spring, 4½ mi. from summit, Mt. Diablo, May 25, 1921, *Abrams 8053* (D); among digger pines, near farm house, in branch of Pine Canyon, Mt. Diablo, May 2, 1914, *Brandt* (UC); north slope of Mt. Diablo, May 7, 1862, *Brewer 1063* (G, UC); near Mt. Diablo, May 26, 1862, *Brewer 1163* (UC); Lafayette, April, 1900, *Carruth* (CA); open fields, near the base of Mt. Diablo, April 8, 1931, *Constance 173* (PA); locality not known, but presumably from near Mt. Diablo, the only place the species has since been found, "Nova California," 1833, *Douglas* (G, Kew TYPE, NY); Mt. Diablo, May 30, 1914, *Eastwood 4442* (CA); Mt. Diablo, May 4, 1923, *Eastwood 11728* (CA); Mt. Diablo, June, 1903, *Elmer 4631* (CA, D, M, NY, P, UC, UO, WS); north slopes, near Pine Canyon, Mt. Diablo, 360 m. alt., May 30, 1916, *Hall 10132* (D, G, P, UC); between Port Costa and Martinez, 18 m. alt., June 5, 1928, *Hitchcock 14* (P); Marsh Creek Canyon, May 4, 1938, *Hoover 3339* (O); Mt. Diablo, April 28, 1868, *Kellogg & Harford 990* (G, NY); Mt. Diablo, May 18, 1913, *Manor* (CA, Clokey, G, NY); Mt. Diablo, May 15, 1899, *Purdy* (D, G, M, NY, RM, UC, UCLA, UO).

4. Calochortus amabilis Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 119. 1901.

Calochortus pulchellus var. *amabilis* Jepson, Fl. W. Mid. Calif., p. 113. 1901.

Calochortus pulchellus var. *maculosus* Watson ex Purdy in Zoe **1**: 245. 1890.

Bulb ovoid, with membranaceous coats; stem usually stout, erect, 1–3 dm. tall, usually branched, each of the ultimate branches, and the stem, terminated by a pair of large, opposite, lanceolate, attenuate bracts subtending a pair of flowering pedicels; basal leaf 2–5 dm. long, 0.5–4 cm. broad, tapering toward both ends, exceeding the stem; cauline leaves 2 to 4, lanceolate to linear, attenuate, 2–20 cm. long, reduced upward; flowers deep yellow, often tinged with brown, globose to globose-campanulate, nodding on rather slender pedicels; sepals equalling to somewhat exceeding the petals, ovate to lanceolate, acute to acuminate, glabrous; petals lanceolate, obtuse, clawed, conspicuously fringed with short, thick hairs, inner face naked, or sometimes with a few short hairs near the gland; gland deeply depressed, bounded above with a narrow, transverse band of long, slender processes, which are more or less coalescent and directed downward, covering the upper portion of the claw; anthers oblong, obtuse or acute, shorter than the basally dilated filaments; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit oblong, obtuse or acute, 3-winged, nodding; seeds irregular, with dark brown, hexagonally reticulate coats.

This species is closely related to, and has been frequently confused with, *C. pulchellus,* but differs from that species in its smaller, deeper yellow flowers and its shorter-fringed, nearly naked petals. These characters are remarkably uniform, and, although intermediates occur, these are very rare and appear to represent only an occasional extreme plant within a perfectly normal population.

DISTRIBUTION. California: brushy slopes in the North Coast Ranges, from Humboldt County southward to Solano and Marin counties.

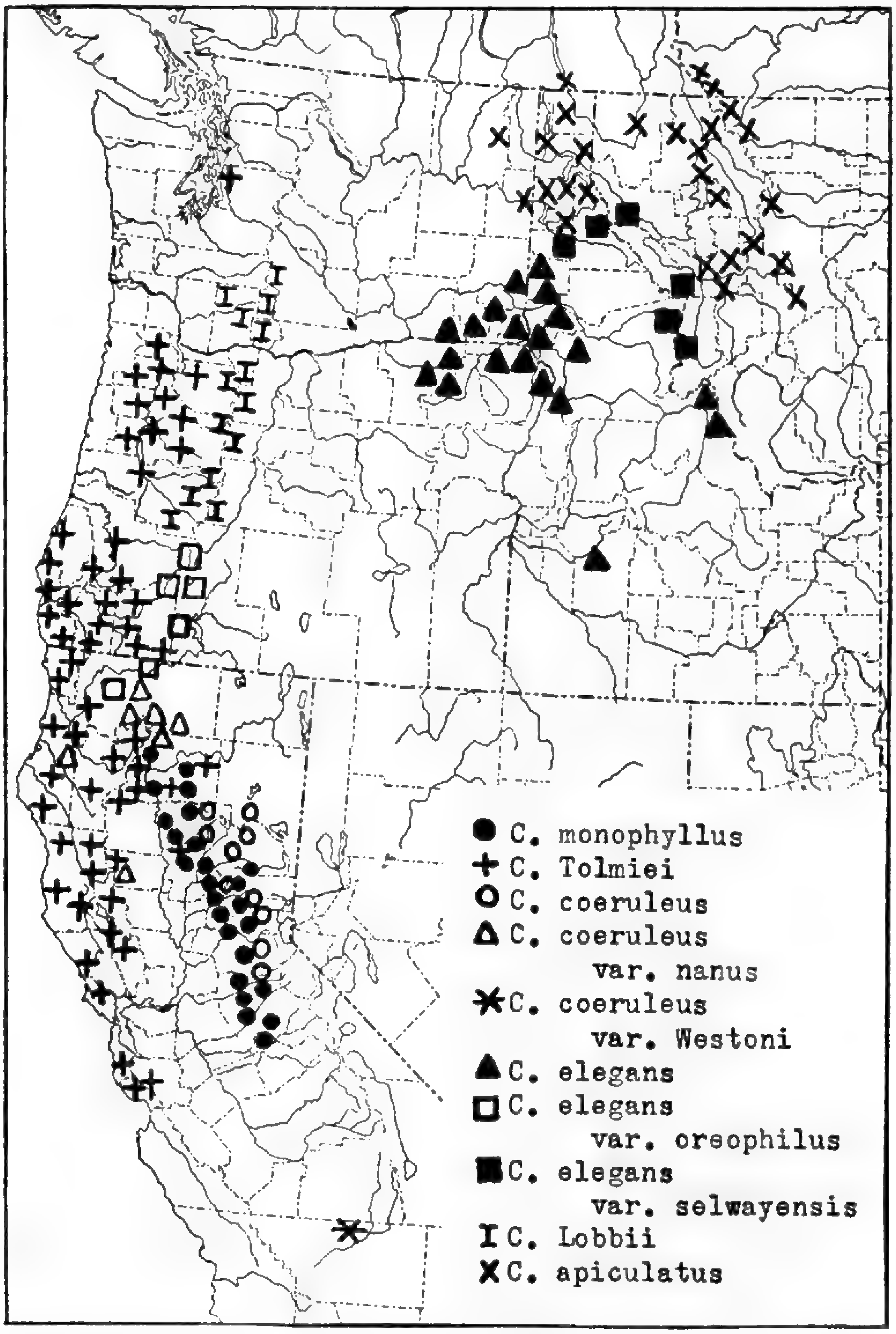
CALIFORNIA. HUMBOLDT CO.: between Blocksberg and Bridgeville, July 11, 1916, *Abrams 5980* (D, NY); roadside n. of Redway, May 25, 1934, *Armstrong* (UC); dry bank above Dyerville-Bull Creek Flat Road, ½ mi. w. of Dyerville, Humboldt Redwood Park, 50 m. alt., June 1, 1934, *Constance 769* (WS); by South Fork of Eel River, s. of Dyerville, June 20, 1899, *Dudley* (D); Carlotta, June, 1915, *Hawver* (CA); Sylvandale, 8 mi. n. of Garberville, May 2, 1931, *Jussel* (CA); Miranda, on South Fork of Eel River, May 16, 1926, *Kildale 2004* (D); Fort Seward, 120 m. alt., May 14, 1914, *Tracy 4422* (UC). MENDOCINO CO.: Santa Rosa Creek, Ukiah, April 24, 1864, *Bolander 3829* (CA, F, G, M, UC, WS); Willitts, June, 1906, *Clark* (CA); Ukiah, June 13, 1913, *Eastwood 3286* (CA, Clokey); Ukiah, May, 1915, *Eastwood* (CA); Potter Valley, May 20, 1925, *Eastwood 12746* (CA); Lost Creek, May 29, 1937, *Eastwood & Howell 4388* (CA); open, grassy north slopes, North Coast Ranges, near the headwaters of Big River, 600 m. alt., June 1, 1919, *Hall 10923* (CA, D, F, G, M, NY, P, RM, UC, UCLA, UO); near Orrs Hot Springs, May 23, 1921, *Head* (CA); near Fort Bragg, May 25, 1921, *Head* (CA); Willitts, May 21, 1921, *Piper* (CA, WS); near Ukiah, *Purdy* (F, G, UC); stony slopes, Potter Valley, 300 m. alt., May, 1894, *Purpus 871* (UC). GLENN CO.: in brush along Dry Creek, near Stonyford, April 23, 1926, *Ferris 6465* (D, NY, P). COLUSA CO.: Grapevine Grade, between Stonyford and Sites, April 23, 1926, *Ferris 6447* (D). LAKE CO.: near Bartlett Springs, May 6, 1928, *Abrams 12488* (D); Houghs Springs, May 7, 1928, *Abrams 12521* (D); dry brushy hillside, Pine Grove, n. of Cobb Mt., March 31, 1934, *Applegate 8875* (D); Lower Lake, June 3, 1917, *Bentley* (D); chamise thickets, Mt. Konocti, May 4, 1925, *Blankinship* (CA); same locality, May 10, 1929, *Blankinship* (M); Lower Lake, May 9, 1902, *Bowman* (D); 2 mi. n. e. of Middletown, North Coast Ranges, 300 m. alt., April 22, 1938, *Constance 2138* (O, WS); Dashiells, Mt. Sanhedrin, May 22, 1925, *Eastwood 12789* (CA); in gravel among the chaparral, Coast Range, north side of the ridge west of Leesville, 450 m. alt., May 10, 1919, *Heller 13131* (CA, D, G, M, NY); moist oak woods near rill-bed, near Lakeport, May 22, 1933, *Henderson 15438* (UO); Jordan Park, Cobb Mt., April 30, 1933, *Jussel* (CA); between Cobb Mt. and Adams Springs, on the Binkley Ranch, June 26, 1933, *Jussel 191* (CA, UC); 3 mi. e. of Bartlett Springs, May 7, 1928, *Kildale 4940* (D); on low hills with open chaparral, 3.3 mi. n. of Middletown, April 3, 1926, *Peirson 6619* (P); foot of Mt. Sanhedrin, June, 1917, *Reynolds* (CA); 1½ mi. s. w. of Lakeport, 450 m. alt., May 19, 1937, *Wilson 395* (UC). NAPA CO.: St. Helena Grade, May 3, 1928, *Abrams 12208* (D); 4 mi. s. of Middletown, May 4, 1928, *Abrams 12287* (D); hills, 1 mi. n. of Napa Soda Springs, April 26, 1925, *Bacigalupi 1226* (D); Howell Mt., 6 mi. n. e. of Pacific Union College, on road to Aetna Springs, June 2, 1933, *Bacigalupi, Ferris & Wiggins 6667* (D, UC); Mt. St. Helena, April 20, 1903, *Baker 2622* (G, M, NY, P); Pope Valley Grade from Calistoga, June 1, 1909, *Brandegee* (UC); Calistoga Road, 1 mi. below Patten's, March 21, 1926, *Howell 1730* (CA); Wooden Valley Grade, 5 mi. e. of Napa, April 2, 1931, *Howell 6076* (CA); in rich loam among rocks on burn, Wooden Valley Grade, west side of Napa Range, 5 mi. n. e. of Napa, 170 m. alt., April 2, 1931, *Keck 1019* (D, G, M, P, PA); in chaparral, north side of Howell Mt., 1 mi. above Pope Valley P. O., May 28, 1933, *Keck 2330* (D, P); rocky hillsides in partial shade, head of Moores Creek, 3–4 mi. e. of Angwin's, Howell Mt., 360 m. alt., May 15, 1902, *Tracy 1480* (P, UC); 2 mi. s. of Hawkins Mount Inn Camp, May 3, 1928, *Wolf 1787* (D). SONOMA CO.: Santa Rosa Creek Canyon, April 23, 1898, *Baker 29* (UC); Stewarts Canyon, May, 1899, *Baker* (UC); Anderson Valley, April, May, 1866, *Bolander 6249* (CA, M, UC, WS); near Sea View, June, 1901, *Carruth* (CA); St. Helena to Santa Rosa, April 27, 1907, *Chandler 7541* (UC); Trosper's, Cazadero, May 20, 1925, *Graff* (CA, P); Skaggs Springs, June 3, 1915, *Hawver* (CA, Clokey); between Santa Rosa and Agua Caliente, April 22, 1902, *Heller & Brown 5339* (D, F, G, M, NY, PA); Cloverdale, April 25, 1924, *Jones* (P); mountains west of Calistoga, May, 1894, *Kraus* (D); mountains near Franze Valley, May 6, 1895, *Kraus* (D); edge of wooded slope in grassland, near Mark West Springs, June 2, 1929, *Mexia 2393* (RM, UC); Los Guilicos, May, 1893, *Michener & Bioletti* (F, G, M, NY, P, UC, WS); Kenwood, May 14, 1933, *Nelson & Nelson 557* (D, M, RM); in oak woods at edge of valley, Alexander Valley, May 9, 1930, *Parks & Parks 605* (D, F, G, M, NY, P, RM, UC, UCLA, UO); Christopher Ranch, 2 mi. from Cazadero, 300 m. alt., June 11, 1930, *Randall* (UC); Cazadero, April 25, 1918, *Wood* (D, M). MARIN CO.: Corte Madera, April 28, 1904, *Heller 7364* (D, F, G, M, NY, PA, RM, UC); Corte Madera Ridge, near Tank, May, 1930, *Jackson* (CA). SOLANO CO.: Mix (Weldon) Canyon, April 23, 1938, *Hoover 3186* (O).

Subsection 2. ELEGANTI.[25]

Flowers broadly campanulate, erect or spreading; petals usually conspicuously fringed and densely bearded, clawed; stems usually scapiform, branched normally in only two species; fruits elliptic to oblong, 3-winged, nodding.

The six species and four varieties included under this subsection are morphologically quite uniform and probably closely related. Three of the species are very distinct. *C. monophyllus* differs from all other members of the subsection in its yellow flowers. In this character and others, it appears to be genetically related to *C. amabilis* and *C. pulchellus* of the preceding subsection. *C. apiculatus* and *C. Lobbii* also stand alone, the former by reason of its dark, nearly circular gland, and the

[25] ELEGANTI subsect. nov., floribus late campanulatis erectis aut patentibus; petalis plerumque insigniter fimbriatis dense barbatis unguiculatis; caulibus plerumque scapiformibus, in duobus speciebus solis normaliter ramosis; capsulis ellipticis vel oblongis 3-alatis cernuis.



Map 2. Distribution of the species and varieties of the subsection ELEGANTI.

latter on the dark, glandular spot near the base of each sepal. The remaining three species and four varieties form a complex, and, while it is believed that the units here recognized represent natural entities, the morphological evidence is not so convincing as that derived from geographical distribution.

5. **Calochortus monophyllus** (Lindley) Lemaire in Fl. des Serres et Jardins **5**: 430b. 1849; Jepson in Madroño **1**: 61. 1917.

Cyclobothra monophylla Lindley in Journ. Hort. Soc. Lond. **4**: 81. 1849.

Cyclobothra elegans var. *lutea* Bentham, Pl. Hartw. p. 338. 1857.

Calochortus Benthami Baker in Journ. Linn. Soc. Lond. Bot. **14**: 304. 1874.

Calochortus nitidus β. *cornutus* Wood in Proc. Acad. Philad. [**20**]: 169. 1868.

Calochortus pulchellus var. *parviflorus* Regel in Gartenflora **23**: 226, *t. 802a.* 1874.

Calochortus Benthami var. *Wallacei* Purdy & Bailey in Bailey, Stand. Cyclop. Hort. **2**: 633. 1914.

Calochortus Wallacei Hort. acc. Purdy & Bailey, *l. c.,* as synonym.

Calochortus maculatus Eastwood in Leafl. West. Bot. **1**: 133. 1934.

Bulb ovoid, with membranaceous coats; stem low, erect, more or less flexuous, usually branched, each branch, and the stem, terminated by a pair of opposite, lanceolate to linear, attenuate bracts subtending a pair of flowering pedicels; basal leaf 1–3 dm. long, 3–15 mm. broad, tapering toward both ends, greatly exceeding the stem; cauline leaves 1 to 3, rarely lacking, lanceolate to linear, attenuate, reduced; flowers deep yellow, frequently with a dark, reddish brown spot on the claw of each petal, erect or spreading on slender pedicels which become recurved in fruit; sepals equalling or exceeding the petals, oblong-lanceolate, acuminate, glabrous; petals oblanceolate, acute or obtuse, clawed, fringed and densely bearded above the gland with short, thick clavate hairs; gland transverse, arched upward, surface depressed, naked, bordered below with a narrow, deeply fringed membrane, and above with a series of short, thick processes, both processes and membrane-fringe densely short-papillose; anthers lanceolate, short-apiculate, equalling the broadly winged filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, obtuse or acute, 3-winged, nodding; seeds irregular, with dark brown, hexagonally reticulate coats.

Calochortus monophyllus is placed in the subsection ELEGANTI because of its flower shape and the character of the gland. It is distinguished from all other species of this subsection by its yellow flowers and characteristic branching. In these and other characters, its resemblance to *C. amabilis* is so striking as to suggest genetic relationship,[26] and perhaps it may represent an ancestral type through which the subsection PULCHELLI has been derived from the subsection ELEGANTI.

DISTRIBUTION. California: in the yellow pine belt, western foothills of the Sierra Nevada, from Shasta County southward to Tuolumne County.

CALIFORNIA. SHASTA CO.: rocky hillside, near Morleys Station, May 9, 1896, *Baker 39* (UC); Reed Road, May 1, 1900, *Baker* (UC); Whitmore, May 11, 1923, *Bethel* (CA); Montgomery Creek, June 27, 1912, *Eastwood* (CA); Redding, April 24, 1934, *Rose* (CA, type of *C. maculatus* Eastwood). TEHAMA CO.: 18 mi. w. of Mineral on Susanville Road, May 9, 1930, *Gillespie 9298* (D); near Pine Creek, "in montibus Sacramento," April, 1847, *Hartweg 1982* (G, Kew, NY); Red Bluff, June, 1917, *Wickes* (CA). PLUMAS CO.: Salmon Lake, 1919, *Kelley* (CA). BUTTE CO.: Little Chico Creek, May, 1883, *Austin 14* (P); same locality, April, 1896, *Austin* (M, UC); Little Chico Canyon, May, 1896, *Austin 25* (NY); Little Chico Butte Creek, May, 1897, *Bruce 2116* (P); near Paradise, lower Sierra Nevada, 600 m. alt., April 12, 1915, *Clark 213* (CA, D, F, G, M, NY, P, RM, UC, UCLA, UO); Brush Creek, 1907, *Conger* (P, RM, UC); Midas Mine, near Enterprise, South Fork of the Feather River, 390 m. alt., May 22, 1937, *Hedges* (UC); in the blue oak-digger pine belt, on grassy banks near Butte Creek, Chico-Centerville Road, 8 mi. from Chico, April 16, 1914, *Heller 11295* (CA, D, F, G, NY, UC); Durham, April 10, 1932, *Morrison* (CA); Chico, May, 1883, *Parry 260* (F, M); Chico, *Purdy* (UC); Honcut, April 12, 1931, *Rose* (CA); near De Sabla, May 5, 1918, *Van Eseltine 1739, 1740* (NY). SIERRA CO.: Downieville, April 15, 1928, *Vortriede* (CA). YUBA CO.: near Indian Valley, May 2, 1934, *Applegate 8891* (D); Los Vergils, May 22, 1921, *Eastwood*

[26] **Calochortus Goldyi** Watkins ex Purdy & Bailey in Bailey, Stand. Cyclop. Hort. **2**: 632. 1914, is said to be possibly a garden hybrid between *C. amabilis* and *C. monophyllus (Benthami)*. Hybrids between *C. monophyllus* and *C. albus* occur in nature, but are rare.

10578 (CA); Camptonville District, Tahoe National Forest, May, 1931, *Smith* (UC). NEVADA CO.: red clay soil, in oak hills, 5 mi. below Grass Valley, Auburn Highway, April 22, 1928, *Applegate 5359* (D); rocky soil by Baltic Trail, June 14, 1893, *Dudley* (D, NY); Nevada City, June 20–22, 1912, April 8, 1918, *Eastwood* (CA); 12 mi. s. of Grass Valley, May 8, 1937, *Eastwood & Howell 4345* (CA); "Bear Valley, montium Sacramento," June, 1847, *Hartweg 1987* (G, NY); in red clay soil, in the yellow pine belt, near Grass Valley, May 25, 1919, *Heller 13204* (CA, D, F, G, M, NY, PA); Rough and Ready, April 13, 1892, *Jepson* (UC); 5 mi. n. of Colfax, 2 mi. w. of Chicago Park, April 10, 1916, *Rolph* (UC). PLACER CO.: near river, Auburn, April 20, 1919, *Bentley* (D); dry soil under *Arctostaphylos* on burned east slope, east edge of Applegate, Sierra Nevada foothills, 600 m. alt., April 30, 1938, *Constance & Morrison 2172* (M, O, WS); Gold Run, April 26, 1923, *Mitchell* (CA); Dutch Flat, April, 1921, *Patterson* (D); under pines, Colfax, May 17, 1891, *Sonne* (M, UC); near Auburn, 1892, *Sonne* (RM); Towles Station, May, 1896, *Sonne* (NY). ELDORADO CO.: open forest n. of Camino, April 13, 1924, *Benson 19* (D); Camino, 7 mi. above Placerville, May 22, 1907, *Brandegee* (UC); near Kelsey, March 26, 1927, *Eastwood 14197* (CA); hillsides, May 22, 1903, *Gross 13* (D); Kelsey, April 21, 1883, *Jones* (CA, Clokey, M, NY, P); Placerville, May, 1923, *King* (CA); 10 mi. e. of Placerville, May 20, 1917, *Ramaley 11292* (UC); above Placerville, April 29, 1928, *Robbins* (P); Placerville Hills, April 21, 1928, *Vortriede* (CA). AMADOR CO.: Agricultural Station, 600 m. alt., April, 1891, *Hansen 47* (M); same locality, April, 1893, *Hansen 47* (D); Middle Fork, 390 m. alt., April 28, 1893, *Hansen 47* (P); 20 mi. above Sutter Creek, May 10, 1918, *Wood* (D). CALAVERAS CO.: Mokelumne Hill, *Blaisdell* (CA, Clokey, G); Angels Camp, April 11, 1923, *Eastwood 11625* (CA); Murphys, May 17, 1887, *Smith* (PA); in open yellow pine forest, near Avery, 1050 m. alt., May 23, 1921, *Tracy 5746* (P, UC). TUOLUMNE CO.: 1 mi. above Italian Bar, T. 3 N., R. 15 E., 600 m. alt., April 13, 1936, *Belshaw 2039* (UC); Sonora, April 25, 1925, *Green* (D); in chaparral beneath scattered pines in red clay, Big Oak Flat Road, 6 mi. e. of Groveland, 1140 m. alt., May 4, 1928, *Keck 412* (D).

6. **Calochortus Tolmiei** Hooker & Arnott, Bot. Beechey's Voy. p. 398. 1841.

Calochortus elegans sensu J. D. Hooker in Bot. Mag. Ser. III. **28**: *t. 5976*. 1872, not Pursh, 1814.

Calochortus Maweanus Leichtlin ex Baker in Journ. Linn. Soc. Lond. Bot. **14**: 305. 1874, as to plate cited.

Calochortus coeruleus var. *Maweanus* Jepson, Fl. Calif. **1**: 301. 1921.

Calochortus elegans var. *Lobbii* Baker in Journ. Linn. Soc. Lond. Bot. **14**: 305. 1874.

Calochortus glaucus Regel in Gartenflora **24**: 260, *t. 841, fig. 1*. 1875.

Cyclanthera caerulea Elwes ex Regel, *l. c.*

Calochortus Purdyi Hort. in Gard. Chron. Ser. III. **23**: 394, *fig. 147*. 1898 (spelled *"Purdeyi")*; Eastwood in Proc. Calif. Acad. Ser. III. Bot. **1**: 137, *pl. 11, fig. 8*. 1898.

Calochortus Maweanus var. *major* Hort. ex Purdy & Bailey in Bailey & Miller, Cyclop. Am. Hort. **1**:. 219. 1900; Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 120. 1901.

Calochortus Maweanus var. *roseus* Hort. ex Purdy & Bailey, *l. c.;* Purdy, *l. c.* 121.

Calochortus Galei Peck in Torreya **28**: 54. 1928.

Bulb ovoid with membranaceous coats; stem simple or more frequently with a branch in the axil of the bract-like cauline leaf (very rarely the cauline leaf is lacking in depauperate specimens), usually slender and somewhat flexuous, 0.5–3 dm. tall; basal leaf 1–4 dm. long, 2–30 mm. broad, tapering toward both ends, equalling to much exceeding the stem; inflorescences subumbellate, 1–5(–10)-flowered, bracts 2 to several, lanceolate to linear, attenuate, unequal, 1–7 cm. long; flowers white or cream-colored, or variously tinged with purple or rose, erect or spreading on slender pedicels which become stouter and strongly deflexed in fruit; sepals shorter than the petals, oblong-lanceolate, acute to acuminate, glabrous; petals obovate, cuneate, acute or obtuse, more or less fringed laterally and densely bearded on the inner face above the gland with long, slender hairs; gland transverse, arched upward, surface naked, depressed, bordered below with a broad, erose to shallowly fringed membrane, and above with one or more series of short, thick processes which occasionally are united at the base to form a second membrane, both processes and fringe of the lower membrane obscurely papillose; anthers lanceolate, acute to apiculate, usually shorter than the basally dilated filaments; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, acute or obtuse, 3-winged, nodding; seeds irregular, with dark brown, hexagonally reticulate coats.

From the species of the subsection ELEGANTI which do not have yellow flowers, *C. Tolmiei* is distinguished by its ordinarily branching stems and inconspicuously fringed petals which are usually bearded to the tip. As here delimited, it is the most variable species in the section EUCALOCHORTUS. It varies greatly from locality to locality in size, coloration of flowers and other characters of minor morphological importance. Specimens from a given locality may be very uniform in these respects, but be so slightly different from those from another locality that they cannot be separated satisfactorily. This condition is not surprising when one considers the numerous barriers which must exist within the present extensive range of the species, and the probability that many of these local races have existed for a long time without appreciable genetic intermingling with the rest of the species. As a whole, however, the major morphological characters are fairly uniform, so that the treatment of the species as a single, somewhat variable entity seems amply justified.

DISTRIBUTION. In dry, often rocky soil, Seattle, Washington, southward through the Willamette and Rogue River valleys of western Oregon, and the North Coast Ranges of California, to the Santa Cruz Peninsula; also in the upper Sacramento Valley.

WASHINGTON. KING CO.: Seattle, June, 1885, *Meany* (WS); Seattle, June 4, 1883, June, 1885, *Piper* (WS).

OREGON. WASHINGTON CO.: moist, open ground, Forest Grove, May 29, 1883, *Henderson 54* (G, UO); Forest Grove, May 16, 1888, *Henderson* (UO); Forest Grove, May, 1913, *Jones* (UC); Forest Grove, May 23, 1891, *Kelsey* (NY); Forest Grove, May 20, 30, 1893, *Lloyd* (NY); dry hillsides, near Forest Grove, April 1, 1926, *Thompson 590* (D, M); same locality, May 5, 1926, *Thompson 610a* (M). CLACKAMAS CO.: dry ground, near Estacada, June 11, 1927, *Thompson 2594* (D). YAMHILL CO.: summit of Coast Mts., 25 mi. w. of McMinnville, June 27, 1893, *Spillman 68* (F); prairie, McMinnville, April 5, 1871, *Summers 840* (UC). POLK CO.: rocky thicket on hillside, Eola, May 14, 1916, *Nelson 578* (D). MARION CO.: Fairmount Hill, Salem, May 13, 1918, *Brasher* (D); Silverton, June, 1881, *Howell* (PA); near Salem, June 28, 1893, *Howell 572, in part* (UC); open ground, Salem, May 15, 1919, *Hunt* (D); Rosedale, May 10, 1918, *Jones* (D); grassy hillside, Salem, April 24, 1915, *Nelson 75* (D); gravelly pasture, Salem, May 20, 1917, *Nelson 1158* (G); grassy thicket on Fairmount Hill, Salem, May 8, 1921, *Nelson 3595* (PA); Salem, May 6, 1910, *Peck 1378* (WU); field near Stayton, May, 30, 1932, *Peck 17002* (WU). LINN CO.: dry ground, 4 mi. s. of Jefferson, May 20, 1928, *Gale 215* (D, G, M); 2½ mi. e. of Corvallis, May 25, 1918, *Lawrence 1580* (D); open, dry ground, 4 mi. s. of Stayton, May 27, 1925, *Peck 13719* (F, G, WU, WS), type collection of *C. Galei* Peck; canyon of Santiam River, near Cascadia, June 30, 1926, *Peck 14530a* (WU); stream bank, near Cascadia, June 3, 1926, *Peck 14641a* (WU). BENTON CO.: roadways, open places, Corvallis, May 6, 1922, *Epling 5061* (UCLA); Philomath, June 21, 1926, *Gale* (PA); dry slope, 2 mi. n. of Corvallis, May 20, 1928, *Gale 212* (D, M, PA);

10 mi. n. w. of Corvallis, April 30, 1919, *Luedinghaus* (M); hillside, 2 mi. n. w. of Corvallis, 66 m. alt., May 18, 1912, *Owens* (D). LANE CO.: grassy south slope, Coburg Hills, Coburg, n. of Eugene, April 19, 1924, *Constance* (UC); grassy slopes, vicinity of Eugene, May 31, 1925, *Constance* (UC); open fields, Eugene, March 14, 1927, *Constance* (WS); grassy, moist, sunny slopes, Lorane Road, near Eugene, May 17, 1931, *Henderson 13578* (PA); grassy hills, Spencer Creek District, April 8, 1934, *Henderson 16170* (UO); meadows and copses, north base of Spencers Butte, May 3, 1934, *Henderson 16294* (UO); exposed hillsides, Coburg, May 7, 1923, *Wynd 1244* (M). DOUGLAS CO.: 19.6 mi. w. of Roseburg, on Marshfield Road, May 13, 1924, *Abrams & Benson 10519* (D); thickets and oak forests, dry hills about Roseburg, Umpqua Valley, April 13, 1924, *Cusick 3882* (WS); hillside, 6 mi. s. of Myrtle Creek, April 28, 1928, *Gale 45* (D, M, P, PA); sunny banks, West Fork of Cow Creek, near bridge, June 6, 1930, *Henderson 12784* (UO); dry slopes, 4 mi. w. of Dothan P. O., June 20, 1917, *Nelson* (G); Roseburg, May 13, 1920, *McMillen* (WU); east foot of Nine-Mile Mt., along West Fork Marial Trail, June 20, 1917, *Peck 3204* (WU); open woods, near Douglas-Josephine Co. Line, on West Fork Marial Trail, June 27, 1917, *Peck 3204* (F); open rocky bluffs at Roseburg, April 8, 1934, *Thompson 10159* (D, M, NY, P, WU); Myrtle Creek, May 18, 1915, *Smith* (CA). KLAMATH CO.: near Pinehurst, May, 1936, *Bellinger* (WU). JACKSON CO.: 1–2 mi. below Siskiyou, May 9, 1924, *Abrams & Benson 10221* (D); head of Jackson Creek, May 10, 1924, *Abrams & Benson 10264* (D); along wooded stream, Carter Creek, north slope of the Siskiyou Mts., s. of Ashland, May 30, 1896, *Applegate 725a* (D); in granite soil on dry oak hills, along Neil Creek, near Ashland, 720–840 m. alt., May 17, 1898, *Applegate 2164* (D); yellow pine woods, Jenny Creek, near Pinehurst, Cascade Mts., May 11, 1924, *Applegate 4052* (D, UC); oak woods, Rogue River, near Gold Hill, April 8, 1925, *Applegate 4155* (D); yellow pine woods, Jenny Creek, about 2 mi. above Pinehurst, Cascade Mts., May 26, 1925, *Applegate 4306* (D, UC); along wooded stream, Keene Creek Canyon, opposite sawmill, Cascade Mts., June 9, 1925, *Applegate 4354* (D, UC); dry, brushy hillside among oaks, Jacksonville Creek, above Jacksonville, April 5, 1926, *Applegate 4592* (D, UC); Wimer, March, April, 1889, *Hammond* (G); Sykes Creek, April 29, 1892, *Hammond 389* (M); near Wimer, May 13, 1892, *Hammond 389* (NY); hills, 20 mi. e. of Medford, June, 1927, *Heckner* (PA, WU); open woods and sunny slopes, Gold Hill, May 5, 1930, *Henderson 12263* (UO); manzanita hills, above Normal School, April 22, 1930, *Henderson 12458* (UO); north slope of Siskiyou Mts., just below summit and Inn, June 13, 1930, *Henderson 12679* (UO); Sunny Creek, n. of Siskiyou Camp, June 13, 1930, *Henderson 12786* (UO); Woodville, May 1, 1889, *Howell* (PA); near Woodville, May, 1890, *Howell 572, in part* (WS); Siskiyou Summit, 1380 m. alt., June 23, 1929, *Kildale & Gillespie 8279* (D); dry hillsides, R. R. crossing of Siskiyou Mts., s. of Ashland, 900 m. alt., June 9, 1899, *Leiberg 4018* (UO); mountainside, near Ashland, July 12, 1913, *Peck 1377* (WU); dry slope, 7 mi. s. e. of Ashland, June 19, 1927, *Peck 14996* (WU); sides of Ashland Canyon, Ashland, June, 1908, *Rose 8* (D); top of Siskiyou Mts., near Siskiyou, May 21, 1924, *Sherwood 608* (WU); Ashland, May 6, 1914, *Smith 663* (CA); wooded slopes of Table Rock, near Medford, April 12, 1934, *Thompson 10310* (M, NY, WU). JOSEPHINE CO.: Deer Creek to Kerby, May 11, 1924, *Abrams & Benson 10318* (D); Waldo, May 11, 1924, *Abrams & Benson 10362* (D); 4 mi. w. of Grants Pass, on Crescent City Road, May 11,

1924, *Abrams & Benson 10396* (D, RM); yellow pine and oak woods, east slope of Eight Dollar Mt., near Clear Creek, June 14, 1929, *Applegate 5725* (D); yellow pine woods, east slope of Eight Dollar Mt., Illinois River Valley, June 18, 1932, *Applegate 7284* (D); yellow pine woods, Waldo, June 19, 1932, *Applegate 7317* (D); Grants Pass, April 18, 1905, *Baker* (UC); near Waldo, May 18, 1936, *Bellinger* (WU); near Jones Creek, Grants Pass, April 13, 1913, *Dale* (D); meadow, Grants Pass, May, 1887, *Drake & Dickson* (F); Caves City to Waldo, April 12, 1934, *Eastwood & Howell 1356* (CA); dry ground, between Kerby and Selma, April 28, 1928, *Gale 18* (D, M, P, PA); hillside, 1 mi. s. of Wolf Creek, April 28, 1928, *Gale 43* (D, M, PA); south side of Sexton Mt., April 30, 1928, *Gale 84* (D, M, P, PA); dry hillside, near Waldo, May 20, 1928, *Gale 241* (D, M, PA); bushy plains, Silver Creek, 1871, *Hall 525* (F, G, M, NY); Grants Pass, May 16, 1910, *Heller 10116* (D); yellow pine forest, under and about shrubs, at the summit of the Siskiyou Mts., 1350 m. alt., June 21, 1922, *Heller 13630* (D, F, M, NY); moist meadows, Grants Pass, May 7, 1887, *Henderson 983* (G, UO); *Ceanothus* and manzanita hills, near Grants Pass, March 20, 1926, *Henderson 5784* (CA, D, M, RM, UO); wet, rocky, red-clay flat, base of Eight Dollar Mt., near Selma, April 14, 1926, *Henderson 5988* (D); wet, sticky soil amongst rocks, hills down Deer Creek, 4 mi. from Selma, April 11, 1926, *Henderson 5989* (CA, D, M, RM, UO); Greenback, 750 m. alt., July 10, 1905, *Kemp* (NY); Waldo, 450 m. alt., May 18, 1930, *Kildale & Kildale 9599* (D); Waldo Junction, 450 m. alt., May 18, 1930, *Kildale & Kildale 9636* (D); dry slope, 3 mi. w. of Merlin, March 24, 1927, *Peck 14767* (WU); Eight Dollar Mt., June 13, 1904, *Piper 5089* (G); Grants Pass, April 6, 1912, *Prescott* (D, F, WU); along Rogue River, 5 mi. e. of Grants Pass, May 16, 1924, *Sherwood 773* (WU); Merlin, May 17, 1915, *Smith* (CA); hills and plains, about Grants Pass, May 3, 1906, *Sweetser* (PA); Kerby, May 20, 1922, *Sweetser* (UO, WU); serpentine, Page Mt., May 21, 1923, *Sweetser* (UO); south side of Sexton Mt., April 7, 1927, *Thompson 2070* (D); south slope of Sexton Mt., April 12, 1927, *Thompson 2284* (M); forested slopes of Mt. Grayback, 1200–1800 m. alt., June 27, 1936, *Thompson 12973* (NY, PA, WS). COOS CO.: Shell Mound, Cape Arago, Sept. 24, 1911, *Haydon 21* (F, UCLA); county road to lighthouse, June 6, 1911, *Haydon 100* (CA, F); top of sea-cliff, near Charleston, July 3, 1926, *Scullen* (UO); camp ground at Bandon, June 3, 1928, *Thompson 4429* (D, G, M); open bluffs and beaches at Bandon, June 20, 1936, *Thompson 12788* (M). CURRY CO.: hills back of Gold Beach, May 16, 1924, *Abrams & Benson 10653* (D); in serpentine, summit, Pistol River to Brookings, May 16, 1924, *Abrams & Benson 10682* (D); near summit of Mt. Emily, along the Chetco River, July 13, 1929, *Andrews 11673* (UO); Illinois River, near confluence with Rogue River at Agness, May 9, 1932, *Applegate 7106* (D); grassy, sub-sunny hill of Chetco River, opposite Moore's, May 12, 1929, *Henderson 10134* (PA); hillside, Gold Beach, May 24, 1915, *Hoyt 42* (D, NY); along Agness-Port Orford Trail, 3 mi. n. w. of Agness, June 23, 1917, *Peck 3203* (WU); meadow, The Heads, Port Orford, June 20, 1919, *Peck 9055* (G, M, NY, WU); Snow Camp, 1200–1275 m. alt., July, 1916, *Thompson 63* (D); Brookings, May, 1915, *Thompson 103* (D); summit of Pistol River Mt., June 4, 1928, *Thompson 4549* (D); on serpentine ridges near Snow Camp Mt., Siskiyou Mts., 1350 m. alt., June 22, 1936, *Thompson 12853* (M). COUNTY UNCERTAIN: "Wallamet," *Tolmie* (Kew TYPE); "Oregon," *Lobb 257* (Kew, type of *C. elegans* var. *Lobbii* Baker); "Willamette Valley," cultivated specimen, *Purdy* (CA, type of *C. Purdyi* Eastwood).

CALIFORNIA. SISKIYOU CO.: Klamath River at Somesbar, April 14, 1928, *Kildale 4596* (D). DEL NORTE CO.: Adams Station, across Smith River, April 26, 1907, *Eastwood 115* (CA); Big Flat, 240 m. alt., June 29, 1930, *Kildale 9934* (D); French Hill, 600 m. alt., June 8, 1930, *Kildale & Kildale 9686* (D); openings among brush, summit of ridge, state line n. of Monumental, at head of Shelley Creek, California side, 930 m. alt., June 13, 1936, *Parks & Tracy 11380* (UC); rocky hillsides, Douglas Park, June 5, 1928, *Thompson 4525* (D, M, P). TRINITY CO.: head of Grizzly Creek, 1800 m. alt., July 21, 1911, *Alexander & Kellogg 269* (UC); brushy, high hill, near Weaverville, May 24, 1933, *Henderson 15445* (UO); Wildwood, 1140 m. alt., May 15, 1931, *Holman* (UC); Weaverville, April 22, 1915, *Junkens* (CA, G); Weaverville, April 25, 1916, *Junkens* (CA); Trinity Center, April 30, 1928, *Kildale 4604* (D); dry, stony slopes and in moister situations, near Weaverville, 615 m. alt., May 15, 1914, *Yates 268* (UC). HUMBOLDT CO.: Trinidad Head, 1899, *Dudley* (D, NY); open woods, prairies and ledges on Chalk Mt., near Bridgeville, June 12, 1936, *Harris & Harris 3330* (G); 25 mi. n. of Garberville, May 2, 1931, *Jussel* (CA); gravelly river terrace, Willow Creek Flat, 150 m. alt., May 2, 1926, *Kildale 1851* (D); Redwood Creek at Berry's, 285 m. alt., May 13, 1927, *Kildale 3248* (D); Willow Creek-Salyer Road, along Trinity River, 3 mi. n. of Willow Creek, April 27, 1929, *Kildale 7451* (D); Snow Camp, May 10, 1931, *Kildale 10563* (D); on ridges, Laribee Valley, May 25, 1930, *Parks & Tracy 0790* (F, UC); Eureka, April 28, 1918, *Paulson* (D, NY, UO); Long Prairie, June 7, 1879, *Rattan 13* (D, G); Lighthouse, Trinidad, June 3, 1911, *Smith 3759* (F, NY); edge of brush, Butler Valley, 150 m. alt., June 7, 1908, *Tracy 2612* (UC); Kneeland Prairie, 750 m. alt., June 8, 1908, *Tracy 2624* (UC); partial shade, Dinsmore's Ranch, in valley of Van Duzen River, opposite Buck Mt., 750 m. alt., June 22, 1913, *Tracy 4263* (UC); in sheltered, grassy place, sand dunes w. of Dows Prairie, 15 m. alt., May 30, 1917, *Tracy 4813* (CA, P, UC); along bluff between Alton and Burnells, near Hydesville, 30–90 m. alt., May 11, 1912, *Tracy & Babcock 3621* (UC). SHASTA CO.: brushy hillside among oaks, 4 mi. s. of Baird, near mouth of Pit River, April 25, 1928, *Applegate 5389* (D); Old Cow Creek Canyon, April 30, 1900, *Baker* (UC); Goose Valley, May 26, 1894, *Baker & Nutting* (UC); Redding, April 16, 1923, *Bethel* (CA); Montgomery Creek, April 18, May 6, 1923, *Bethel* (CA); Burney, May 31, 1923, *Bethel* (CA); Pollards Gulch, April 21, 1934, *Eastwood & Howell 1803* (CA); w. of Beegum, on old road from Red Bluff to Fortuna, April 23, 1933, *Holman* (UC); near Whiskeytown, April 6, 1927, *Howell 2310* (CA); Redding, April 4, 1910, *Jones 47* (G); Ydalpom, April 29, 1918, *McAllister* (CA); Iron Mt., April 14, 1914, *Smith 629* (CA, G). TEHAMA CO.: thickets of brush, Beegum, April 13, 1932, *Applegate 7048* (D, UC). BUTTE CO.: mountains above Chico, May 16, 1878, *Bidwell* (G); Forest Ranch, June, 1897, *Bruce 2407* (D); mountains, May, 1898, *Bruce 2407* (D, NY, P); Chico, April 10, 1903, *Copeland 3023* (F, G, M, P, UC); De Sabla, May, 1917, *Edwards* (D, NY); near Stirling, 1057 m. alt., June 7, 1913, *Heller 10812* (D); on serpentine, in the yellow pine and oak belt, near Magalia, May 5, 1918, *Heller* (CA); in fine gravel, open places, yellow pine and Kellogg oak belt, Stirling, 1056 m. alt., May 18, 1919, *Heller 13168* (CA, D, F, G, M, NY, PA); in rich soil about serpentine rocks, in the yellow pine belt, Magalia, April 29, 1928, *Heller 14534* (D, M, NY); Durham, April 17, 1932, *Morrison* (CA); near De Sabla, May 5, 1918, *Van Eseltine 1738* (G). MENDOCINO CO.: South Mill Creek Canyon, on the road to Carl Purdy's, near Ukiah, April 28, 1918, *Abrams 6924* (D); Ukiah, *Armstrong 893* (NY); yellow pine forest, Mt. Sanhedrin, 1260 m. alt., May 29, 1927, *Bacigalupi 1528* (D, P); dry hillsides, Ukiah, 1864, *Bolander 3933* (F, G, UC); Long Valley, 1866, *Bolander 4712* (F, M, UC); Rowes, 150 m. alt., May 11, 1901, *Chandler 1049* (UC); between Orrs Spring and Mendocino City, June 22, 1894, *Eastwood* (G); Ukiah, June 13, 1913, *Eastwood 3360* (CA); trail to Buck Rock, Forest Reserve, June 7, 1928, *Eastwood 15280* (CA); 10 mi. s. of Cummings, April 10, 1934, *Eastwood & Howell 1319* (CA); near Bell Springs, June 21, 1937, *Eastwood & Howell 4610A* (CA); sunny hillside, near Coolidge Redwoods, May 26, 1933, *Henderson 15432* (UO); grassy road along ocean bluffs, Elkhorn Cabins, May 25, 1933, *Henderson 15455* (UO); near Handleys, May, 1903, *McMurphy 170* (D, NY); Willits, May 21, 1921, *Piper* (CA); Ukiah, *Purdy* (F, G, UC); stony slopes, Sanhedrin, 900–1500 m. alt., May 1894, *Purpus 879* (UC); Round Valley, *Westerman* (UC). GLENN CO.: in open places in the forest, yellow pine belt, Houghtons Trail, near Bennet Spring, on the Newville-Covelo Road, 960 m. alt., June 3, 1915, *Heller 11946* (CA, D, F, G, M, NY). LAKE CO.: 6 mi. up grade, west side of Bartlett Mt., May 6, 1928, *Abrams 12418* (D); brushy hills, Egan's Ranch, Pine Grove, near and n. of Cobb Mt., March 8, 1934, *Applegate 8890* (D); southeast slope of Cobb Mt., near "Whispering Pines," 840 m. alt., May 1, 1927, *Baker 2105a* (UC); upland pine woods, Siegler Springs, April 29, 1923, *Blankinship* (CA); Dashiells, Mt. Sanhedrin, May 25, 1925, *Eastwood 12858* (CA); Elk Mt., 1110 m. alt., May 17, 1938, *Eastwood & Howell 5698* (CA); 4 mi. up Bartlett Springs Grade, May 6, 1928, *Wolf 1975* (D). NAPA CO.: 4 mi. s. of Middletown, May 4, 1928, *Abrams 12291* (D); Middletown Grade, near Lake Co. Line, May 5, 1893, *Jepson* (UC); Calistoga, April, 1922, *Wright* (CA). SONOMA CO.: Coast Road, April 5, 1898, *Baker 5* (UC); hills back of Dillon's Beach, April, 1899, *Baker* (UC); Bodega, April, 1901, *Eastwood* (G, NY); Bodega Bay, April 11, 1902, *Heller & Brown 5263* (D, F, G, M, NY, P, PA). MARIN CO.: Inverness, April, 1920, *Kelley* (CA); Point Reyes, May, 1906, *Eastwood* (CA). SAN MATEO CO.: Kings Mt., May 20, 1902, *Abrams 2473* (D, M, NY); new La Honda Grade, May 15, 1922, *Bacigalupi* (P); Kings Mt., May 10, 1902, *Baker 796* (P); wet shaded places, above Woodside, Santa Cruz Mts., 240 m. alt., May 3, 1930, *Benson 2107* (G); dry woods, near Pescadero Creek, June 6, 1895, *Dudley* (D, P); Kings Mt., April 27, 1907, *Dudley* (D); Kings Mt., Sierra Morena Ridge, May 18, 1920, *Hichborn* (M); Kings Mt., April 27, 1907, *Randall 225* (D). SANTA CLARA CO.: in chaparral on rocky slope, Mt. Umunhum, 1020 m. alt., May 9, 1920, *Davis* (D); Uvas Canyon, April 18, 1926, *Howell 1909* (CA). SANTA CRUZ CO.: on road up to Cattermoles, Loma Prieta, May 30, 1893, *Dudley* (D); California Redwood Park, June 7, 8, 1919, *Shockley* (D). COUNTY UNCERTAIN: cultivated specimen, bulbs from California (Leningrad, type of *C. glaucus* Regel; M, photograph).

7. Calochortus coeruleus (Kellogg) Watson in Proc. Am. Acad. **14**. 263. 1879.

Cyclobothra coerulea Kellogg in Proc. Calif. Acad. **2**: 4. 1863.

Calochortus Maweanus Leichtlin ex Baker in Journ. Linn. Soc. Lond. Bot. **14**: 305. 1874, as to specimen cited *(Lobb 242)*.

Bulb ovoid, with membranaceous coats; stem low, usually scapiform, slender, erect or somewhat flexuous; basal leaf 1–2 dm. long, 2–10 mm. broad, tapering toward both ends, greatly exceeding the stem; inflorescence subumbellate, 1–5(–10)-flowered, bracts 2 to several, lanceolate to linear, acuminate, unequal; flowers bluish, erect or spreading on slender pedicels which become strongly deflexed in fruit; sepals slightly shorter than the petals, oblong-lanceolate, acuminate, glabrous; petals obovate, acute or obtuse, clawed, inner face smooth, laciniate-ciliate and bearded above the gland with long, coarse hairs; gland transverse, arched upward, surface naked, slightly depressed, bordered below with a broad, ascending, erose to shallowly fringed membrane, and above with a series of short, thick processes, both processes and membrane-fringe densely papillose; anthers large, oblong, acute, usually equally or exceeding the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, acute, nodding; seeds with hexagonally reticulate coats.

Calochortus coeruleus is distinguished from *C. elegans,* which it resembles in size and habit, by its large, oblong anthers and more conspicuously ciliate, more densely bearded petals, which are not papillose on the inner face.

DISTRIBUTION. California: in open coniferous forests, Lassen and Tehama counties, southward in the Sierra Nevada to Amador County.

CALIFORNIA. LASSEN CO.: Susanville, July 2, 1892, ex herb. *Brandegee* (D). PLUMAS CO.: without exact locality, May, 1876, *Austin* (F, G); Forest Lodge, Greenville, June 11, 1927, *Eastwood 14456* (CA, P); Nelson Point, 1350 m. alt., June 25, 1912, *Hall 9395* (UC); open hillsides, Massack Creek, 1410 m. alt., May 25, 1919, *Wagner 261* (D). TEHAMA CO.: in loose soil (leaf mold) among creeping shrubs, summit of mountain between Mineral and Viola, 3 mi. n. of Mineral, July 15, 1938, *Ownbey & Ownbey 1743* (G, Kew, M, O, RM, UC). BUTTE CO.: Colby, July, 1896, *Austin 74* (M); near Stirling, 1056 m. alt., June 7, 1913, *Heller 10812* (D, F, G, M, NY, PA, UC); open gravelly places in the yellow pine forest, Butte Meadows, June 20, 1928, *Heller 14623* (D, M, NY). SIERRA CO.: Camptonville District, Tahoe National Forest, May, 1931, *Smith* (UC). NEVADA CO.: Bear Valley, *Bolander & ''Kellock''* [*Kellogg*] (G); by Baltic Trail, June 14, 1893, *Dudley* (D); Bear Valley, *Hartweg 1988* (G, NY). PLACER CO.: Cisco, 1872, *Bolander & Kellogg* (G); Red Point, 1350 m. alt., July, 1892, *Price* (D); Blue Canyon, 1410 m. alt., June 23, 1908, *Walker 1242* (UC). ELDORADO CO.: Armstrongs Station, 1590 m. alt., June 13, 1895, *Hansen 1071* (P, UC). AMADOR CO.: Hams Station, 1500 m. alt., May, 1895, *Hansen 1071* (D, M). COUNTY UNCERTAIN: ''California,'' 1857, *Lobb 242* (Kew).

7a. Calochortus coeruleus var. **nanus** (Wood) Ownbey, n. comb.

Calochortus elegans var. *nanus* Wood in Proc. Acad. Philad. [**20**]: 168. 1868.

Calochortus nanus Piper in Bull. Torr. Bot. Club **33**: 537. 1906.

Anthers smaller, lanceolate, short-apiculate; otherwise as in the species.

In the character of the anthers this variety approaches *C. elegans,* but by all other criteria, including geographical distribution, it clearly belongs with *C. coeruleus.*

Distribution. California: in open coniferous woods, vicinity of Mount Shasta, southward in the North Coast Ranges to Lake County; infrequent except in the Mount Shasta Region.

California. siskiyou co.: dry woods, Sisson, May 28, 1895, *Applegate 725* (D, G); Sisson, June 10, 1896, *Baker 97* (UC); McCloud, May 22, 1923, *Bethel* (CA); north side of Mt. Shasta, 1500–2700 m. alt., June 11–16, 1897, *Brown* (M, NY); Mt. Bradley, near Shasta Retreat, 1800 m. alt., July 5, 1911, *Condit* (UC); Shasta Springs, May 20, 1923, *Eastwood 11856* (CA, NY); Dunsmuir, 600 m. alt., June, 1903, *Hall & Babcock 4033* (UC); near Sisson, June 15, 1905, *Heller* (CA); in open places in the forest, Metcalf's Ranch, northeast base of Mt. Eddy, 1140 m. alt., June 1920, *Heller 13386* (D, F, M, NY); Shasta Springs, May, 1920, *Herrin* (CA); Salmon Summit, via Horn Creek Trail, 1950 m. alt., July 2, 1928, *Kildale 5348* (D); Dunsmuir, May 12, 1913, *Smith 208* (CA); Sisson, June 9, 1914, *Smith 713* (CA, G); mountains w. of Yreka, June, 1866, *Wood 967* (G type). shasta co.: in pine woods, Castle Crags, May 30, 1904, *Piper 6398* (G); Sweetbriar Creek, Castella, 1050 m. alt., June 6, 1916, *Rosenbaum* (UC). trinity co.: Trinity Summit, June 21–23, 1899, *Davy 5744½* (UC); Scott Mts., n. of Carrville, June 25, 1937, *Eastwood & Howell 4987* (CA); Trinity Summit, July 1–15, 1901, *Manning 8* (UC). humboldt co.: Blake Lookout, South Fork Mt., 1700 m. alt., June 7, 1931, *Gillespie 10586* (D). glenn co.: barren soil under conifers, Plaskett Meadows, 8 mi. s. e. of Mendocino Pass, July 12, 1938, *Ownbey & Ownbey 1724* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS). lake co.: Mt. Hull, 1950 m. alt., July 25, 1913, *Hall 9558* (UC).

7b. Calochortus coeruleus var. **Westoni** (Eastwood) Ownbey, n. comb.

Calochortus Westoni Eastwood in Proc. Calif. Acad. Ser. IV. Bot. **20**: 136. 1931.

Petals lanceolate, acute, laciniate-ciliate laterally only; anthers lanceolate, apiculate; otherwise as in the species.

This variety is very close morphologically to *C. coeruleus* var. *nanus,* but apparently may be distinguished by its much narrower, less conspicuously fringed petals. The three plants on the type sheet are very uniform in their short scapes and numerous (5–7) flowers, but these characters may be expected to vary when more material is available. Two statements in the original description should be corrected. (1) The number of bracts is not "generally two," but is approximately equal to the number of flowering pedicels which they subtend. (2) The gland is not "covered with short crisped hairs," but with short, thick processes which are densely beset distally with long papillae.

DISTRIBUTION. California: known only from the type collection.

CALIFORNIA. KERN CO.: saddle at summit of the Greenhorn Mts., above Shirley Meadows, May 20, 1927, *Weston 680* (CA TYPE).

8. **Calochortus elegans** Pursh, Fl. Am. Sept. **1**: 240. 1814.

Cyclobothra elegans Bentham ex Lindley in Bot. Reg. **20**: under *t. 1662.* 1834.

Calochortus elegans α. minor Hooker, Fl. Bor. Am. **2**: 183. 1839.

Calochortus elegans β. major Hooker, *l. c.*

Bulb ovoid, with membranaceous coats; stem usually scapiform, 5–15 cm. tall, slender and more or less flexuous; basal leaf 1–2 dm. long, 2–10 mm. broad, tapering toward both ends, usually greatly exceeding the stem; inflorescence subumbellate, 1–2(–7)-flowered, bracts 2 to several, lanceolate to linear, acuminate, unequal; flowers greenish white, often with a purple crescent on each petal above the gland and a similar blotch on each sepal, erect or spreading on slender pedicels which become strongly deflexed in fruit; sepals shorter than the petals, oblong-lanceolate, acute to acuminate, inner face minutely papillose and usually glabrous; petals oblanceolate or broader, acute or obtuse, clawed, inner face papillose, fringed laterally and densely bearded above the gland with long, slender, more or less flexuous hairs; gland transverse, arched upward, surface depressed, naked, bordered below with a narrow, ascending, deeply fringed membrane, and above with one or more series of short, thick processes, both processes and the fringe of the membrane densely papillose; anthers lanceolate, long-apiculate, exceeding the basally dilated filaments in length;

ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic to orbicular, obtuse or acute, 3-winged, nodding; seeds irregular, with light brown, hexagonally reticulate coats.

This species is most closely related to *C. coeruleus*, with which it agrees in size and habit, but from which it is distinguished by its lanceolate, apiculate anthers and its papillose, less conspicuously fringed and bearded petals.

Distribution. Grassy hillsides and open coniferous woods, central Idaho and adjacent Washington and Oregon.

Idaho. latah co.: Moscow, May, 1900, *Abrams 605* (D, M, NY, UC); Cedar Mt., June 6, 1925, *Bartlow* (RM); northeast ridge, Cedar Mt., July 2, 1911, *Beattie 4312* (WS); Moscow Mt., June 1, 1895, *Cloud* (WS); rocky outcrop in *Abies-Thuja-Pseudotsuga* forest, crest of ridge west of Cedar Peak, May 23, 1936, *Constance, Peters & Dillon 554* (WS); Moscow Mt., July, 1929, *Epling* (UCLA); grassy hills, Moscow, May 30, 1894, *Henderson 2483* (RM); Cedar Creek, 1900, *Ried* (WS); shady places near Juliaetta, June 8, 1892, *Sandberg, MacDougal & Heller 344* (CA, G, NY). nez perce co.: near Summit, May 21, 1903, *Bashor* (WS); near Lake Waha, Craig Mts., June 25, 1902, *Beattie* (WS); about Lake Waha, 1050–1200 m. alt., June 3, 4, 1896, *Heller & Heller 3172* (M, NY, UC); dry slopes, near Lake Waha, 700 m. alt., July, 1891, *Leiberg* (UO); hillsides, region of Lake Waha, May 20, 1892, *Sandberg, MacDougal & Heller 196* (CA, D, F, G, M, NY, P, PA, WS); prairie hillside on foothills of Craig Mts., 1 mi. n. w. of Lake Waha, May 15, 1938, *Sharsmith 3553* (O). idaho co.: grassy slopes above Sheep Creek, T. 25 N., R. 2 W., Snake River Canyon, 600 m. alt., May 16, 1936, *Constance, Rollins & Dillon 1602* (D, M, WS); S. 1, T. 25 N., R. 1 W., Nez Perce National Forest, 1410 m. alt., July 10, 1922, *Deasy 6* (UM); rocky soil on dry, bare ridge, 1 mi. s. e. of the mouth of Sheep Creek, T. 25 N., R. 2 W., Snake River Canyon, 660 m. alt., May 16, 1936, *Gaines 72* (UC); moist, grassy hillsides in the Seven Devils Mts., above the Snake River, Snake River Canyon, and above Sheep Creek, May 16, 1936, *Meyer 251* (O); old burn, moist, north slope, Three Creeks Saddle, 1260 m. alt., June 13–30, 1937, *Packard 273* (WS); Lolo Trail, ridge above Clearwater, Aug. 23, 1880, *Watson 418* (G). lemhi co.: rocky ground along ridge, in medium stand of lodgepole pine, North Fork of Crone Creek Trail, 2100 m. alt., June 16, 1936, *Blair* (O); open hillside, Salmon, 1500 m. alt., June 27, 1920, *Payson & Payson 1805* (CA, Clokey, G, M, NY, RM). elmore co.: Twin Springs, May 17, 1937, *Price* (O).

Washington. whitman co.: moist slope, ¾ mi. w. of Pullman, 600 m. alt., May 11, 1930, *Clarke* (WS); hillsides, Pullman, June 6, 1896, *Climer* (WS); meadows, Pullman, July 4, 1896, *Elmer 62* (P); meadows, Pullman, June 20, 1896, *Elmer 220* (RM); near Pullman, 1892, *Henderson 2483* (G); Pullman, May 16, 1892, *Hull 811* (WS); in dense wooded land, north side of Kamiak Butte, May 28, 1922, *Parker 416* (WS); Pullman, June 10, 1896, *Piper* (UO); under dense brush of *Prunus emarginata*, Kamiak Butte, May 14, 1938, *Sharsmith 3548* (O). asotin co.: pine woods, 1½ mi. w. of Anatone, May 15, 1926, *Gessell* (P, WS); open woods, Blue Mts., June 1928, *Jones 981* (WS); Wenatchee Ranger Station, Blue Mts., 1650 m. alt., July 19, 1923, *Shaw* (WS). garfield

CO.: north exposure, bunch-grass prairie, 8 mi. s. of Pomeroy, April 28, 1934, *Pickett 1490* (WS). COLUMBIA CO.: Blue Mts., T. 9 N., R. 40 E., July, 1913, *Darlington* (WS); open ridges, Wolf Fork of Touchet River, May 30, 1925, *St. John, Davison & Scheibe 6956* (WS). WALLA WALLA CO.: Blue Mts., June 10, 1911, *Hill* (WS); hillsides, Waitsburg, May 1, 1897, *Horner B485* (G).

OREGON. WALLOWA CO.: summit of Imnaha-Snake Divide, 23 mi. above Imnaha, July 12, 1933, *Peck 17625* (WU); dry woods, 28 mi. n. of Enterprise, June 21, 1934, *Peck 18221* (D, NY, WU); west slope of Mt. Wilson, 1260 m. alt., May 20, 1897, *Sheldon 8106* (M, NY). UNION CO.: Kamela, 1260 m. alt., June 1, 1910, *Heller 10143* (PA). UMATILLA CO.: gravelly bottom, in thickets, along the Umatilla River, 1 mi. above Bingham Station, 530 m. alt., May 21, 1908, *Cusick 3238* (D, F, G, M, NY, RM, UC, UO, WS); 15 mi. n. e. of Pendleton, May 17, 1923, *Sherwood 376* (WU); near Emigrant Springs, near summit of Blue Mts., June 14, 1928, *Thompson 4725* (D, M). BAKER CO.: dry, shaded soil of Pine Creek, May 25, 1898, *Cusick 1894* (F, G, M, P, UC, WS).

8a. Calochortus elegans var. **selwayensis** (St. John) Ownbey, n. comb.

Calochortus selwayensis St. John in Proc. Biol. Soc. Wash. **41**: 192. 1928.

Gland shorter, nearly straight, not depressed; petals only moderately bearded; otherwise as in the species.

DISTRIBUTION: Open coniferous forests in the Bitterroot Mountains of western Montana and adjacent Idaho.

MONTANA. SANDERS CO.: without exact locality, May, 1938, *Hecht* (Beal). MISSOULA CO.: near Bear Creek, upper Lolo Valley, June, 1916, *Kirkwood* (UM); in woods on flats, Lolo Valley, about 15 mi. from Lolo, July 9, 1921, *Kirkwood 1054* (M); Lolo Divide, June 28, 1937, *Rose 491* (O). RAVALLI CO.: in pine woods, Lake Como, 1440 m. alt., June 19, 1906, *Blankinship 792* (F, M, P, RM, UC, UM).

IDAHO. SHOSHONE CO.: Bearskull Mt., St. Joe National Forest, July, 1929, *Epling* (UCLA); near Stevens Peak, 1980 m. alt., Aug. 4, 1895, *Leiberg 1467* (M, NY, UO). BENEWAH CO.: Santa, July, 1929, *Epling* (UCLA); along St. Maries River, 990 m. alt., June 27, 1895, *Leiberg 1087* (G, M, NY, UO). IDAHO CO.: moist, shady place beside Paradise Creek, T. 32 N., R. 14 E., 1200 m. alt., June 29, 1927, *Baker* (WS TYPE); same locality, June 24, 1928, *Baker* (G, WS); near Indian P. O., Lolo Trail, Bitterroot Mts., July 21, 1902, *Piper 4104* (WS). COUNTY NOT DETERMINED: in the Palouse country and about Lake Coeur d'Alene, June, July, 1892, *Aiton* (D, F, M, NY).

8b. Calochortus elegans var. **oreophilus** Ownbey, n. var.[27]

Membrane below the gland erose to shallowly fringed; hairs of petal usually more sparse, shorter and thicker; petals more conspicuously fringed; otherwise as in the species.

[27] **Calochortus elegans** var. **oreophilus** var. nov., membrana subter glandulam erosa vel anguste fimbriata; pilis petali plerumque sparsioribus brevioribus crassioribus; petalis insignius fimbriatis; aliter similis speciei.

Distribution. On grassy slopes or in open coniferous forests, Cascade Mountains from eastern Douglas County, Oregon, southward to the California Line, and in the mountains of western Siskiyou County, California.

Oregon. douglas co.: openings in fir woods, between Hershberger Mt. and Rabbit Ears, Rogue River Watershed, July 13, 1929, *Applegate 6027* (D); lodgepole pine woods, beyond Diamond Lake, towards Windigo Pass, 1500 m. alt., July 9, 1929, *Henderson 12881* (PA, UO); Diamond Lake, June 21, 1931, *Howell 6880* (CA); dry, grassy slope about Diamond Lake, July 13, 1936, *Peck 19273* (WU). klamath co.: open ground in moss, side of Mt. Scott, 1350 m. alt., July 22, 1899, *Barber 36* (G); dry, grassy soil, Longs Prairie, June 26, 1931, *Evans 329* (UO); dry, wooded slope, west side of Four-Mile Lake, July 2, 1931, *Peck 18543* (WU); Red Blanket Creek, Crater Lake Park, July 2, 1928, *Wynd 2089* (UO). jackson co.: dry, open, rocky summit, west side of Abbott Butte, on boundary line between Jackson and Douglas counties, 1650 m. alt., June 29, 1898, *Applegate 2582* (D); dry yellow pine woods, near summit of Little Chinquapin Mt., Jenny Creek Region, Cascade Mts., May 25, 1925, *Applegate 4298* (D, UC); dry, grassy slopes, near Abbott Butte, 2000 m. alt., July 6, 1899, *Leiberg 4238* (UO); summit of Mt. Ashland, July 15, 1913, *Peck 1379* (WU); open ground, summit of Cascade Mts., along Ashland-Klamath Falls Road, July 4, 1920, *Peck 9251* (D, G, M, NY, PA, WU); dry woods, 1 mi. w. of Pinehurst, June 19, 1927, *Peck 15019* (WU).

California. siskiyou co.: Humbug Mt., May 1, 1910, *Butler 1260* (UC); Shackleford Creek, June 5, 1910, *Butler 1508* (UC); Marble Mt., 2400 m. alt., June, 1901, *Chandler 1646* (D, M, NY, UC); summit, Siskiyou Mts., June 16, 1894, *Howell 296* (G, UO); loose, somewhat rocky soil, open slopes, 2½ mi. n. w. of Dry Lake Lookout, summit of Siskiyou Mts., July 19, 1938, *Ownbey & Ownbey 1748* (CA, Clokey, D, F, G, Kew, M type, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS).

9. **Calochortus Lobbii** Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 122. 1901, excl. syn.

Calochortus subalpinus Piper in Contrib. U. S. Nat. Herb. **11** [Fl. Wash.]: 195. 1906; Bull. Torr. Bot. Club **33**: 538. 1906.

Bulb ovoid, with membranaceous coats; stem usually scapiform, 0.5–3 dm. tall, erect or flexuous; basal leaf 1–3 dm. long, 2–15 mm. broad, tapering toward both ends, usually equalling or exceeding the stem; inflorescence subumbellate, 1–5(–7)-flowered, bracts 2 to several, lanceolate to linear, acuminate, unequal, 1–5 cm. long; flowers yellowish white, sometimes lavender-tinged, frequently with a narrow purple crescent on each petal above the gland, and usually with a purple, glandular spot near the base of each sepal, erect or spreading on rather slender pedicels which become stouter and strongly deflexed in fruit; sepals shorter than the petals, oblong-lanceolate, acute to acuminate, inner face minutely papillose, glabrous; petals broadly obovate, cuneate, obtuse or acute, inner face densely papillose, fringed laterally and moderately bearded nearly to the apex above the gland with long, slender hairs; gland transverse, arched upward, more or less deeply depressed, bordered below with a narrow, ascending, deeply fringed membrane, and above with a narrow, merely crenate membrane, invested toward the upper portion of the enclosed surface with rather long, slender processes, both processes and fringe of the lower membrane densely long-papillose; anthers lanceolate, long-apiculate, usually longer than the basally dilated filaments; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, usually acute, 3-winged, nodding; seeds irregular, with pale yellow, hexagonally reticulate coats, and terminal, netted crests.

Calochortus Lobbii is not closely related to any other species of the section EUCALOCHORTUS. In size and habit, it somewhat approaches *C. apiculatus,* but the characters of the gland and the glandular spots on the sepals distinguish it from this and all other species.

DISTRIBUTION. In loose, volcanic soils, southern Washington from the vicinity of Mount Adams and Mount St. Helens, southward in the Cascade Mountains to the region of the Three Sisters in central Oregon.

WASHINGTON. YAKIMA CO.: Klickitat River, June 24, 1899, *Flett 1124* (WS); sandy soil, Signal Peak, S. 25, T. 9 N., R. 13 E., 1200 m. alt., July 3, 1932, *Heidenreich 188* (WS); grassy slopes of Mt. Adams, Aug. 8, 1882, *Henderson 982* (D); Mt. Adams, 1883, *Henderson* (G); North Fork of Tieton River, July 26, 1911, *Hinman* (UCLA); Mt. Adams, Aug. 9, 1894, *Lloyd* (NY); loose soil on mountain slopes, Mt. Paddo (Adams), June, Aug., 1883, *Suksdorf* (F, PA); dry alpine meadows of Mt. Adams, 1500 m. alt., July 30, 1934, *Thompson 11134* (M, NY); moist soil of mountain meadows, Surprise Lake, near Goat Rocks, S. 2, T. 11 N., R. 11 E., east slope of Cascade Mts., 2220 m. alt., Aug. 21, 1936, *Wilcoxon 80* (WS). KLICKITAT CO.: near Trout Lake, base of Mt. Adams, July 10, 1879, *Henderson* (UO); loose sandy soil in open *Pinus ponderosa* forest, along road, about 2 mi. n. of Glenwood, June 18, 1938, *Meyer 1496* (WS); open pine woods, Trout Lake, June, 1923, *Pearson 347* (WS); loose, volcanic soil, Falcon Valley, July 1, Aug., 1881, *Suksdorf* (F, NY). SKAMANIA CO.: Observation Peak Lookout, Columbia National Forest, 1260 m. alt., June 28, 1925, *Ingram 1914* (WS); open, park-like areas, Observation Peak Trail, 1050 m. alt., *Kienholz* (UO); Ice Cave, near Trout Lake, Aug. 5, 1894, *Lloyd* (NY); high mountains, Aug. 11, 1886, *Suksdorf* (G).

OREGON. HOOD RIVER CO.: Cloud Cap Inn, Mt. Hood, 1800 m. alt., July 25–28, 1922, *Abrams 9386* (D, P, RM); Mt. Hood, 1950 m. alt., Aug. 26, 1899, *Barber 230* (G); rich meadows, south side of Mt. Hood, 1800 m. alt., July 3, 1926, *English* (WS); Mt. Hood Region, June, 1920, *Hawver* (CA); alpine glades, Mt. Hood, Aug. 13, 1896, *Henderson* (RM); grassy alpine slopes, Mt. Hood, June, Aug., 1924, *Henderson 810* (G, M); middle elevations, Mt. Hood, Aug., 1891, *Howell & Howell* (UO); Mt. Hood, Aug. 5, 1881, *Howell* (F, G, PA), type collection of *C. subalpinus* Piper; Mt. Hood, Aug., 1889, *Howell* (UO); Mt. Hood, 1500 m. alt., July 31, 1897, *Jones* (P); Mt. Hood, Aug., 1898, *Savage, Cameron & Lenocker* (F, M); dry south slope of Bluegrass Ridge, Mt. Hood, July 31, 1927, *Thompson 3312* (D); Bluegrass Ridge, Mt. Hood, 1500–1650 m. alt., July 22, 23, 1928, *Thompson 5063* (D, G, M, PA); Cloud Cap, Mt. Hood, Summer, 1929, *Van Dyke* (CA); Mt. Hood, Aug. 20, 1866, *Wood 1576* (G). CLACKAMAS CO.: south side of Mt. Hood, 2100 m. alt., July 9, 1931, *Howell 7271* (CA); grassy slopes and banks, above Government Camp, south slope of Mt. Hood, 1800 m. alt., Aug. 18, 1936, *Munz 14450* (D, P, UC, WS); dry ridge, 4 mi. w. of Table Rock, May 30, 1924, *Peck 13219* (PA, WU); Paradise Park, Aug. 4, 1927, *Thompson 3397* (D, WU); Mt. Lowe, July, 1918, *Wash* (UO). WASCO CO.: Barlow Road, near Mt. Hood, July 24, 1894, *Lloyd* (NY); dry hillside, near White River, Mt. Hood, 1050 m. alt., July 23, 1928, *Thompson 5011* (D). MARION CO.: Jefferson Park, Aug. 9, 1933, *Leach* (WU); top of House Mt., May 31, 1926, *Peck 14641* (WU); dry slope, 4 mi. s. e. of Breitenbush, *Peck 16228* (WU); dry slope, 2 mi. s. of Breitenbush Lake, Aug. 10, 1935, *Peck 18780* (WU); very dry south slope, Jefferson Park, S. 11, T. 10 S., R. 8 E., Mt. Jefferson Primitive Area, Aug. 13, 1936, *Peters 197* (WS); Mt. Jefferson, Aug., 1897, *Purdy* (Kew), TYPE COLLECTION. JEFFERSON CO.: loose soil, open pine-larch forest, 1 mi. s. of Camp Sherman, near the source of the Metolius River, July 29, 1938, *Ownbey & Ownbey 1799* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); dry talus slope about Harvey Lake, Aug. 13, 1935, *Peck 18837* (WU), *18837a* (WS). LANE CO.: summit of Horse Pasture Mt., June 16, 1934, *Andrews 436* (UO); McKenzie Pass, Skyline Trail, 2 mi. from Frog Camp, July 1, 17, 1934, *Andrews* (UO); rocky ridges above Benson Lake, western side of the Cascade Summit, near McKenzie Pass, July 11, 1924, *Constance* (UC); sunny, loose soil, McKenzie Pass, July 28, 1934, *Henderson* (UO); dry, open, loose soil, McKenzie Pass, July 28, 1935, *Henderson 17581* (UO); south side of Jackass Ridge, Bohemia Mt., 1650 m. alt., Aug. 9, 1927, *Henderson & Patterson 14226* (PA, UO); very loose soil, borders of meadows and edge of coniferous woods, 5½ mi. w. of McKenzie Pass, July 27, 1938, *Ownbey & Ownbey 1797* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS,); summit of Cascade Mts., along McKenzie Pass 1700 m. alt., July 11, 1914, *Peck 3200* (WU); summit of Horse Pasture Mt., 10 mi. s. of McKenzie Bridge, 2000 m. alt., July 1, 1914, *Peck 3201* (G, WU); dry ground along McKenzie Pass, 7 mi. w. of summit of Cascade Mts., Aug. 7, 1920, *Peck 9807* (D, G, M, NY, PA, WU); Castle Rock, near Three Sisters, June 10, 1903, *Sweetser* (UO). DESCHUTES CO.: Island Meadows, 3 mi. w. of Elk Lake, June 27, 1934, *Andrews* (UO); headwaters of Deschutes River, Aug. 16, 1897, *Coville & Applegate 550* (D).

10. Calochortus apiculatus Baker in Journ. Linn. Soc. Lond. Bot. **14**: 305. 1874.

Bulb ovoid, with membranaceous coats; stem usually scapiform, 1–3 dm. tall, usually stout and erect; basal leaf 1–3 dm. long, 5–15 mm. broad, tapering toward both ends, usually shorter than the stem; inflorescence subumbellate, 1–5-flowered, bracts 2 to several, lanceolate to linear, acuminate, unequal, 1–5 cm. long; flowers yellowish white, sometimes pencilled with purple, erect or spreading on rather stout pedicels which become strongly deflexed in fruit; sepals shorter than the petals, oblong-lanceolate, acute to acuminate, inner face minutely papillose below, glabrous; petals obovate to oblanceolate, acute or obtuse, clawed, inner face densely papillose, fringed laterally and moderately bearded on the lower half above the claw with slender, more or less flexuous hairs; gland small, depressed, nearly circular in outline, bordered below with a dark-colored, deeply fringed membrane, which may be lacking, surface covered with short, thick processes, uniformly scattered or aggregated at the upper margin; anthers lanceolate, long-apiculate, equalling or exceeding the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, acute, 3-winged, nodding; seeds irregular, with light brown, hexagonally reticulate coats.

Calochortus apiculatus is easily separated from all other species of the subsection ELEGANTI by its small, nearly circular, dark-colored gland.

DISTRIBUTION. Dry, rocky slopes in open, coniferous woods, southwestern Alberta and adjacent northwestern Montana, westward to British Columbia and northeastern Washington.

ALBERTA. Waterton Lake, July 28, 1895, *Macoun 13813* (G, NY); Crows Nest Pass, Lat. 49° 30′, Aug., 1897, *Macoun 25049* (NY).

BRITISH COLUMBIA. Mountain sides, woods, Creston, Kootenay Co., July 12, 1917, *Anderson* (WS).

MONTANA. GLACIER CO.: Grinnell Lake, Glacier Park, July 13, 1923, *Hollis & Hollis 5724* (M, UCLA); moist woods near Cutbank Creek, Glacier National Park, July 15, 1934, *Jones 5489* (UC); on open rocky slopes, trail to Grinnell Glacier, Glacier National Park, July 28, 1928, *Peirson 8093* (UC); Blackfeet Indian Reservation, Aug., Sept., 1909, *Thompson* (NY); hills, Midvale, June 16–18, 1903, *Umbach 104* (D, F, NY, RM); Two Medicine Lake, Glacier National Park, July 2, 1930, *Van Dyke* (CA); Lake St. Marys, Glacier National Park, July 3, 1930, *Van Dyke* (CA). FLATHEAD CO.: Olney, July 12, 1937, *Bachert 11* (UM); Whitefish, June 8, 1937, *Bachert 613* (UM); Whitefish Flat, July 9, 1937, *Bohinger 24* (UM); Big Fork, July 14, 1908, *Butler 925, 926* (NY); MacDougal, July 3, 1908, *Butler 992* (NY); MacDougal Peak, July 30, 1908, *Butler 3029* (NY); MacDougal Peak, vicinity of Flathead Lake, July 31, 1908, *Clemens* (D, F, M); Kalispell, 900 m. alt., June 8, 1937, *Harding 873* (UM); alpine meadow, on ridge directly n. of Hidden Lake, Glacier National Park, 2400 m. alt., July 26, 1933, *Hitchcock 1900* (P, UM); alpine, MacDougal Peak, Flathead Lake, 1950 m. alt., July 30, 1908, *Jones 9213* (P, UM); Daphnia Lake, Big Fork, 870 m. alt., July 18, 1908, *Jones 9214* (P); MacDougal Peak, Flathead Lake, 1200 m. alt., July 30, 1908, *Jones 9215* (P); Big Fork, June 15, 1904, *Jones* (G, UC); Elk Mt., near Kalispell, Blackfeet National Forest, *Krukoff* (NY); Red Meadow Creek, North Fork of Flathead River, June 15, 1928, *Lemmon* (UM); Big Fork, 1000 m. alt., July 9, 1901, *MacDougal 584* (NY, UM); MacDougal Peak, 1700 m. alt., Aug. 2–10, 1901, *MacDougal 839* (NY, UM); open woods, Snyder Creek, Glacier National Park, June 18, 1926, *St. John 4852* (WS); slopes of Kootenai Mts., Big Fork, Aug. 11, 1901, *Umbach 76* (F, NY, PA); Glacier Basin, below Sperry Glacier, 1800–1950 m. alt., Aug. 5, 1901, *Vreeland 1052* (NY); Columbia Falls, June 24, 1894, *Williams 635* (G, M, NY, RM, UM); in open woods along Camas Creek, 1050 m. alt., July 11, 1937, *Yuncker & Yuncker 6797* (F). LEWIS AND CLARK CO.: woodlands, near headwaters of Blackfoot River, July 14, 1883, *Canby 325* (G); woodlands, along Clear Creek, July 13, 1881, *Canby 325* (PA); Priests Pass, Helena, July, 1892, *Starz* (M); North Fork of Sun River, Aug. 1887, *Williams 635* (F, G). LAKE CO.: dry roadside, Biological Station, east shore of Flathead Lake, June 15, 1938, *Barkley & Reed, 2626A, 2626B* (G, M, O); Flathead Lake, 1050 m. alt., June 14, 1937, *Fluto 884* (UM); Yellow Bay, June, 1913, *Kirkwood* (Clokey). POWELL CO.: Pinewood, Aug., 1902, *Burns 89* (RM). MISSOULA CO.: mountain woods, Missoula, July, 1923, *Burtness* (Clokey); Rattlesnake Creek, July, 1916, *Hughes* (UM); Evaro, 1200 m. alt., July 13, 1909, *Jones* (P); open woods, benches, Grant Creek, near Missoula, July 4, 1922, *Kirkwood 1053* (M, UM); Johnston Gulch, Bonner, June 14, 1925, *Maclay* (UM); Rattlesnake Creek, n. of Missoula, May 22, 1935, *Rose 169* (O, UM); Rattlesnake Creek, n. of Missoula, June 15, 1937, *Rose 484* (O); Sunset, 1901, *Scheuber 256* (NY); Granite Canyon, near Missoula, Aug. 5, 1881, *Watson 420* (G). LINCOLN CO.: rocky hillside, Zeigler Mt., T. 33 N., R. 28 W., 1620 m. alt., July 8, 1928, *Snow* (WS). COUNTY NOT DETERMINED: near Teddy, Lewis and Clark Forest, July 7, 1937, *Kramer 19* (UM); woods, Sin-yale-a-min Lake, 1000 m. alt., June 18, 1901, *MacDougal 303* (NY, UM).

IDAHO. BONNER CO.: hillside, Hope, May 18, 1914, *Dunkle 426* (RM); in woods along trail, 2 mi. below Priest River Experiment Station Lookout, July 19, 1928, *Ellison* (UCLA); open places, roadsides, Priest River Experiment Station, 750 m. alt., July, 1923, *Epling 5725* (F, M, UCLA); Hope, July, 1929, *Epling* (UCLA); near lower end of Priest Lake, 600 m. alt., July 26, 1900, *MacDougal 151* (NY); Priest Lake, Aug., 1901, *Piper 3777* (WS); near Coolin, Aug. 10, 1923, *Piper* (WS). SHOSHONE CO.: in limestone talus on open southwest slopes of Grizzly Peak, n. of Coeur d'Alene River, Coeur d'Alene National Forest, S. 3, T. 51 N., R. 3 E., July 3, 1938, *Sharsmith 3592* (G, M, O). KOOTENAI CO.: in open places, Coeur d'Alene, June 12, 1909, *Johnson 147* (RM); dry ground, south end of Lake Pend Oreille, 610 m. alt., June, 1889, *Leiberg* (M, UO); ridges s. from Wiessners Peak, region of Coeur d'Alene Mts., 2000 m. alt., July 26, 1895, *Leiberg 1370* (RM, UO); sand plain, Coeur d'Alene, June 17, 1927, *St. John 8264* (WS);

rich woods, near Farmington Landing, Lake Coeur d'Alene, July 2, 1892, *Sandberg, MacDougal & Heller 532* (CA, D, G, NY, PA, UC); 1½ mi. n. of Hayden Lake, May 29, 1925, *Smith* (WS). COUNTY NOT DETERMINED: near log chute from Fox Creek into Big Creek, Kaniksu Forest, June 16, 1928, *Ellison* (UCLA); Roman Nose Mt., Pend Oreille Forest, July, 1929, *Epling* (UCLA).

WASHINGTON. STEVENS CO.: Biglow Gulch, July 3, 1923, *Large 46* (D, WS). SPOKANE CO.: Liberty Lake, June 3, 1919, *Kienholz* (WS); Spokane, *Reed* (WS).

STATE NOT DETERMINED. Hills, Pend Oreille and Kootenay rivers, June, 1861, *Lyall* (G, Kew TYPE; G, NY, PA, WS, photographs of type).

Subsection 3. NUDI.[28]

Flowers campanulate, erect or spreading; petals obovate, cuneate, not fringed, glabrous or nearly so; stems scapiform or leafy, branched in one species; fruits elliptic, 3-winged, usually nodding.

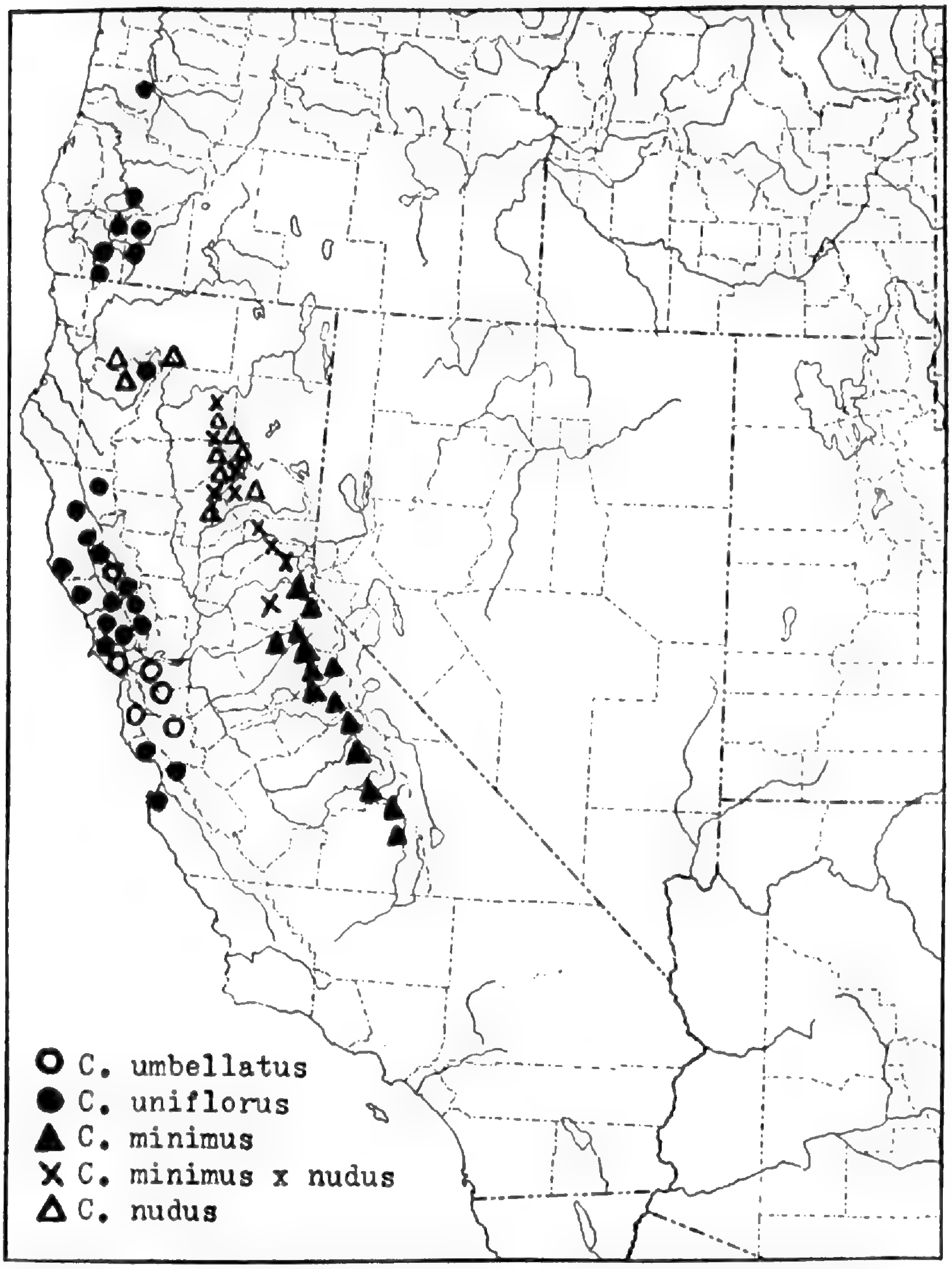
The four species included under this subsection fall into two natural groups. The first of these includes *C. umbellatus* and *C. uniflorus,* which are distinguished by their non-scapiform stems and pocket-like glands. The second group is characterized by scapiform stems and straight or arched glands. Here are placed *C. minimus* and *C. nudus.* The latter is of interest in that it is the only species in the first three subsections of EUCALOCHORTUS that normally has erect capsules.

11. Calochortus umbellatus Wood in Proc. Acad. Philad. [**20**]: 168. 1868.

Calochortus collinus Lemmon in Erythea **3**: 49. 1895.

Bulb ovoid, with membranaceous coats; stem low, usually 2-branched, each of the branches subumbellately 2–6-flowered, very rarely bulbiferous; basal leaf 2–4 dm. long, 5–15 mm. broad, tapering toward both ends, much exceeding the inflorescence; cauline leaf one (rarely two), linear, attenuate; bracts 2 to several, linear, attenuate, unequal; flowers white or pale lilac, often with a purple spot on each petal near the gland and a similar spot near the base of each sepal, erect or spreading on slender pedicels which become strongly recurved in fruit; sepals shorter than the petals, elliptic-lanceolate, acuminate, glabrous; petals broadly obovate, cuneate, rounded

[28] NUDI subsect. nov., floribus campanulatis erectis aut patentibus; petalis obovatis cuneatis non fimbriatis glabris aut subglabris; caulibus scapiformibus aut foliatis, in una specie ramosis; capsulis ellipticis 3-alatis plerumque cernuis.



Map 3. Distribution of the species and hybrids of the subsection NUDI.

and erose above, not ciliate, inner face with a few slender hairs near the gland, otherwise naked or nearly so; gland convex basally, truncate above, covered with a broad, ascending membrane which is fringed at its upper margin, bordered above with a row of short processes, the enclosed surface naked; anthers oblong, obtuse or acute, shorter than the basally dilated filaments; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit oblong, obtuse, 3-winged, nodding; seeds irregular, with dark brown, hexagonally reticulate coats.

Calochortus umbellatus is closely allied to *C. uniflorus,* but is easily distinguished from that species by its smaller, more numerous flowers, taller, branched stem, shorter pedicels and almost complete lack of bulblets. Their habitats are also very distinct; *C. umbellatus* is found on hillsides, whereas *C. uniflorus* prefers low, wet meadow lands.

DISTRIBUTION. California: Coast Ranges from Lake County to Santa Clara County, particularly abundant on the hills about San Francisco Bay.

CALIFORNIA. LAKE CO.: mountain, near Kelseyville, April, 1901, *Bowman* (D). MARIN CO.: Pipeline Trail, ½ mi. e. of Rattlesnake Camp, Mt. Tamalpais, April 29, 1922, *Abrams 8082* (D); 1½ mi. below Western Peak, Mt. Tamalpais 480 m. alt., *Bacigalupi* (D); between Mill Valley and Redwood Canyon, April, 1904, *Baker* (UC); Mt. Tamalpais, Feb. 26, 1900, *Chandler 482* (UC); Mt. Tamalpais, Feb. 22, 1901, *Chandler 750* (UC); road to Muir Woods, Mill Valley, April 8, 1913, *Condit* (UC); Big Carson Ridge, June 7, 1925, *Eastwood 12981* (CA); in chaparral, Mt. Tamalpais, April 20, 1917, *Grant 927* (D, NY); Pipeline Trail, April 5, 1925, *Howell 905* (CA); Mill Valley, April 28, 1917, *Mason* (Clokey); on ridges above Muir Woods, April, 1926, *Parks* (D, F, M, NY, P, UC); Eastwood Place, Mt. Tamalpais, May 6, 1923, *Sutliffe* (CA). CONTRA COSTA CO.: Walnut Creek, s. of Camp 69, May 1, 1862, *Brewer 1035* (UC); San Pablo Hills, March 24, 1900, *Hall* (UC); hills e. of St. Mary's College, May 14, 1933, *Howell 11261* (CA). ALAMEDA CO.: near Lake Temescal, April, 1891, *Bioletti* (Kew, UC); Oakland Hills, April, *Bolander* (D, G, NY); near Mountain View Cemetery, April 3, 1890, *Cannon* (CA); Oakland Hills, March, 1900, *Carruth* (CA); head of Long Canyon, e. of Oakland, May 9, 1891, *Chesnut & Drew* (UC); under brush and in open, northeast end of Redwood Ridge, March 4, 1932, *Constance 333* (UC); Laundry Farm, *Dunn* (G); Laundry Farm, April, 1894, *Eastwood* (UC); Grizzly Peak, Berkeley, May 10, 1907, *Eastwood* (CA); Berkeley, April 15, 1895, *Jepson* (D, M); on open, grassy hillside, Claremont Canyon, in hills back of Berkeley, April 3, 1920, *Johnston* (P); Berkeley, March 14, 1914, *Jones 46* (G); Laundry Farm, March 14, 1917, *Kelley* (CA); Oakland Hills, April, 1878, *Kellogg* (D); at Thompson's, San Antonio Creek, April 18, 1868, *Kellogg & Harford 1003, in part* (CA, G); near Lake Chabot, May, 1895, *Merrill* (P); Berkeley, April 24, 1892, *Michener & Bioletti 2121* (NY, UC); Oakland, *Purdy* (F, G); Laundry Farm, *Purdy* (UC); Oakland Hills, *Purdy* (UC, type of *C. collinus* Lemmon); North Berkeley, April 27, 1914, *Shuquist* (UC). SAN MATEO CO.: Belmont, June 17, 1893, *Davy 795* (UC). SANTA CLARA CO.: steep hill-slope above Santa Isabella Creek, northern base of Mt. Hamilton, 525 m. alt., March 30, 1934, *Sharsmith 672* (WS); edges of chaparral, western canyon slope of Long Branch Creek, southeast end of Mt. Day Ridge, Mt. Hamilton Range, 720 m. alt., May 4, 1935, *Sharsmith 3026* (O).

12. Calochortus uniflorus Hooker & Arnott, Bot. Beechey's Voy. p. 398, *t. 94.* 1841; J. D. Hooker in Bot. Mag. Ser. III. **25**: *t. 5804.* 1869.

Cyclobothra uniflora Kunth, Enum. Pl. **4**: 669. 1843.

Calochortus lilacinus Kellogg in Proc. Calif. Acad. **2**: 5. 1863.

Bulb ovoid, with membranaceous coats; stem very short, barely reaching above the surface of the ground, usually not branched, bulbiferous in the axils of the cauline leaves, subumbellately 1–5-flowered; basal leaf 1–4 dm. long, 5–20 mm. broad, tapering toward both ends, much exceeding the inflorescence; cauline leaves 1 to 3, linear, attenuate, reduced upward; bracts 2 to several, linear, attenuate, unequal; flowers lilac, often with a purple spot on each petal about the gland, erect on very long pedicels which usually become characteristically recurved in fruit; sepals shorter than the petals, elliptic-lanceolate, acuminate, glabrous; petals broadly obovate, cuneate, rounded and erose-denticulate above, occasionally with a few inconspicuous hairs on the lateral margins and usually with a few hairs in the vicinity of the gland, otherwise naked or nearly so; gland convex basally, truncate above, covered with a broad, ascending membrane which is fringed at its upper margin, bordered above with a row of slender processes, the enclosed surface naked; anthers oblong, obtuse or acute, shorter than the basally dilated filaments; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit oblong, obtuse, narrowly 3-winged, usually nodding; seeds irregular, with dark brown, hexagonally reticulate coats.

This species is easily distinguished by its bulbiferous habit, short stem and long pedicels.

DISTRIBUTION. In low meadow lands, southwestern Oregon and southward to Monterey County, California.

OREGON. LANE CO.: swale banks, moist, sunny roadsides, about 7 mi. n. w. of Eugene, April 16, 1934, *Henderson 16224* (UO, WU); meadow, 6 mi. n. w. of Eugene, April 16, 1934, *Rose 34206* (CA). DOUGLAS CO.: Canyonville, April, 1881, *Howell* (F, PA). JACKSON CO.: Queens Branch, near Wimer, May 17, 1892, *Hammond 390* (M, NY, UO); Woodville, May 16, 1890, *Howell* (PA). JOSEPHINE CO.: dry ground, 4 mi. s. of Waldo, May 19, 1928, *Gale 247* (D, M); moist meadows, Merlin, May 7, 1887, *Henderson 1378* (G, UO); grassy borders of wet meadows, Grants Pass, May 10, 1887, *Henderson* (UO); Grants Pass, May 27, 1887, *Henderson* (UO); wet, rocky, red-clay flat, base of Eight Dollar Mt., near Selma, April 14, 1926, *Henderson 5988* (CA, D, M, RM, UO); moist, disintegrated granite, New Hope Road, June 8, 1930, *Henderson 12785* (UO); Grave Creek, May 21, 1884, *Howell* (G); in wet meadows, Grants Pass, May, 1884, *Howell 295* (UO); Grants Pass, May 12, 1885, *Howell 1396* (M, NY, UC, UO); meadow, near Waldo Junction, May 18, 1930, *Kildale & Kildale 9591* (D); Grants Pass, June 10, 1904, *Piper 6282* (G); pasture, Grants Pass, May 4, 1912, *Prescott* (F, G, WU); moist, subwooded flats, Grants Pass, May 3, 1906, *Sweetser* (PA).

CALIFORNIA. TRINITY CO.: Preacher Meadow, June 25, 1937, *Eastwood & Howell 4930* (CA); Carrville, *Reynolds* (CA). MENDOCINO CO.: Ukiah, 1866, *Bolander 4666* (F, M); swamps, Long Valley, 1866, *Bolander 4710* (G, UC); Sherwood Valley, June 17, 1899, *Dudley* (D); 6 mi. s. of Point Arena, May 31, 1937, *Eastwood & Howell 4483* (CA, NY); Ukiah, May 8, 1869, *Kellogg* (D); Ukiah, April, 1881, *Purdy* (G); Ukiah, *Purdy* (F, G, UC); Round Valley, 1898, *Westerman* (UC). LAKE CO.: wet places, Siegler Springs, April 29, 1923, *Blankinship* (CA); low woods, Siegler Springs, April 30, 1929, *Blankinship* (M); near Adams Springs, May 18, 1938, *Eastwood & Howell 5764* (CA); Piner's pasture, vicinity of Kelseyville, April 12, 1904, *Irwin 64* (UC); Kelseyville, April 1, 1931, *Jussel 93* (CA); Jordan Park, Coleman Estate, April 30, 1932, *Jussel* (CA); Four-Mile Grade, open meadow near Mendocino County Line, June 5, 1933, *Lodge 379* (UC); 2 mi. n. of Middletown, May 4, 1928, *Wolf 1897* (D). NAPA CO.: damp adobe meadow opposite Myrtledale Geyser, 1½ mi. n. of Calistoga, March 27, 28, 1926, *Bacigalupi 1249* (D, G, NY, P); meadows, Calistoga, April 19, 1903, *Baker 1979* (CA, F, G, M, NY, P, RM, UC); Calistoga Geyser, April 23, 1927, ex herb. *Baker 2202a* (D); Calistoga, June 5, 1915, *Eastwood 4632* (CA); Calistoga, May 2, 1918, *Eastwood 6879* (CA, Clokey); Calistoga, April 20, 1892, *Greene* (UC); Myrtledale Hot Springs, near Calistoga, March 27, 1926, *Howell 1757* (CA); St. Helena, April 1, 1921, *Hunt* (CA); salt marsh, near Calistoga, May 2, 1893, *Jepson* (UC); Conn Valley, *Jepson 6254* (G); in alkaline field, geysers just n. w. of Calistoga, 110 m. alt., April 4, 1931, *Keck 1097* (D, G, M, P, PA, UC). SONOMA CO.: between Stewarts Point and Sea View, April 5, 1898, *Baker* (UC); Sonoma Valley, near Santa Rosa, April, 1899, *Baker* (UC); Sonoma, *Bioletti* (UC); in meadow, Mark West, 1864, *Brewer 3960* (UC); Santa Rosa, April 24, 1921, *Eastwood 10336* (CA). MARIN CO.: Lake Lagunitas, May 11, 1918, *Campbell* (CA); Lagunitas, April 28, 1918, *Grinnell* (D). SANTA CRUZ CO.: Soquel Point, April 27, 1902, *Thompson* (D). SAN BENITO CO.: Aromas, April 6, 1915, *Eastwood 4186* (CA). MONTEREY CO.: Monterey, 1889, ex herb. *Abbott* (CA, NY); pine woods near Cypress Point, Monterey, May 22, 1860–62, *Brewer 656* (G); woods, Monterey, May 12, 1901, ex herb. *Congdon* (D); locality uncertain, but presumably near Monterey, "California," *Douglas* (G, NY), TYPE COLLECTION; grassy meadows, April 14, 1894, *Dudley* (D); pine woods, Pacific Grove, May 16, 1903, *Heller 6729* (D, F, G, NY, P, PA, RM, UC, UO); Monterey, March, 1868, *Kellogg & Harford 1003, in part* (M, NY); vicinity of reservoir, Pacific Grove, July 6, 1906, *McGregor 50* (D); Monterey, 1850, *Parry* (NY); back of Pebble Beach Lodge, 17-Mile Drive, March 28, 1910, *Randall 155* (D); in field, off road to Point Lobos, April 17, 1910, *Randall* (D); near Pebble Beach, 17-Mile Drive, April 30, 1910, *Randall 417* (D).

13. Calochortus minimus Ownbey, n. sp.[29]

Calochortus elegans var. *subclavatus* Baker in Proc. Linn. Soc. Lond. Bot. **14**: 305. 1874.

Bulb ovoid, with membranaceous coats; stem scapiform, low, usually reaching only to the surface of the ground, subumbellately 1–3(–10)-flowered; basal leaf 1–2 dm. long, 3–10 mm. broad, usually greatly exceeding the inflorescence; bracts usually 2, opposite, lanceolate, acuminate, unequal, 1–2(–6) cm. long; flowers small, white, erect or spreading on slender pedicels which become strongly deflexed in fruit; sepals shorter than the petals, lanceolate, acuminate, glabrous; petals obovate, cuneate, usually acute, erose-denticulate above, not ciliate, naked or with a few slender hairs near the gland; gland transverse, straight, surface naked, not depressed, bordered below with a broad, ascending, laciniate or fringed membrane, the margin of which is minutely papillose; anthers linear-oblong, acute, about equalling the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, obtuse, 3-winged, nodding; seeds irregular, with hexagonally reticulate coats.

Specimens of *C. minimus* were included under *C. nudus* by Watson, but the original description of that species was drawn from specimens collected in Plumas County by Mrs. R. M. Austin. Purdy interpreted the plant here described as *C. nudus,* and proposed the name *C. shastensis* for the more northern species. This interpretation has been followed by

[29] **Calochortus minimus** sp. nov., bulbo ovoideo membranaceo-tunicato; caule scapiformi humili plerumque perveniente tantum usque ad summam terram, subumbellate 1–3(–10)-floro; folio basali 1–2 dm. longo, 3–10 mm. lato, plerumque inflorescentiam multo superante; bracteis plerumque 2, oppositis lanceolatis acuminatis inaequalibus, 1–2(–6) cm. longis; floribus parvis albis erectis aut patentibus in pedicellis gracilibus et fructu insigniter deflectentibus; sepalis petalis brevioribus lanceolatis acuminatis glabris; petalis obovatis cuneatis plerumque acutis apice eroso-denticulatis non ciliatis glabris aut paucis pilis gracilibus prope glandulam; glandula transversa recta, superficie nuda, non depressa, subter membrana lata adscendente laciniata aut fimbriata marginata, cuius margo minute papillosus est; antheris lineari-oblongis acutis filamentis basilariter dilatatis subaequilongis; ovario 3-alato, stylo brevi, stigmate persistente trifido; capsula elliptica obtusa 3-alata cernua; seminibus irregularibus testis hexagono-reticulatis.

later writers, apparently without consulting either Watson's specimens or his original description.

C. minimus is the smallest of the *Calochorti.* It is very uniform throughout the range here given, but northward it has hybridized with *C. nudus* to such an extent that it can be said to occur there only as *minimus*-like individuals. Since *C. nudus* is its dominant element, this hybrid population is included under that species, where it is more fully discussed.

DISTRIBUTION. California: in open coniferous woods, eastern Eldorado County, southward in the Sierra Nevada to Tulare County.

CALIFORNIA. ELDORADO CO.: Grass Lake, near Lake Tahoe, July 17, 1904, *Baker* (UC); Lake Lucille, Glen Alpine Region, July 25, 1906, *Eastwood 1027* (CA); Fallen Leaf, trail via Lake of Woods to Desolation Valley, July 10, 1920, *Ehlers 882* (UC); near Forni, Pyramid Peak, 2190 m. alt., Aug. 1, 2, 1903, *Hall & Chandler 4754* (UC); near Velma Lakes, on trail to Eagle Lake, Lake Tahoe Region, June 28, 1925, *Howell 1238* (CA); Velma Lakes, Lake Tahoe Region, July 22, 1928, *Jussel* (CA); very damp soil, in the woods near Grass Lake, near Glen Alpine Spring, July 19, 1909, *Lathrop* (D); Wrights Lake, July 7, 1935, *Lillard* (P); Grass Lake, Aug. 8, 1909, *McGregor 6* (D, NY); Desolation Valley, 2250 m. alt., Aug. 18, 1909, *McGregor 163* (D, NY); Grass Lake Trail, 2070 m. alt., July 23, 1907, *Pendleton & Reed 1028* (UC); Grass Lake Trail, Glen Alpine, 2100 m. alt., July 23, 1907, *Pendleton & Reed 1073* (UC); Glen Alpine, vicinity of Lake Tahoe, 1860–2700 m. alt., July 6–21, 1901, *Setchell & Dobie* (UC); Lake of the Woods, meadow near lake shore, 2430 m. alt., July 15, 1913, *Smiley 58* (G). CALAVERAS CO.: Big Trees, June, 1874, *Edwards* (NY); "Calaveras," Aug., 1883, *Meehan* (PA); Big Trees, May 15, 1887, *Smith* (PA); near Dunbar Crossing, May 21, 1923, *Steinbeck* (CA); in open yellow pine forest, near Avery, 1140 m. alt., May 23, 1921, *Tracy 5763* (UC). TUOLUMNE CO.: Peach Growers Mill, Middle Fork of Tuolumne River, about 2 mi. s. of Mather, May 9, 1926, *Bacigalupi 1448* (D TYPE, NY, P); Hetch-Hetchy Valley, June, 1900, *Bioletti* (UC); North Fork Griswold Creek, near Grizzly Meadows, Stanislaus National Forest, June 1, 1934, *Quick 1264* (CA); Cow Creek, 1890 m. alt., June 10, 1937, *Quick 1804* (CA); Sequoia, June, 1906, *Saunders* (CA); in wet meadow, Tioga Road, near Dark Hole, 2310 m. alt., Aug. 23, 1916, *Smiley 881* (C); marshy meadow near Aspen Valley, Tioga Road, 1920 m. alt., Aug. 24, 1916, *Smiley 908* (G); Pinecrest Recreation Area, Stanislaus National Forest, 1780 m. alt., June 8, July 29, 1934, *Wiggins 6794* (D). MARIPOSA CO.: near Stoneman Orchard, Yosemite Valley, 1200–1350 m. alt., June 19, 1911, *Abrams 4389* (D, G, NY, P); Glacier Point, Yosemite Valley, July, 1902, *Camp* (D); Fatman Mt., May 13, 1894, ex herb. *Congdon* (UC); Big Tree Grove, June 15, 1894, *Dudley* (D); back of Glacier Point, Yosemite, 1872, *Gray* (G); low ground, Yosemite Valley, 1230 m. alt., June 7, 1911, *Hall 8878* (UC); moist, shady place, Chilnualna Fall Trail, Wawona Valley, 1650 m. alt., May 27, 1923, *Howell 27* (CA); near Glacier Point, Yosemite Valley, June 30, 1913, *Kennedy 3002* (CA); near Yosemite Valley, 1875, *Muir 813* (M, PA); Camp Curry, Yosemite Valley, May 23, 1915, *Stone*

(PA); Mariposa Big Trees, Yosemite National Park, June 13, 1894, *Tompkins* (D). MADERA CO.: Shut Eye Pass, Sierra National Forest, 1950 m. alt., July 15, 1912, *Abrams 4941* (D); moist granitic sand, under *Pinus* and *Populus*, edge of North Fork of Willow Creek at Lower Soquel Meadows, near Kelty Meadows, above Sugar Pine, Sierra Nevada, 1500 m. alt., June 20, 1938, *Constance 2373* (O); Mt. Raymond, head of Big Creek, July 13, 1901, *Dudley* (D). FRESNO CO.: Pine Ridge, 1650 m. alt., June 15–25, 1900, *Hall & Chandler 177* (D, M, NY, PA, UC); Balanced Rock Trail, General Grant National Park, July 4, 1927, *Jussel* (CA). TULARE CO.: Sequoia National Park, 1920 m. alt., June 29, 1929, *Anderson* (UCLA); near Mineral King, Sierra Nevada, Aug. 3, 1891, *Coville & Funston 1447* (G); Hockett Meadows, July 14, 1904, *Culbertson 4219* (CA, F, G, M, NY, P, UC); granite slopes of Mt. Silliman, 3000 m. alt., July 5, 1928, *Derby* (CA); vicinity of Camp Alta, region of Tule-Little Kern Divide, 2700–3000 m. alt., July 31, 1895, *Dudley 993* (D); north ravine, Mt. Silliman, 3320 m. alt., July 29, 1896, *Dudley 1507* (D); granitic soil, trail s. of Calison Cabin, vicinity of Homers Nose, region of Sequoia National Forest, 2700 m. alt., July 13, 1897, *Dudley 1814* (D); in grass beneath pines, Hockett Meadows, 2550 m. alt., Aug. 5, 1904, *Hall & Babcock 5641* (UC); Kaweah River Basin, June 30, 1901, *Hopping 40* (UC); near Wielan Creek, Sequoia National Park, June 29, 1931, *Larson* (CA); open woods, Middle Tule River, 2100–2400 m. alt., June, 1896, *Purpus 1786* (UC). COUNTY UNCERTAIN: "California," 1857, *Lobb 243* (Kew).

14. Calochortus nudus Watson in Proc. Am. Acad. **14**: 263. 1879, excl. syn.

Calochortus shastensis Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 125. 1901.

Calochortus nudus var. *shastensis* Jepson, Fl. Calif. **1**: 301. 1921.

Bulb ovoid, with membranaceous coats; stem erect, scapiform, 5–15 cm. tall, subumbellately 1–3(–6)-flowered; basal leaf 1–2 dm. long, 5–15 mm. broad, tapering toward both ends, usually much exceeded by the inflorescence; bracts usually 2, opposite, lanceolate, acuminate, unequal, 1–2(–5) cm. long; flowers erect, white to pale lavender; sepals shorter than the petals, lanceolate, acuminate, glabrous; petals broadly obovate, cuneate, rounded and erose-denticulate above, not ciliate, naked or occasionally with a few slender, flexuous hairs near the gland; gland transverse, straight or arched upward, surface naked, not depressed, bordered below with a broad, ascending, fringed membrane, the fringe minutely papillose; anthers linear-oblong, obtuse or acute, about equalling the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, acute at both ends, 3-winged, erect; seeds irregular, with light brown, hexagonally reticulate coats.

The above description was drawn from a considerable series of specimens from the vicinity of Mount Shasta, where the species is remarkably uniform. The specimens on which Watson based his original description were collected in Plumas County and are essentially the same. The name, *C. nudus,* however, has been generally associated with the preceding species, an interpretation which could be justified only by disregarding Watson's description and applying the name to the Yosemite specimen which he cites first, but does not describe.

In the vicinity of Mount Shasta, *C. nudus* is uniform, but south of the Pit River it occurs in pure stand with decreasing frequency as one passes southward. In eastern Eldorado County and southward, only the closely related *C. minimus* occurs. Between the two geographically, there is a bewildering assortment of plants showing independent recombination of the various morphological characters which separate these two species. Such a population can be explained only as the result of long-continued hybridization and probably repeated backcrossing, particularly with *C. nudus.* Pure *C. minimus* does not seem to occur within the area, so the entire population is here referred to *C. nudus.* It should be pointed out, however, that occasional specimens are so close to *C. minimus* that they can be distinguished only by geographical criteria.

From the evidence at hand, it appears that at one time these species were separated by a geographical barrier which allowed evolution to proceed in different directions on either side. As a result there was developed a robust northern race, with larger flowers, rounded petals, taller stems, proportionately shorter and broader basal leaves, and erect fruits which are acute at both ends. It is fortunate that this race has persisted in a nearly pure state in the Mount Shasta Region, and at numerous stations in the northern Sierra Nevada.

The southern race is smaller in all respects, the petals acute, the stems very short, the basal leaves greatly exceeding the inflorescences, the fruits obtuse and nodding on slender, strongly deflexed pedicels. This race now occupies the southern Sierra Nevada, from eastern Eldorado County southward to Tulare County, in a practically pure condition. The combinations of morphological criteria which separate the southern from the northern race are certainly of specific value. It is only when the intervening population is considered that there is any possibility of another interpretation.

Today the barrier which once separated these two species has disappeared, and they have come together again. Since they were presumably derived from the same stock, the hybrids are fertile and interbreed both among themselves and with both parent species. The result should be a population possessing the characters of both parents, but in different combinations. This is exactly what we find. It is impossible to separate such a population completely into two, or even a dozen, categories, yet the morphological differences between *C. nudus* and *C. minimus* do not permit their inclusion within a single species. Even if such an assignment were possible, it would be undesirable, as it would obscure their probable genetic relationships.

It is of interest to note that this hybrid population occupies almost the identical geographical region, as does the cytologically demonstrated amphidiploid *Penstemon neotericus* Keck. Furthermore, the distributions of the parent species are, in both cases, strikingly similar.

Distribution. California: in low meadows and in the coniferous woods about their margins, vicinity of Mount Shasta southward to western Eldorado County.

California. siskiyou co.: South Fork of Salmon River, 1500 m. alt., July 16, 1911, *Alexander & Kellogg 249* (UC); Tamarack Road, near summit of Mt. Shasta, July 9, 1898, *Baker 354* (UC); near Kentuck's, Tamarack Road, *Baker 439* (UC); near Sisson, 1065 m. alt., June 1–10, 1897, *Brown 334* (M, NY); Shasta, June 17, 1895, *Cannon* (CA); McCloud, July 15, 1911, *Condit* (UC); near Sisson, June 19, 1893, *Dudley* (D); upper Sacramento River, Aug. 26, 1899, *Dudley* (D); meadow, foot of Mt. Eddy, Aug. 4, 1905, *Dudley* (D); McCloud, July 15, 1912, *Eastwood 1109* (CA, Clokey, G, NY); Castle Lake, July 24, 1921, *Eastwood 10791* (CA); n. of Sisson to near Upton, Mt. Shasta, 1050 m. alt., June, 1903, *Hall & Babcock 4067* (UC); in open, swampy places in the forest, Mt. Eddy, 1350 m. alt., July 15, 1915, *Heller 12100* (CA, D, F, G, M, NY, PA); South Fork of Salmon River, near Big Flat, 1500 m. alt., July 23, 1937, *Howell 13366* (CA); Mt. Shasta, 1800 m. alt., June 1, 1914, *Kusche* (CA); mountains about the headwaters of the Sacramento River, 2250 m. alt., Aug. 20, 1881, *Pringle*

82 (F, G); Sisson, Mt. Shasta, July 15, 1902, *Setchell & Dobie* (UC). TRINITY CO.: Pine Creek, Salmon Mts., 1500 m. alt., July, 1909, *Hall 8684* (UC). SHASTA CO.: Burney, June 14, 1923, *Bethel* (CA)*[30]; shore of Summit Lake, Lassen Volcanic National Park, July 15, 1934, *Bonar* (UC); Lassen Peak, 1800 m. alt., July 7, 1897, *Jones* (P); Lassen National Park, near Prospect Peak, Summer, 1932, *Krancer* (CA)*; moist soil in open spaces in woods, 1000-Lake Basin, s. of Burney, 1920 m. alt., July 12, 1932, *Peirson 10130* (UC); Kelly Camp, Mt. Lassen National Park, June 13, 1931, *Van Dyke* (CA). TEHAMA CO.: Dry Lake, n. of Mineral, 1800 m. alt., July 13, 1911, *Eggleston 7205* (G, NY); near Mineral, July 16, 1935, *Epling & Robison* (UCLA); Park's Ranch, Mill Creek Canyon, near Morgan, 1500–2100 m. alt., July 1, 2, 1903, *Hall & Babcock 4321, 4351* (UC); open pine woods, Dry Lake, 7 mi. n. of Mineral on Viola Road, July 16, 1938, *Ownbey & Ownbey 1744* (G, Kew, M, O, UC); Morgan Spring, June 25, 1912, *Wilder* (UC). PLUMAS CO.: moist ground near stream, Warner Valley, below Drakesbad, Mt. Lassen Region, June 20, 1929, *Applegate 5762* (D); yellow pine woods, between Kelley's Camp and Drakesbad, Warner Valley, Mt. Lassen Region, June 21, 1929, *Applegate 5795* (D); without exact locality, May, 1876, *Austin* (F, G TYPE); without exact locality, May, 1877, *Austin* (G, M); Prattville, July 4, 1892, ex herb. *Brandegee* (D)*; Quincy, June 22, 28, 1920, *Clemens* (CA)*; Prattville, July 7, 1902, *Coombs* (G, NY)*; Prattville, Summer, 1906, *Coombs* (CA)*; west end of Hawkins Valley, S. 10, T. 24 N., R. 7 E., 1590 m. alt., June 12, 1934, *Embree 99* (UC); in moist, grassy places, in granite in the yellow pine belt, near the summit of Soapstone Ridge, Sierra Nevada, 12 mi. w. of Bucks, July 7, 1915, *Heller 12066* (CA, D, F, G, M, NY)*; Drakesbad, Mt. Lassen National Forest, June 17–30, 1928, *Hollis* (UCLA); Greenville, July, 1920, *Kelley* (CA); Mohawk Valley, May 27, 1889, *Lemmon* (M, NY, P, UC)*; Silver Lake, 1800 m. alt., July 13, 1929, *Merrill* (CA, UC, UCLA)*; dry meadow and under pines, below Humboldt Summit, on road between Jonesville and Lake Almanor, July 14, 1938, *Ownbey & Ownbey 1740* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS). BUTTE CO.: Colby, July, 1896, *Austin 22* (M, UC)*; Dye Place, June, 1897, *Bruce* (D); Dye Place, 2400 m. alt., May, June, 1898, *Bruce 2405* (NY, P); in low, open woods, Jonesville, 1550 m. alt., July 21, 1929, *Copeland 353* (CA, D, F, G, M, NY, P, RM, UC, UCLA, UO)*; Scotch John Meadows, 1200–1800 m. alt., July 11, 1920, *Copeland 69* (D); in damp woods, Jonesville, 1500 m. alt., June 9, 1931, *Copeland 1513* (D, P); shaded edge of meadow, Jonesville, 1500 m. alt., July 4, 1938, *Copeland* (O); dry hillsides, near Bald Hill, 1800 m. alt., July 8, 1900, *Leiberg 5066* (UO); mountains above Durham, July 4, 1932, *Morrison* (CA). SIERRA CO.: "Sierra Nevada," 1875, *Lemmon 267* (D, F, M)*; Camptonville District, Tahoe National Forest, May, 1931, *Smith* (UC).* NEVADA CO.: Bear Valley, *Hartweg 1986* (G, NY).* PLACER CO.: 1½ mi. w. of Black Mt., S. 4, T. 16 N., R. 12 E., 1740 m. alt., May 28, 1934, *French 370* (UC)*; Emigrant Gap, June 28, 1882, *Jones 3300* (CA, Clokey, D, M, NY, P)*; Cisco, June, 1870, *Kellogg* (D)*; Cisco, July 6, 1923, *Raphael* (CA)*; Cisco, 1780 m. alt., June 26, 1908, *Walker 1317* (UC).* ELDORADO CO.: near Sportsman's Hall, 12 mi. above Placer-

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[30] Collections showing characters of both *C. minimus* and *C. nudus* are indicated by an asterisk (*).

ville, May 23, 1907, *Brandegee* (UC)*; under pines, 10 mi. e. of Placerville, May 20, 1917, *Ramaley 11290* (UC).*

Subsection 4. NITIDI.[31]

Flowers campanulate, erect or spreading; petals obovate, cuneate, or in one species triangular-lanceolate and clawed, usually inconspicuously fringed and sparingly bearded above the gland; stems erect, usually with a single, reduced, cauline leaf, rarely branched; fruits 3-winged, erect in all but one species.

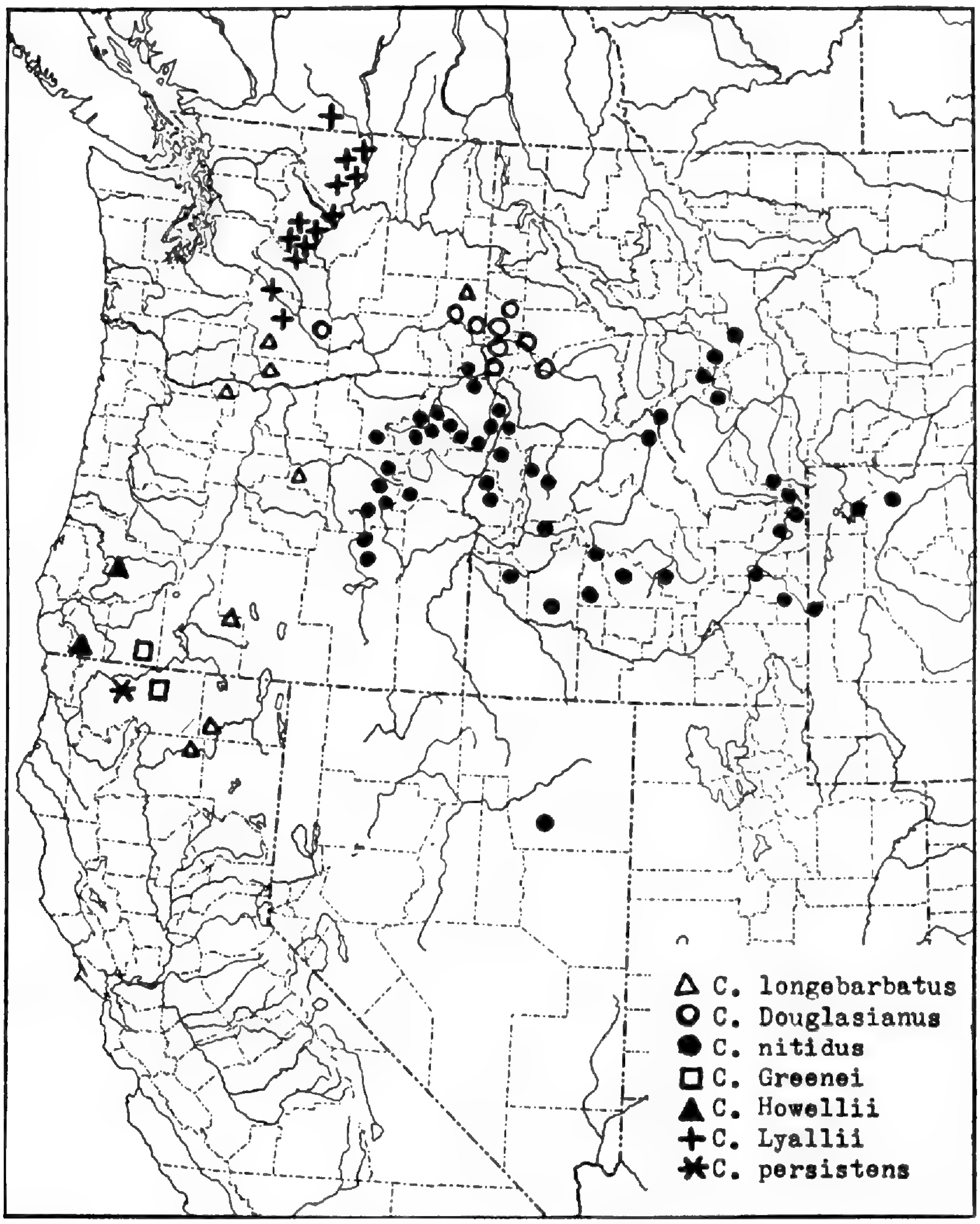
The seven species included under this subsection, although somewhat diverse, appear to represent a very natural alliance. All are so distinct that there is rarely any difficulty in assigning the correct name to a given specimen. *C. longebarbatus* is distinguished from all other members of this group by its short lower internode and bulbiferous habit; *C. nitidus,* by the reddish purple blotch in the middle of each petal; *C. Greenei,* by its lunate, deeply depressed gland; *C. Howellii,* by its branched gland processes; *C. Lyallii,* by its triangular-lanceolate, fringed and clawed petals; *C. persistens,* by its nodding capsule and persistent perianth segments. The only species of this subsection which cannot be distinguished from all other members on the basis of a single morphological character is *C. Douglasianus.* It is remarkable in that it combines certain of the distinctive characters of *C. longebarbatus* and *C. nitidus.* This and other evidence for its probable origin by hybridization between these two species are discussed elsewhere.

15. Calochortus longebarbatus Watson in Proc. Am. Acad. **17**: 381. 1882.

Bulb ovoid, with membranaceous coats; stem erect, 1–3 dm. tall, bulbiferous in the axil of the narrow, nearly basal, cauline leaf, subumbellately 1–3-flowered; basal leaf 2–3 dm. long, 5–10 mm. broad, tapering gradually toward both ends, usually shorter than the inflorescence; bracts usually two, opposite,

[31] NITIDI subsect. nov., floribus campanulatis erectis aut patentibus; petalis obovatis cuneatis, in una specie triangulari-lanceolatis et unguiculatis, plerumque inconspicue fimbriatis supra glandulam parce barbatis; caulibus erectis plerumque folio caulino unico reducto, raro ramosis; capsulis 3-alatis, in omnibus speciebus praeter unam erectis.

narrowly lanceolate, long-acuminate, 2–6 cm. long, unequal; flowers lavender-pink, with a deep, purplish red spot on each petal just above the gland, drying purple, erect on rather slen-



Map 4. Distribution of the species of the subsection NITIDI.

der pedicels; sepals shorter than the petals, ovate to lanceolate, acuminate, glabrous; petals broadly obovate, cuneate, obtuse and rounded or acute at the apex, with a few scattered, very long, flexuous hairs on the inner face above the gland; gland transversely oblong, surface naked, slightly depressed, bordered below with a broad, deeply fringed membrane, and above with a band of short, thick processes, both processes and fringe of membrane beset with numerous papillae; anthers obtuse to short-apiculate, about one-half as long as the basally dilated filaments; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic to nearly orbicular, 3-winged, erect; seeds irregular, with light brown, hexagonally reticulate coats.

Calochortus longebarbatus is distinguished from all other species of the subsection NITIDI by its short lower internode and its bulbiferous habit. The only other species of the section EUCALOCHORTUS which is consistently bulbiferous is *C. uniflorus,* but in that species the whole stem is very short, the flowering pedicels greatly elongated and the capsule usually nodding.

DISTRIBUTION. Infrequent in low, grassy meadows, southeastern Washington, west to the Cascade Mountains, and southward to Shasta County, California.

WASHINGTON. WHITMAN CO.: border of a wet meadow near Oakesdale, July 14, 1916, *Suksdorf 8856* (CA, D, G, M, NY, PA, UC, WS). YAKIMA CO.: Yakima Region, June, 1882, *Brandegee* (M, UC); sandy soil, Smith Spring, S. 1, T. 8 N., R. 15 E., 900 m. alt., July 6, 1932, *Heidenreich 186* (WS). KLICKITAT CO.: Klickitat River, July 17, 1899, *Flett 1123* (WS); wet places, Klickitat Prairie, July, 1880, *Howell 12577* (PA); Goldendale, June, 1881, *Howell* (NY, PA, UO); Klickitat, June, 1881, *Howell 560* (D, F, G, UO); low, grassy grounds, Falcon Valley, July 2, Aug., 1881, *Suksdorf* (F, G TYPE, M, PA); same locality, July 12, Aug., 1882, *Suksdorf* (D, F, NY, PA, UC); same locality, July 2, Aug., 1885, *Suksdorf* (M, NY, UC, UO).

OREGON. HOOD RIVER CO.: moist, open ground, along rills, Hood River Valley, July 3, 1880, *Henderson* (UO); along rills and ponds, Hood River Prairie, June 26, 1882, *Henderson 984* (F); grassy banks of rills, Hood River Valley, June 21, Aug. 2, 1896, *Henderson* (RM). WHEELER CO.: grassy margin, wet meadow, headwaters of Marks Creek, Ochoco National Forest, July 29, 1938, *Ownbey & Ownbey 1800* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); meadow margin, Ochoco Forest, June 30, 1932, *Peck 17200* (WU). KLAMATH CO.: wet meadow near the Cycan [Sycan] River, Aug. 14, 1901, *Cusick 2756* (F, G, M, NY, P, RM, UC, UO).

CALIFORNIA. MODOC CO.: on land wet in Spring, adobe, June–Aug. 1893, *Baker* (UC); Forestdale, Aug., 1897, *Baker 161* (UC); Big Valley, near Lookout, June 29, 1894, *Baker & Nutting* (UC). SHASTA CO.: Goose Valley, June 29, July 11, 1912, *Eastwood 955* (CA, NY, P).

16. Calochortus Douglasianus Schultes f. in Van Hall, Vrolik & Mulder, Bijdr. Nat. Wet. **4**: 127. 1829; Schultes & Schultes, Syst. Veg. **7**: 1532. 1830.

Calochortus sp. Douglas in Trans. Hort. Soc. Lond. **7**: 278. 1828.

Calochortus pavonaceus Fernald in Bot. Gaz. **19**: 335. 1894.

Bulb ovoid, with membranaceous coats; stem erect, 2–4 dm. tall, usually with a single, reduced, cauline leaf about midway, simple, subumbellately 1–4-flowered; basal leaf 1–3 dm. long, 10–25 mm. broad, tapering toward both ends, becoming involute, not exceeding the inflorescence; bracts 2 to several, narrowly lanceolate to linear, long-attenuate, 2–10 cm. long, unequal; flowers erect, large and showy, purplish, with a deep purple crescent on each petal above the gland; sepals shorter than the petals, ovate to lanceolate, acuminate, glabrous; petals obovate to oblanceolate, cuneate, rounded or acute at the apex, more or less ciliate laterally and sparingly invested above the gland with long, flexuous hairs; gland more or less triangular-lunate, slightly depressed, bounded below with a narrow, deeply fringed membrane, and covered with short, thick processes, both processes and membrane-fringe densely beset with long papillae; anthers oblong, obtuse, 6–10 mm. long, shorter than the basally dilated filaments; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic to nearly orbicular, 3-winged, erect; seeds irregular, with light-colored, hexagonally reticulate coats.

The original brief description and locality given by Douglas and Schultes are sufficient to identify the name, *C. Douglasianus,* unquestionably, with the present entity. It is also particularly appropriate that one of the most beautiful species of the genus which Douglas, more than anyone else, made known should bear his name.

Calochortus Douglasianus is remarkable in that it combines many of the distinctive characteristics of *C. nitidus* and *C. longebarbatus,* and possesses no single character which will distinguish it from both of these species. In size and habit, it resembles the former, but is separated by its purplish flowers which have a purple crescent on each petal above the gland. These are both characters of *C. longebarbatus,* from which it differs in its long lower internode and non-bulbiferous habit. In the characters of the gland, it is intermediate between the two, as it is in its choice of ecological habitat. Geographically, it occurs where the ranges of these two species most nearly approach each other. All of this evidence suggests that *C. Douglasianus* may have arisen by hybridization between *C. nitidus* and *C. longebarbatus,* an hypothesis which is in accord with the cytological evidence available. *C. Douglasianus* is a tetraploid species (n = 20), while *C. nitidus* is diploid (n = 10). Little material of *C. longebarbatus* was available for cytological study.

Distribution. In low meadows, along creeks, southeastern Washington and adjacent Idaho.

Idaho. latah co.: Troy, July, 1900, *Abrams 816* (D, P, UC); 7 mi. s. of Moscow, 780 m. alt., July 14, 1937, *Brown 132* (G, Kew, M, O, UC); Thatuna Hills, July 3, 1926, *Epling & Hauch* [*Houck*] *9199* (UCLA); near Moscow, July 1, 1937, *Hanscom* (CA); along creeks and in moist, grassy woods, July 24, Sept. 6, 1894, *Henderson 2484* (RM). clearwater co.: Clearwater Canyon, near Orofino, July, 1929, *Epling* (UCLA); Orofino, 1898, *Huntting* (WS). nez perce co.: Sweetwater, July, 1896, *Heller & Heller* (M, P); about Lake Waha, 750–900 m. alt., July 8, 1896, *Heller & Heller 3397* (D, M, NY, PA, UC); dry plains, Lake Waha, 700 m. alt., July, 1884, *Leiberg* (UO). idaho co.: meadow at base of ridge, Lolo Trail, Bitterroot Mts., Aug. 25, 1880, *Watson 419* (G, PA).

Washington. whitman co.: in low, hard-dried places, Pullman, July 2, 1896, *Elmer 222* (M, NY); Pullman, June, 1892, *Henderson 2484* (G, type of *C. pavonaceus* Fernald); bottom land, Pullman, July, 1899, *Hunter* (WS); Union Flat, July 17, 1892, *Lake & Hull 618* (G); in low bottoms, Pullman, July 27, 1892, *Lake & Hull 618* (WS); Pullman, Aug. 10, 1913, *Muenscher* (WS); in low meadows, Pullman, July 24, 1893, *Piper 1680, in part* (G, WS); in bottoms, Pullman, July 18, 1894, *Piper* (RM); in low meadows, Pullman, July 21, 1894, *Piper* (UO). yakima co.: sand plains, n. of Rattlesnake Mts., May 31, 1901, *Cotton 393, in part* (WS).

17. Calochortus nitidus Douglas in Trans. Hort. Soc. Lond. **7**: 277, *pl. 9A*. 1828.

Cyclobothra nitida Kunth, Enum. Pl. **4**: 230. 1843.

Calochortus eurycarpus Watson, Bot. U. S. Geol. Expl. 40th Par. [Bot. King's Exped.] p. 348. 1871.

Calochortus nitidus var. *eurycarpus* Henderson in Bull. Torr. Bot. Club **27**: 356. 1900.

Calochortus parviflorus Nuttall ex Baker in Journ. Linn. Soc. Lond. Bot. **14**: 306. 1874.

Calochortus umbellatus A. Nelson in Bot. Gaz. **54**: 405. 1912, not Wood, 1868.

Calochortus euumbellatus A. Nelson, *l. c.* Errata.

Bulb ovoid, with membranaceous coats; stem erect, 1–5 dm. tall, with a single, bract-like, cauline leaf about midway, simple, subumbellately 1–5-flowered; basal leaf 1–3 dm. long, 5–25 mm. broad, tapering toward both ends, becoming involute, shorter than the inflorescence; bracts 2 to several, narrowly lanceolate to linear, long-attenuate, 1–5 cm. long, unequal; flowers erect, creamy-white (drying yellowish) to lavender, with a conspicuous red-purple blotch in the middle of each petal; sepals usually much shorter than the petals, ovate to lanceolate, acute to acuminate, glabrous; petals broadly obovate, cuneate, rounded or acute at the apex, invested near the gland with a few, long, flexuous hairs; gland triangular-lunate, slightly depressed, bordered below with a comparatively narrow, deeply fringed membrane, and above often with a narrower, crenate one, enclosed surface densely covered with long, yellowish processes, which, with the membrane-fringe, are often inconspicuously papillose; anthers oblong, obtuse, nearly equalling the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic-oblong, 3-winged, erect; seeds irregular, with light-colored, hexagonally reticulate coats.

Calochortus nitidus is distinguished from *C. Douglasianus*, which it resembles in size and habit, by its usually white petals, which are always marked with a reddish purple spot near the middle. There has been little agreement among American authors as to which of these species should take the name "*C. nitidus.*" The original description and illustration could equally well be applied to either, and presumably Douglas had opportunity to collect both. The present interpretation is based on an examination of photographs of the Douglas specimen preserved in the Hooker Herbarium at Kew. This specimen so closely resembles the original illustration of *C. nitidus* that it seems to be, with little doubt, the actual historic type. The flower in the drawing is obviously a reconstruction, and that of the original specimen is withered. The petals, however, still show, in the photographs, the characteristic central spot, which definitely associates this name with the above-described species.

Distribution. In dry meadows and open coniferous forests, southwestern Montana to southeastern Washington, southward to Elko County, Nevada.

Montana. lewis and clark co.: Priests Pass, near Helena, July 31, 1891, *Kelsey* (D, F, NY, P, UC); Priests Pass, Helena, Aug., 1892, *Starz* (M). powell co.: Deer Lodge, July 21, 1901, *Scheuber* (RM). deer lodge co.: Mill Creek, near Anaconda, 1800 m. alt., July 20, 1905, *Jones* (NY, P, UO). silver bow co.: meadows, 1800–2400 m. alt., July, 1888, *Tweedy 42* (NY). madison co.: among the sagebrush on the slopes, Alaska Basin, Sept. 2, 1899, *Nelson & Nelson 6814* (RM). beaverhead co.: open summits and in coniferous woods, Continental Divide at Big Hole Pass, along the Montana-Idaho Line, 8½ mi. e. of Gibbonsville, Idaho, Aug. 17, 1938, *Ownbey & Ownbey 1867* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS).

Wyoming. park co.: dry, open country, foothills, Cody, July 14, 1915, *Marston 161X, in part* (RM). yellowstone national park: east shore of Yellowstone Lake, Aug. 22, 1871, *Hayden* (F, G, PA); without exact locality, July, 1926, *Mexia* (CA); without exact locality Aug. 10, 1893, *Rose 165* (CA); without exact locality, 1873, *Parry 265* (G, NY, PA). lincoln co.: near mouth of McKoy Creek, Alpine, July 15, 1923, *Payson & Armstrong 3505* (G, M, P, PA, RM).

Idaho. fremont co.: Henrys Fork, Snake River, 1872, *Coulter 1048* (PA); parks and woodland, Island Park, Sept. 5, 1899, *Henderson 4804* (G); Snake River, near Henry Lake, Aug. 19, 1892, *Mulford* (M, NY); stony, basaltic field, Route 191, above Warm Creek, Targhee N. F., 1890–1920 m. alt., July 24, 1938, *Pennell & Schaeffer 23485* (PA); ridge north of Ashton, July 29, 1923, *Piper* (WS); forest shade, Trude, July 18, 1932, *Rose 32386* (CA); sandy soil, near Snake River, Rea P. O., Aug. 17, 1916, *Rust 894* (CA); Henry Lake, 2400 m. alt., Aug. 1, 1897, *Rydberg & Bessey 3874* (F, G, NY, PA, RM, UM). madison co.: Menan, Aug. 14, 1895, *Elrod* (F). bonneville co.: lower, open slopes, Caribou Mt., July 17, 1923, *Payson & Armstrong 3506* (G, M, P, PA, RM). butte co.: dry sage-brush plains, along the north side of the big lava flow, w. of Martin and the Craters of the Moon, June 20, 1930, *Applegate 6331* (D, UC); grassy hillside, 1 mi. s. of Martin, 1590 m. alt., June 25, 1938, *Hitchcock, Rethke & Van Raadshooven 3812* (WS). lemhi co.: Anderson Mt. Lookout, 2490 m. alt., July 15, 1936, *Blair* (O); Salmon, July, 1896, *Kirtley* (RM); red clay slope, Salmon, 1500 m. alt., July 1, 1920, *Payson & Payson 1850* (CA, G, M, NY, RM). blaine co: among *Artemisia,* Trail Creek, about 5 mi. above Ketchum, July 27, 1938, *Davis 700* (G, Kew, M, O, UC); near Sawtooth, west shore of Alturas Lake, 2130–2190 m. alt., July 22–24, 1896, *Evermann 628* (F); near Sawtooth, head of Alturas Lake, 2160 m. alt., July 30, 31, 1896, *Evermann 664* (F); moist meadow, Lava Lake, 1800 m. alt., July 4, 1916, *Macbride & Payson 3031* (CA, D, G, M, NY, P, RM, UC); open, loamy slopes, Ketchum, 1770 m. alt., July 19, 1911, *Nelson & Macbride 1197* (G, NY, RM, type of *C. umbellatus* Nels., not Wood); open sagebrush land, near Wood River, Ketchum, 1710–1740 m. alt., July 1, 1937, *Pennell 20646* (PA); sagebrush slopes, at end of road along Hyndman Creek, 2010 m. alt., July 27, 1936, *Thompson 13523* (M, NY, PA, WS); alpine slopes at head of Boulder Creek, Sawtooth National Forest, 2700 m. alt., July 13, 1937, *Thompson 14135* (G, NY). CAMAS CO.: dry soil in meadow, Corral, 1710 m. alt., June 28, 1916, *Macbride & Payson 2928* (CA, D, G, M, P, RM, UC). IDAHO CO.: open flat, sandy loam soil, Hibbs Cow Camp, Dry Diggins, Seven Devils Mts., July 27, 1938, *Packard 459* (WS). VALLEY CO.: rocky knoll in yellow pine, south end of Payette Lake, near McCall, 1500 m. alt., July 4, 1937, *Constance 1951* (CA, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UM, WS); Payette Lake, 1800 m. alt., July 24, 1899, *Jones* (P); under *Pinus ponderosa* near Warm Lake, 28 mi. n. e. of Cascade, 1500 m. alt., July 23, 1938, *Rollins & Chambers 2591* (O); pine slopes on Gold Fork Lookout, Payette National Forest, Sawtooth Mts., 2100 m. alt., July 13, 1937, *Thompson 13835* (G, NY). BOISE CO.: dry hillside in yellow pine woods, between Garden Valley and Lowman, Payette River, Sawtooth Mts., June 17, 1930, *Applegate 6289* (D, UC). ELMORE CO.: brush-covered, loamy hillside, Toll Gate Ranch, near Dixie, 1350 m. alt., June 28, 1916, *Macbride & Payson 2858* (CA, D, G, M, NY, P, RM, UC). ADAMS CO.: Black Lake to Bear P. O., Seven Devils Mts., 1350–2400 m. alt., July 20, 1931, *Johnston* (CA). WASHINGTON CO.: meadow n. of Cambridge, June 16, 1937, *Davis 178–37* (G, Kew, M, NY, O, RM, UC); Salubria, 690 m. alt., July 10, 1899, *Jones* (CA, M, NY, P); Rush Creek, 1200 m. alt., July 10, 1899, *Jones* (P); Cuddy Mts., 1800 m. alt., July 11, 1899, *Jones* (P); southwest slope of Cuddy Mt., July 3, 1932, *Orr* (UC). ADA CO.: dry hills and plains, Boise (Clear Creek), 1500 m. alt., July 4, 1911, *Clark 75* (D, G, M, RM); Boise City, June, 1881, *Wilcox* (G).

WASHINGTON. ASOTIN CO.: along ridge w. of Big Butte, Blue Mts., June, 1928, *Jones 1891* (WS).

OREGON. WALLOWA CO.: yellow pine woods, Paradise, July 3, 1930, *Applegate 6482* (D, UC); dry sand, head of Hurricane Creek Valley, 2100 m. alt., Aug. 3, 1935, *Constance & Jacobs 1371* (D, WS); gravelly summit of Lookout Mt., among *Artemisia*, west rim of Hells Canyon, Snake River, 2040 m. alt., Aug. 6, 1935, *Constance & Jacobs 1425* (M, UC, WS); dryish, grassy flat at second lake, near source of Wallowa River, 2400 m. alt., Aug. 15, 1908, *Cusick* (UO); open, rocky slope in coniferous woods, along Lick Creek, 24 mi. s. e. of Joseph, Wallowa Mts., Aug. 7, 1938, *Ownbey & Ownbey 1829* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); open slope and in borders of coniferous woods, 13 mi. s. e. of Imnaha, on Hat Point Road, Aug. 8, 1938, *Ownbey & Ownbey 1832* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); open places and borders of coniferous woods 1 mi. n. w. of Hat Point Lookout, above Snake River Canyon, Aug. 8, 1938, *Ownbey & Ownbey 1834* (G, Kew, M, O, RM, UC); moist meadows along Adams Creek, 4 mi. s. w. of Wallowa Lake, Wallowa Mts., Aug. 9, 1938, *Ownbey & Ownbey 1851* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); dry ground, Wallowa Mts., 10 mi. n. of Cornucopia, 2250 m. alt., Sept. 3, 1915, *Peck 3583* (WU); dry ground, Little Sheep Creek Canyon, 12 mi. above Imnaha, July 16, 1933, *Peck 17665* (D, NY, WU); dry slope, Imnaha Canyon, 20 mi. above Imnaha, July 16, 1933, *Peck 17711* (NY, WU); east slope of Lostine Canyon, 20 mi. above Lostine, July 18, 1933, *Peck 17730* (WU); dry sterile ridge, 28 mi. n. of Enterprise, June 23, 1934, *Peck 18219* (D, WU); near summit of Imnaha-Snake Divide, 23 mi. above Imnaha, July 12, 1933, *Peck 176621* (D, NY, WU); Powder River Mts., Aug., 1896, *Piper 2460* (NY, UO, WS); Elk Mt., 1500 m. alt., June 30, 1897, *Sheldon 8462* (M, NY). UNION CO.: about Crater Lake, near Wallowa, Wallowa Mts., 2400 m. alt., Aug. 8, 1938, *King 512* (UO); dry ground, Beaver Meadows, 10 mi. w. of North Powder, Aug. 17, 1915, *Peck 3582* (WU); mountain above La Grande, July 29, 1910, *Peck 3584* (WU); Union, *Purdy* (UC). BAKER CO.: Hereford, July 3, 1930, *Jones 25180* (D, M, P). UMATILLA CO.: Ukiah, June 23, 1935, *Sipe* (UO). GRANT CO.: open hill above Strawberry Creek, 5 mi. s. of Prairie City, July 1, 1919, *Ferris & Duthie 744* (D); moist, rocky slopes of Dixie Mt., Blue Mts., 2250 m. alt., July 26, 1925, *Henderson 5627* (CA, D, G, M, UO); moist or dry borders of natural meadows, Austin Ranch, July 21, 1925, *Henderson 5628* (CA, D, G, M, UO); dry slope, Blue Mt. Springs, 14 mi. s. e. of Prairie City, July 19, 1921, *Peck 10325* (D, F, NY); yellow pine slopes, 10 mi. n. of Seneca, 1200 m. alt., July 6, 1935, *Thompson 11927* (D, NY, WU). HARNEY CO.: Camp Harney, 1875, *Bartholt* (M); yellow pine slopes, 25 mi. n. of Burns, July 16, 1936, *Thompson 13304* (NY, PA, WS, WU).

NEVADA. ELKO CO.: canyon at the head of South Fork of the Humboldt, East Humboldt or Ruby Mts., 2160 m. alt., Aug. 11, 1908, *Heller 9385* (D, G); East Humboldt Mts., 2250 m. alt., Aug., 1868, *Watson 1173, in part* (G, type of *C. eurycarpus* Watson).

STATE NOT DETERMINED: "On the mountains of the interior," *Douglas*, photograph, of TYPE in the Hooker Herbarium at Kew (G, NY, P, PA, WS); "Rocky Mts.," *Nuttall* (G), type collection of *C. parviflorus* Nuttall.

18. **Calochortus Greenei** Watson in Proc. Am. Acad. **14**: 264. 1879.

Calochortus Greenei var. *calvus* Henderson in Rhodora **33**: 204. 1931.

Bulb ovoid, with membranaceous coats; stem erect, 1–3 dm. tall, with one or two reduced, cauline leaves, simple or with a branch in the axil of one of the cauline leaves, subumbellately 1–5-flowered; basal leaf about 2 dm. long, 1–2 cm. broad, tapering upward, strongly involute, not exceeding the inflorescence; bracts 2 to 4, narrowly lanceolate to linear, long-acuminate, 2–4 cm. long, unequal; flowers erect on long pedicels, purplish, with a darker purple crescent on each petal above the gland; sepals shorter than the petals, ovate, acuminate, glabrous; petals broadly obovate, cuneate, rounded at the apex, loosely bearded above the gland with long flexuous hairs; gland lunate, deeply depressed, surface naked, bordered below with a broad, deeply fringed membrane, and above with a series of short, thick processes, both processes and membrane-fringe densely beset with long papillae; anthers oblong-lanceolate, obtuse or acute, 8–12 mm. long, nearly equalling the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, acute, 3-winged, erect; seeds not known.

Calochortus Greenei resembles *C. nitidus* and *C. Douglasianus* in size and habit, but is easily distinguished from both by its deeply depressed, lunate gland. This species has been a puzzle to western botanists who, lacking authentic material, have almost without exception associated Watson's name and description with Californian specimens of the very different *C. longebarbatus.* Watson, himself, was apparently unaware of the characters which distinguish this from related species. His original description, however, was drawn from Greene's Table Rock collection, which must therefore be considered as the type. Specimens of the type collection of *C. Greenei* var. *calvus* seem to be identical in every respect.

DISTRIBUTION. Brushy hillsides, Jackson County, Oregon, near the California Line, and on top of Table Rock, Siskiyou County, California.

OREGON. JACKSON CO.: in copses and on open slopes, south slope of Siskiyou Mts., near the California Line, July 12, 1930, *Henderson 12809* (UO), type collection of *C. Greenei* var. *calvus* Henderson; open brushy hillside, 4 mi. n. of the California Line, June 24, 1931, *Peck 16381* (WU).

CALIFORNIA. SISKIYOU CO.: on top of Table Rock, Little Shasta River, July 6, 1876, *Greene 914* (G TYPE, M, PA).

19. Calochortus Howellii Watson in Proc. Am. Acad. **23**: 266. 1888.

Bulb ovoid, with membranaceous coats; stem slender, erect, 2–3 dm. tall, with a single bract-like, cauline leaf at or above the middle, simple or rarely with a branch in the axil of the cauline leaf, subumbellately 1–3-flowered; basal leaf 2–3 dm. long, about 5 mm. wide, tapering gradually upward; bracts two, subopposite, linear to narrowly lanceolate, attenuate, 1–3 cm. long; flowers yellowish-white, with purplish hairs toward the base of the petals, erect on rather slender pedicels; sepals shorter than the petals, ovate, acuminate, glabrous; petals broadly obovate, cuneate, rounded at the apex, inconspicuously fringed laterally and sparingly clothed on the inner face with short hairs; gland transversely oblong, slightly depressed, densely covered with short, distally branched processes, the bases of those at the lower margin united to form an inconspicuous, discontinuous membrane; anthers oblong-lanceolate, acute to short-apiculate, exceeding the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, acute at both ends, 3-winged, erect; seeds irregular, light-colored, without reticulate coats.

Calochortus Howellii has no very close relatives. Its habit and erect capsule place it with the subsection NITIDI, but its distally branched gland-processes and merely roughened seed-coats mark it as very distinct from any other known species of the section EUCALOCHORTUS.

DISTRIBUTION. Oregon: dry, rocky soil, near Roseburg, Douglas County, and near Waldo, Josephine County.

OREGON. DOUGLAS CO.: Roseburg, June 7, 1887, *Howell 727* (G TYPE). JOSEPHINE CO.: Waldo, June 22, 1910, *Howell* (UO); Waldo, June 18, 1884, *Howell 294* (G); dry hillsides, near Waldo, July 7, 1887, *Howell 1282* (M, NY, PA); Waldo, July, 1889, *Howell* (F); rocky soil along Whiskey Creek, 6 mi. s. w. of Waldo, July 23, 1938, *Ownbey & Ownbey 1770* (CA, D, F, G, Kew, M, NY, O, RM, UC); near Waldo, Aug. 4, 1913, *Peck 1376* (WU); dry, stony ground, 6 mi. s. w. of Waldo, July 4, 1918, *Peck 7848* (F); dry ground along West Fork of Illinois River, 8 mi. w. of Waldo, July 4, 1918, *Peck 8413* (G).

20. Calochortus Lyallii Baker in Journ. Linn. Soc. Lond. Bot. **14**: 305. 1874.

Calochortus ciliatus Robinson & Seaton in Bot. Gaz. **18**: 238. 1893.

Bulb ovoid, with membranaceous coats; stem erect, 1–5 dm. tall, usually with a single bract-like leaf about midway, simple or with a branch in the axil of the cauline leaf, subumbellately 1–4(–9)-flowered; basal leaf 1–3 dm. long, 2–20 mm. broad, tapering toward both ends, usually not exceeding the inflorescence; bracts 2 to several, lanceolate to linear, attenuate, 1–5 cm. long, unequal; flowers white or purplish-tinged, usually with a purple crescent on each petal above the gland, and a similar spot on each sepal, erect or spreading on rather slender pedicels which become stouter and stiffly erect in fruit; sepals usually about equalling the petals, lanceolate, acuminate to attenuate, often papillose on the inner face, glabrous; petals ovate to lanceolate, acute, abruptly contracted at the base to a short claw, usually conspicuously fringed with long, slender hairs, inner face more or less papillose, invested with a few long hairs above the claw; gland transverse, arched upward, depressed, bordered below with a broad, ascending, deeply fringed membrane, and above with a narrower membrane which is merely crenate, invested toward the upper portion of the enclosed surface with short, thick processes, both fringe of lower membrane and the processes densely long-papillose; anthers oblong-lanceolate, acute to short-apiculate, usually equalling the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, acute at both ends, 3-winged, nodding; seeds irregular, with light-colored, more or less hexagonally reticulate coats.

Calochortus Lyallii has no close relatives. Its small flowers and conspicuously ciliate and clawed petals distinguish it at once from any other species of the subsection NITIDI, and suggest affinity with the subsection ELEGANTI. These resemblances, however, are entirely superficial, and its erect capsules definitely exclude it from that subsection.

DISTRIBUTION. Dry slopes, southern British Columbia, southward along the eastern front of the Cascade Mountains to Yakima County, Washington.

BRITISH COLUMBIA. Open hilltops near Similkameen River, 1050 m. alt., June 14, 1905, *Macoun 70212* (F, G, M, P).

WASHINGTON. OKANOGAN CO.: dry soil on bunch-grass flat, near Twisp, 480 m. alt., May 15, 1936, *Edwards 220* (WS); vicinity of Omak, May 14, 1931, *Fiker 88* (WS); Oroville, June 24, 1911, *Jones* (P); Conconully, July 3, 1911, *Jones* (D, P, UC); dry, open woods, limestone hills, Riverside, July 1, 1923, *St. John 7718* (G, M, WS); near Conconully, *Steward 203* (UM); open, timbered slopes near Salmon Meadows, 1050 m. alt., June 28, 1931, *Thompson 7057* (D, G, M, PA, UC); pine woods by Loop-Loop Road, e. of Winthrop, 1050 m. alt., July 2, 1934, *Thompson 10916* (D, M, NY). CHELAN CO.: Lake Wenatchee, July 24, 1910, *Bailey* (UCLA); Wenatchee Region, July, 1883, *Brandegee 1107* (G); hills, Mission Creek, Cashmere, May 15, 1923, *Jones* (WS); Cashmere, May 28, 1913, *Mann 1* (RM); mountainside w. of Leavenworth, 360 m. alt., May 15, 1918, *Otis 673* (CA); Leavenworth, July, 1919, *Phelps* (CA); open woods, granite slide, Chelan, May 20, 1928, *St. John, Eggleston, Beals & Warren 9414* (NY, WS); dry, sandy hillside, Leavenworth, May 18, 1928, *St. John, Eggleston, Beals & Warren 9500* (WS); Peshastin, July, 1893, *Sandberg & Leiberg* (WS); slopes of Mt. Stuart, 1219–1524 m. alt., July 24, 1893, *Sandberg & Leiberg 575* (CA, F, G, M, NY, PA, UC, UO, WS); among dry sagebrush at Leavenworth, May 23, 1931, *Thompson 6424* (D, G, M, PA); open, rocky slopes, Lookout Mt., near Leavenworth, 600 m. alt., May 23, 1931, *Thompson 6449* (D, G, M, PA); lower wooded slopes of Dirtyface Peak, 900 m. alt., June 24, 1932, *Thompson 8558* (D, G, M, NY, UC); yellow pine slopes of Tumwater Mt., 600 m. alt., May 12, 1934, *Thompson 10435* (D, M, NY, P); yellow pine slopes along Entiat River, near Entiat, May 18, 1935, *Thompson 11476* (D, G, NY, P, WS); Wenatchee, May 28, 1896, *Whited 40* (WS); sandy soil, rocky slope near Icicle Creek, w. of Peshastin, S. 25, T. 24 N., R. 11 E., 600 m. alt., June 16, 1936, *Wilcoxon 2* (WS). KITTITAS CO.: Wenatchee Mts., June 29, 1903, *Cotton 1266, 1313* (WS). YAKIMA CO.: Yakima Region, June, 1882, *Brandegee* (G, M, UC); Ahtanum Creek, S. 32, T. 12 N., R. 15 E., 330 m. alt., May 31, 1932, *Heidenreich 128* (WS); grassy, pine woods, Upper Naches River, June 15, July 16, 1892, *Henderson 2485* (G, type of *C. ciliatus* Robinson & Seaton, RM).

21. Calochortus persistens Ownbey, n. sp.[32]

Bulb ovoid, with membranaceous coats; stem low, erect, about 1 dm. tall, stout, more or less flexuous, with a single, bract-like, cauline leaf above the middle, simple or with a branch in the axil of the cauline leaf, subumbellately 2-flowered; basal leaf about 2 dm. long, 15–20 mm. broad, tapering toward both ends, exceeding the inflorescence; bracts 2, opposite, lanceolate, acuminate, unequal, 2–3 cm. long; flowers large, purplish, erect on rather stout pedicels which become deflexed in fruit; sepals shorter than the petals, elliptic-lanceolate, acuminate, glabrous; petals obovate, cuneate, obtuse or acute, fringed laterally, and invested above the gland with a patch of long, yellow hairs; gland transverse, more or less lunate, surface naked, depressed, bordered below with a broad,

[32] **Calochortus persistens** sp. nov., bulbo ovoideo membranaceo-tunicato; caule humili erecto circiter 1 dm. alto robusto plus minusve flexuoso, supra medium folio caulino solitario bractiali, simplici aut ramoso in axillo folii caulini, subumbellate 2-floro; folio basali circiter 2 dm. longo, 15–20 mm. lato, ad utrumque extremum attenuato, inflorescentiam superante; bracteis 2, oppositis lanceolatis acuminatis inaequalibus, 2–3 cm. longis; floribus magnis purpurellis erectis in pedicellis subrobustis et fructu deflectentibus; sepalis petalis brevioribus elliptico-lanceolatis acuminatis glabris; petalis obovatis cuneatis obtusis aut acutis lateraliter fimbriatis, supra glandulam fasciculo pilorum longorum fulvorum praeditis; glandula transversa sublunata, superficie nuda, depressa, subter membrana lata adscendente late fimbriata marginata, supra serie processorum brevium, et processis et fimbria membranae papillis longis dense praeditis; antheris lanceolatis apiculatis filamentis basilariter dilatatis subaequilongis; ovario 3-alato, stylo brevi, stigmate persistente trifido; capsula elliptica acuta 3-alata cernua, segmentis perianthii diuturne persistentibus parte inclusa; seminibus ignotis.

ascending, deeply fringed membrane, and above with a series of short processes, both processes and fringe of the membrane densely beset with long papillae; anthers lanceolate, apiculate, about equalling the basally dilated filaments in length; ovary 3-winged, contracted to a short style and a persistent, trifid stigma; fruit elliptic, acute, 3-winged, nodding, partially enclosed by the long-persistent perianth segments; seeds unknown.

The long-persistent perianth segments mark this species at once as distinct from any other species of the section EUCALOCHORTUS. Its nodding capsule separates it from the remainder of the subsection NITIDI, and suggests affinity with the subsection ELEGANTI, but on all other characters it is best placed with the former subsection. It is apparently very localized, and has been missed entirely by botanical collectors since Greene discovered it in 1876, although Mr. Carl Purdy has handled bulbs of it, as "*C. Greenei,*" for years. Greene's collection at the Gray Herbarium was included under *C. Greenei* by Watson, but his description of that species was drawn entirely from Greene's Table Rock specimens, which represent another very distinct and localized entity. Greene recognized the distinctness of his two collections and protested against their inclusion under a single species, but his letters were placed with the sheet in the Gray Herbarium and presumably forgotten. Writing from Silver City, New Mexico, March 7, 1881, Greene says:

> The *Calochortus* herewith enclosed, you called, in 1876 "*C. apiculatus,* Baker," but afterwards you appear to have made it a part of your *C. Greenei.* Am I correct in so believing? If so, I beg you to let the tall, umbellately branched one, from Table Rock on Little Shasta, be so called, & this *C. Watsoni;* for this is distinct from that, notwithstanding the close likeness in the petals. It even belongs to § 1 of the genus. The fruiting pedicels, & even the flowering at a certain stage of advancement, are strongly recurved. But it does not seem referable to any of the published species of that section. What do you say?

Writing again on April 16, of the same year, he adds:

> I have had no time to take a second look at those *Calochorti* since you wrote that the small one is not of the *Eucalychorti.* I thought its recurved *(strongly so)* fruiting pedicels were enough to place it there; but do not remember about other points. No one who has ever seen the two growing will be convinced that

they are one species, and the distinctions should be made out,—the matter cleared up—as soon as possible, by ourselves. One important note which I think I neglected to make to you is, the marked difference in shape of flowers. Those of the tall one (from which the char. of *C. Greenei* seems to have been mainly drawn) are what I call cup-shaped, i. e. the orifice not at all spreading, or expanded, & the base nearly as broad; those of the short one are, in shape like those of *C. Nuttallii*, *C. Gunnisonii* &c. You recognize, I know, the importance of this kind of character, in the genus, but know how easily it disappears in the process of pressing & drying. I wish, if you have sufficient faith in the accuracy of my observations, you would accept the aid of my several notes &, when it falls to your hand, straighten the matter out. I fully sympathize with your objection to having it called *C. Watsoni*, though such things have been done I see, already, with your name, as with that of many another author.

Distribution. California: known only from the type locality.

California. siskiyou co.: mountains near Yreka, June 30, 1876, *Greene 903* (F, G type, M, PA); grown from bulbs secured from Carl Purdy as "*C. Greenei,*" *Ownbey & Ownbey* (O).

Section II. Mariposa

Mariposa Wood in Proc. Acad. Philad. [**20**]: 168. 1868; Watson in Proc. Am. Acad. **14**: 264. 1879; Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 127. 1901, as section; Baker in Journ. Linn. Soc. Lond. Bot. **14**: 308. 1874, as subgenus.

Platycarpus Baker, *l. c.* 305, as subgenus, in part.

Bulbs ovoid, with membranaceous coats; stems rarely branched, often bulbiferous in the axils of the lower cauline leaves; leaves linear, attenuate, the basal one usually withering before anthesis; inflorescences monochasial or subumbellate, the flowers campanulate, erect; sepals lanceolate, obtuse to attenuate, usually glabrous; petals obovate to oblanceolate, cuneate, rounded and obtuse to acuminate, usually sparingly bearded near the gland; glands variously shaped, sometimes depressed, with or without a membrane, densely covered with more or less filiform or distally branched processes; anthers oblong to linear, obtuse to apiculate; ovaries linear, rarely winged, tapering to a persistent, trifid stigma; fruits oblong to linear, 3-angled or narrowly 3-winged, erect; seeds more or less flattened, with hexagonally reticulate coats. (Spp. 22–42).

Type Species: **Calochortus venustus** Douglas.

The species of the section Mariposa are distinguished by their membranaceous bulb coats and usually 3-angled capsules. In the latter character, they are connected with the section Eucalochortus by *C. catalinae,* which has narrowly 3-winged fruits. There is no question, however, but that this species properly belongs in Mariposa, as it is, in all other respects, similar to the other species of this section, and very different

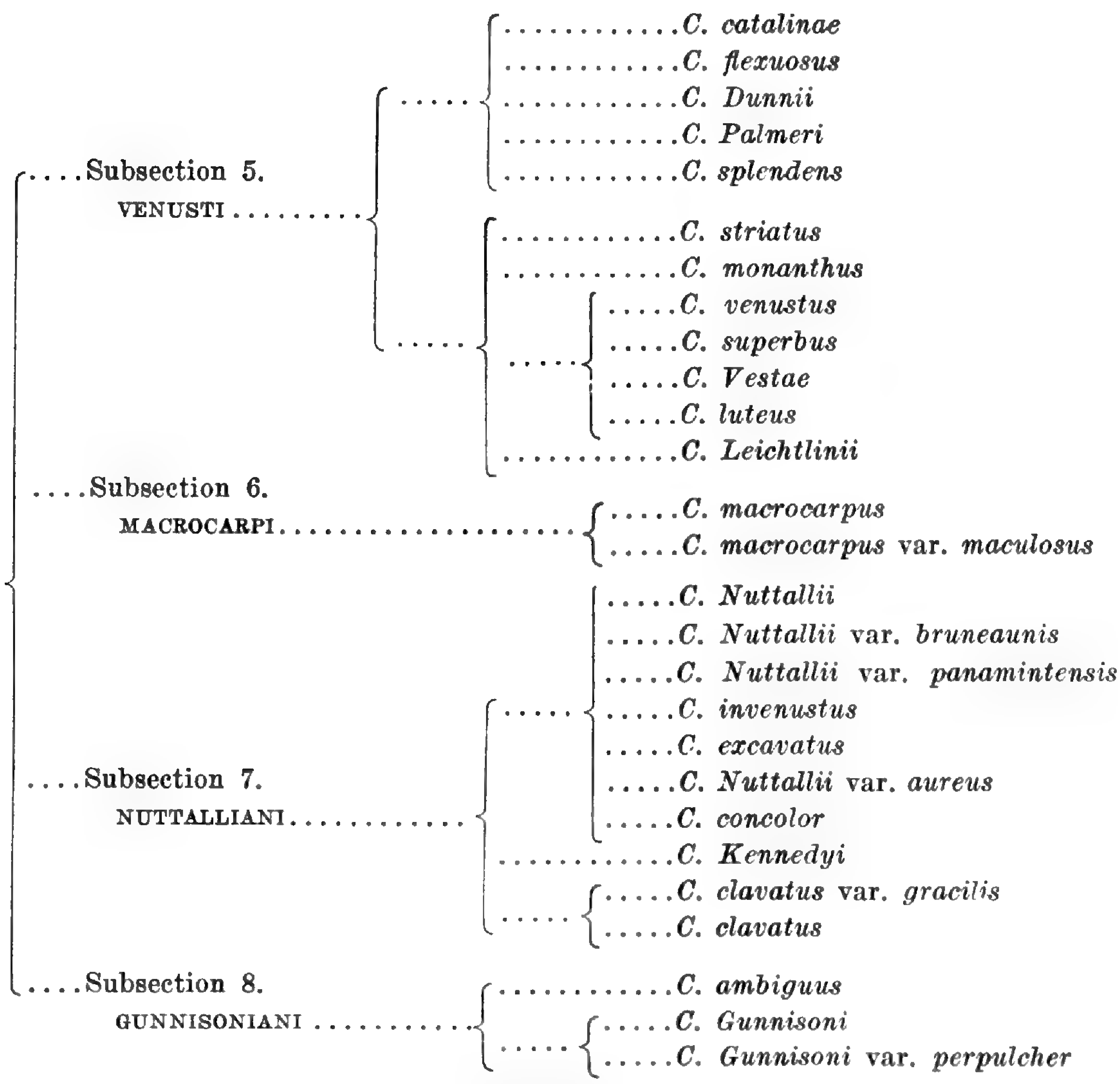


Fig. 2. Diagram showing the morphological relationships of the subsections, species and varieties of the section Mariposa.

from any species included in the section Eucalochortus. Unlike most of the species of the other two sections, the basal leaves of Mariposa usually wither before anthesis and are but rarely collected.

Morphologically, Mariposa is the most uniform of the three sections of *Calochortus.* The four subsections, although apparently very natural, are distinguished on relatively inconspicuous characters, and the species are often very difficult to delimit. In contrast to this morphological uniformity, MARIPOSA is the most varied of the sections cytologically. In the subsection VENUSTI, the basic chromosome number is six or seven; in the MACROCARPI, seven; in the NUTTALLIANI, eight; and in the GUNNISONIANI, nine. This exact correlation between chromosome number and morphological subdivisions demonstrates the value of cytological data for the interpretation of natural alliances.

In distribution, the section MARIPOSA is widespread, from Canada to Mexico, and east to the Dakotas. The subsection VENUSTI is almost confined to California, but one species crosses the deserts to western Colorado. The subsection MACROCARPI has a Columbian Plateau distribution. The NUTTALLIANI are found from northern Lower California to the northern Great Plains, but are mostly confined to California and adjacent states. The GUNNISONIANI are found in the Rocky Mountains, and in the semi-desert regions of New Mexico and Arizona.

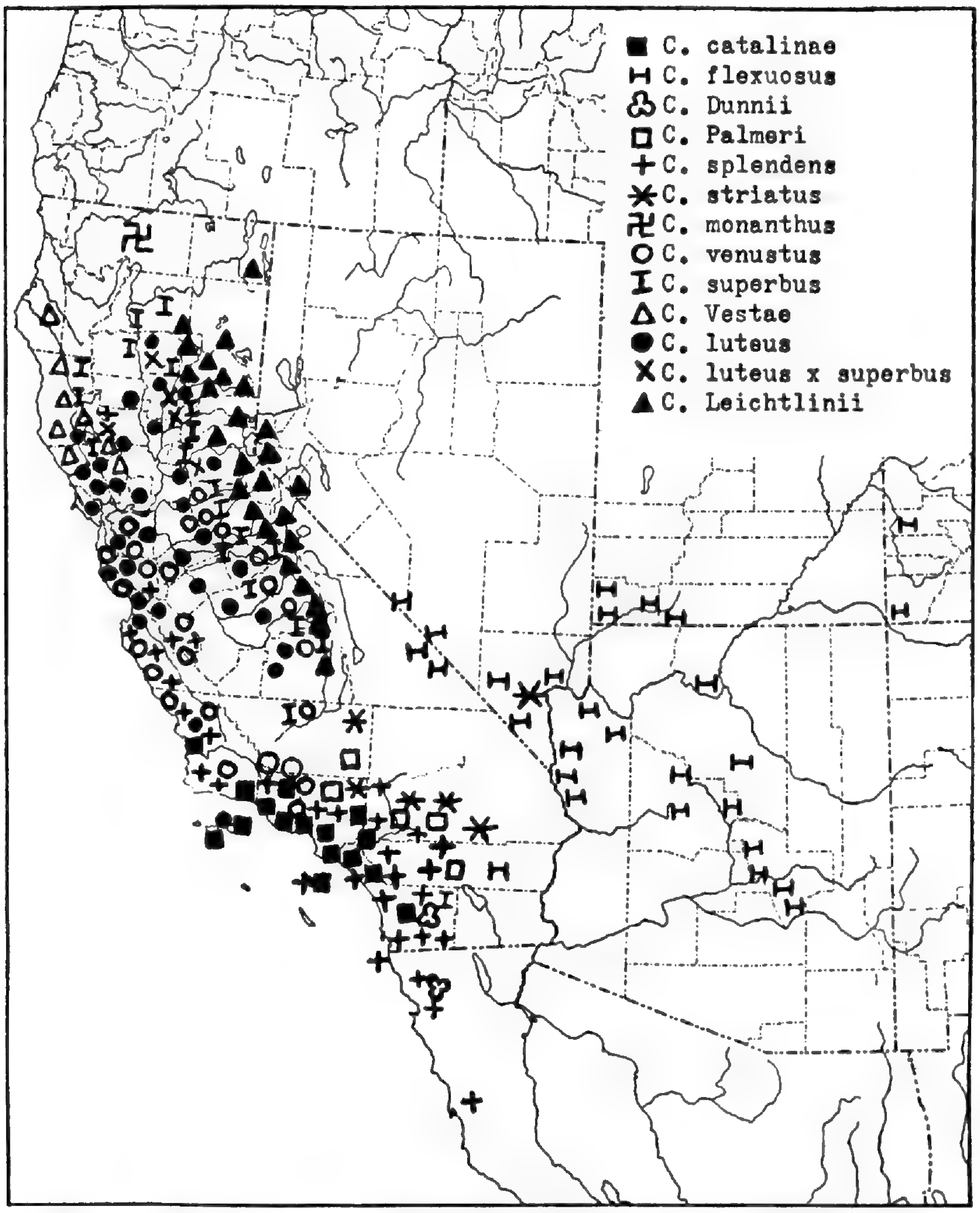
Subsection 5. VENUSTI.[33]

Inflorescences monochasial or subumbellate; sepals usually shorter than the petals, lanceolate, acute to acuminate; petals obovate, cuneate, usually rounded and obtuse, sparingly invested near the gland with simple hairs; glands not depressed (rarely slightly so), variously shaped, not surrounded with a membrane, but densely covered with hair-like, subclavate or distally fungoid processes; anthers linear-oblong to linear-lanceolate, obtuse to apiculate; fruits linear-lanceolate to linear, 3-angled to narrowly 3-winged; seeds more or less flattened, usually with obscurely hexagonally reticulate coats.

The VENUSTI are distinguished by their plane gland-surface

[33] VENUSTI subsect. nov., inflorescentiis monochasialibus aut subumbellatis; sepalis petalis plerumque brevioribus lanceolatis acutis vel acuminatis; petalis obovatis cuneatis plerumque rotundo-obtusis, prope glandulam pilis simplicibus parce praeditis; glandulis non depressis (raro subdepressis) diversiformibus, membrana non circumdatis sed processis filiformibus subclavatis aut apice fungiformibus dense vestitis; antheris lineari-oblongis vel lineari-lanceolatis obtusis vel apiculatis; capsulis lineari-lanceolatis vel linearibus triangulatis vel anguste 3-alatis; seminibus plus minusve complanatis, testis plerumque obscure hexagono-reticulatis.

and lack of a gland-membrane. Although the species fall into distinct alliances, those with definitely monochasial inflorescences, and those in which the inflorescence is subumbellate,



Map 5. Distribution of the species and hybrids of the subsection VENUSTI.

the subsection seems to be a very natural one. The species of the first alliance are well defined, while those of the second are somewhat difficult of delimitation. The chromosome base number of the entire subsection, as far as known, is six or seven.

The latter number is the usual one. Two cases of triploidy and one of tetraploidy are known. In distribution, the subsection is almost limited to California. Two species, *C. Leichtlinii* and *C. striatus*, reach Nevada, while a third, *C. flexuosus*, crosses the deserts of the Southwest to western Colorado (Map 5).

22. Calochortus catalinae Watson in Proc. Am. Acad. **14**: 268. 1879.

Calochortus Lyoni Watson, *l. c.* **21**: 455. 1886.

Bulb ovoid, with membranaceous coats; stem erect, more or less zigzag or flexuous, usually branched above, bulbiferous near the base; leaves linear, attenuate, reduced upward; inflorescence distinctly monochasial, the bracts opposite the flowering pedicels; flowers large, erect, white to lilac, usually with a purple spot at the base of each petal about the gland and a similar spot on each sepal at the base; sepals shorter than the petals, lanceolate, acuminate, glabrous; petals obovate, cuneate, usually rounded and obtuse, naked except for a few slender hairs near the base; gland not depressed, densely covered with long, slender processes; anthers oblong, obtuse or acute, shorter than the basally dilated filaments; ovary strongly 3-angled, abruptly contracted to a sessile, persistent, trifid stigma; fruit oblong, obtuse, narrowly 3-winged, erect; seeds elliptic, strongly flattened, with light-colored, hexagonally reticulate coats.

Although this species unquestionably belongs in the section MARIPOSA, its narrowly 3-winged ovary and fruit connect it directly with the section EUCALOCHORTUS. It is most closely related to *C. flexuosus* of the southwestern deserts, but is easily distinguished by its obtuse fruits, erect stems and bulbiferous habit.

DISTRIBUTION. California: open slopes, usually near the coast, southern San Luis Obispo County, southward to San Diego County; also on the Santa Barbara Islands.

CALIFORNIA. SAN LUIS OBISPO CO.: Pismo Beach, April 5, 1934, *Jones* (P). SANTA BARBARA CO.: Santa Barbara, 1886, *Bingham* (UC); roadside, Santa Barbara, March 4, 1884, *Dexter* (G); Mission Creek, May 11, 1908, *Eastwood* (CA); Carpinteria, April 6, 1929, *Jones 26107* (D, M, P, UM); dry slope, Mountain Drive, April 12, 1926, *Munz 10337* (P, UC); Santa Barbara, April 19, 1887, *Smith* (PA). SANTA CRUZ ISLAND: Valle del Medio, April 10, 1931, *Howell 6186*

(CA); without exact locality, June 6, 1918, *Miller* (CA); among cactus, Portazuela, April 12, 1931, *Sheldon* (Clokey). SANTA ROSA ISLAND: without exact locality, April 8, 1930, *Hoffmann* (CA); grassy slopes, below Torrey Pines, April 8, 1930, *Munz & Crow 11615* (P). VENTURA CO.: Santa Paula, April 3, 1908, *Cobb 134* (UC); Nordhoff, April 21, 1916, *Eastwood 4956* (CA); Griffins, Mt. Pinos, July, 1902, *Elmer 3962* (D, F, G, M, NY); Sulphur Mt., April 3, 1931, *Epling & Anderson* (NY, PA, UCLA); Ventura, April, 1921, *Evermann* (CA); Casitas Pass, 180 m. alt., May 6, 1902, *Hall 3137* (D, UC); rocky slope, Conejo Grade, May 9, 1930, *Howell 4773* (CA); Camarilla, April 27, 1926, *Jones* (P); Cuyama Canyon, April 28, 1926, *Jones* (P); Ventura, 1923, *Kendall* (P); burn in chaparral, Ojai Valley, April 6, 1930, *Munz & Crow 11495* (P). LOS ANGELES CO.: Sepulveda Canyon, Santa Monica Mts., April, 1899, *Abrams 251* (D); Santa Monica Mts., April 3, 1901, *Abrams 1266* (D, M, P); grassy slopes, San Pedro Hills, March 14, 1903, *Abrams 3143* (D, G, M, NY, P, PA, UCLA); Glendora, May 5, 1902, *Braunton 268* (D, UC); Mandeville Canyon, near Santa Monica, April 20, 1928, *Bryan 53* (P); Hollywood, April 24, 1918, *Carlson* (CA); open hillside, Puddingstone Dam, May 9, 1935, *Clokey & Anderson 6545* (Clokey, F, M, NY, P); openings among brush, dry ridge, Mandeville Canyon, Santa Monica Mts., 425 m. alt., April, 1929, *Clokey & Templeton 4426* (Clokey, F, G, NY, P, UC); hillsides, Santa Monica Mts., March 28, 1916, *Crawford & Hiatt 568* (D, P); Los Angeles, May, 1894, *Davidson* (G); Garvanza, May 27–June 10, 1906, *Eastwood 19* (CA); Topanga Canyon, May 8, 18, 1926, *Epling* (UCLA); Los Alisos Canyon, May 9, 1931, *Epling* (CA, D, F, M, NY, PA, UC, UCLA); Topanga Canyon, May 18, 1929, *Epling & Ellison* (UCLA, UM); Las Flores Canyon, March 28, 1930, *Epling & Ellison* (F, M, UC, UCLA, UM); grassy slope, ridge above Providencio Rancho, Santa Monica Mts., May 25, 1929, *Ewan 3485* (P); Newhall, Feb.–May, 1885, *Gray* (G); Sierra Santa Monica, May 11, 1902, *Hall 3263* (D, UC); hillsides, Pacific Palisades, July 16, 1931, *Hastings* (NY); Topanga Canyon, May 19, 1933, *Hilend* (UCLA), Los Angeles, May 1, 1882, *Jones 3212,* (CA, Clokey, M, NY, P); Malibu Hills, April 26, 1926, *Jones* (P); San Dimas, April 20, 1927, *Jones* (P); Temescal Canyon, Santa Monica Mts., April 8, 1923, *Lloyd* (UC); hills about Los Angeles, 1885, *Lyon* (G, type of *C. Lyoni* Watson); ridge s. w. of Museum Hill, Los Angeles, April 14, 1916, *Moxley 306* (CA); dry hillside, Topanga Canyon, Santa Monica Mts., 210 m. alt., May 17, 1920, *Munz & Harwood 3991* (P, RM); grassy hillside, Lone Hill, April 19, 1919, *Munz, Street & Williams 2486* (D, P); rocky hillside, at mouth of Los Alisos Canyon, Santa Monica Mts., June 27, 1938, *Ownbey & Ownbey 1667* (CA, D, F, G, Kew, M, NY, O, RM, UC); hillsides, Lone Hill, near San Dimas, April 19, 1919, *Parish 19296* (G, UC); hillside, Malibu Road, Santa Monica Mts., May 11, 1935, *Purer 6558* (M). SANTA CATALINA ISLAND: without exact locality, May 11, 1890, ex herb. *Brandegee* (G); Avalon, April 28, 1914, *Carlson* (CA, F); Avalon, May 7, 1918, *Carlson* (M); grassy hills, Isthmus, 90 m. alt., March 17, 1928, *Dunkle 1752* (P); dry, grassy hillsides, Little Harbor, 60 m. alt., March 31, 1928, *Dunkle 1762* (P); open north slope, hill n. of Avalon, 50 m. alt., May 6, 1932, *Fosberg 8167* (M, P, UCLA); Avalon, March 30, 1900, *Grant* (D); open plain, March, 1901, *Grant 2378* (NY); without exact locality, April 21–26, 1904, *Grant & Wheeler 126a–1847* (D, F, M, PA, RM, UC); Avalon Canyon, April 26, 1932, *Herley* (UCLA); Isthmus, May 29, 1927, *Jones* (P); stony soil of hillside, head of Hamilton Canyon, April 17, 1921, *Knopf 87* (F); gravelly soil, hillside above Wireless Station, Pebble Beach

Road, May 15, 1921, *Knopf 107* (Clokey, F); Cottonwood Canyon, April 30, 1922, *Knopf 399* (F); hillside above gas plant, May 22, 1922, *Knopf 417, 438, 439* (F); without exact locality, June 11, 1918, *Miller* (CA); Schoolhouse Ridge, April 28, 1920, *Nuttall 6* (F); without exact locality, 1878, *Schumacher* (F, fragment, G TYPE, NY); Avalon Canyon, 24 m. alt., May 26, 1912, *Smith 4985* (F). SAN BERNARDINO CO.: dry clay mesa top, among grass, Red Hill, near Upland, April 28, 1917, *Johnston 1210* (Clokey, D, P, UM); Serrano Club Grounds, Chino, May 1, 1926, *Jones* (CA, D, NY, P); grassy slope, Red Hill, near Upland, April 25, 1918, *Munz 2098* (P); dry hills, Upland, May 2, 1917, *Parish 11149* (UC). ORANGE CO.: Santiago Creek, May, 1899, *Bowman* (D); Fullerton Hills, April 14, *Hilend 15* (UCLA); hillsides, Santa Ana River Canyon, May 3, 1919, *Munz, Street & Williams 2624* (P); Santa Ana Canyon, April 11, 1922, *Pierce* (P). SAN DIEGO CO.: Ramona, April 20, 1891, *Thurber* (F).

23. Calochortus flexuosus Watson in Am. Nat. **7**: 303. 1873.

Bulb ovoid, with membranaceous coats; stem erect or often more or less decumbent and twining, usually branched, rarely bulbiferous; leaves linear, attenuate, reduced upward; inflorescence monochasially 1–4-flowered, its internodes short; flowers campanulate, erect, white to pink, each petal with a transverse yellow band at the gland, and usually a purple spot on the claw, sepals similarly marked; sepals shorter than the petals, lanceolate, obtuse or acute, glabrous; petals obovate, cuneate, rounded and obtuse above, sparsely invested near the gland with short, thick hairs; gland not depressed, transversely lunate to nearly circular, densely covered with rather short processes; anthers oblong, obtuse or umbonate, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit lanceolate, acute, 3-angled, erect; seeds strongly flattened, with light-colored, hexagonally reticulate coats.

Well-developed specimens of this species are distinguished by their characteristic, flexuose-twining habit. In depauperate specimens, however, this character is not so evident, and, due to the uncertainty of favorable growing conditions throughout the range, such specimens are not infrequent. The lanceolate, acute capsules are also characteristic, and fruiting specimens could not be very easily confused with those of any other species. Its nearest ally seems to be *C. catalinae,* but the relationship is remote, and the two are easily separated on a number of characters.

DISTRIBUTION. On desert hills and mesas, southwestern Colorado, westward to southern Nevada and adjacent California, southward to central Arizona.

COLORADO. MONTROSE CO.: red clay soil, Naturita, 1620 m. alt., May 12, 1914, *Payson 289* (F, G, M, RM, WS); same locality, May 26, 1914, *Payson 357* (F, G, M, RM, WS). MONTEZUMA CO.: McElmo Creek, June, 1892, *Eastwood* (F).

UTAH. KANE CO.: Kanab, *Thompson* (G TYPE). WASHINGTON CO.: dry hillside, 10 mi. e. of St. George, May 10, 1938, *Barkley 3207* (O); sandstone mesa n. of St. George, May 17, 1933, *Benson 31* (UC); lava hill, Belveau, 1200 m. alt., June 1, 1929, *Cottam, Stanton & Harrison 3991* (P); dry situations, sage association, Pine Valley, 1950 m. alt., June 3, 1929, *Cottam, Stanton & Harrison 4058* (P); St. George, May 13, 1902, *Goodding* (RM); in shrubs, rocky hillside, just outside west entrance to Zion National Park, May 10, 1937, *Hitchcock 2981* (O, UM); w. of St. George, April 16, 1880, *Jones* (P); in gravel, La Verkin, 1020 m. alt., May 8, 1894, *Jones 5187* (F, M, NY, P, RM, UC); red sand, Springdale, 1200 m. alt., May 16, 1894, *Jones 5249* (P); Zion Canyon, May 21, 1923, *Jones* (CA, P, PA, UC); mesa e. of Hurricane, 1125 m. alt., May 3, 1932, *Maguire & Blood 1310* (RM, UC); on gravelly slopes, 3 mi. n. of Toquerville, April 2, 1934, *Maguire, Maguire & Maguire 4753* (RM, WS); Valley of the Virgin, near St. George, May, 1874, *Parry 254* (F, G, M, PA); on limestone, Pine Valley Road, 15 mi. w. of St. George, 1500 m. alt., May 6, 1934, *Stone 166* (NY); on sandstone, 34 mi. from St. George, toward Cedar City, 1530 m. alt., May 9, 1934, *Stone 200* (NY); in sand, Red Hill, St. George, May 2, 1908, *Tidestrom 9266* (M); piñon belt, on slopes between St. George and Beaverdam Mts., May 6, 1919, *Tidestrom 9313* (NY).

ARIZONA. COCONINO CO.: San Francisco Mts., July, 1884, *Lemmon & Lemmon* (UC); Bright Angel Trail, Grand Canyon of the Colorado River, May 6, 1917, *Meiere* (CA); Bright Angel Trail, Grand Canyon, 1908, *Shockley* (D). YAVAPAI CO.: Montezuma Castle National Monument, May 20, 1937, *Cutler 1123* (M); Prescott, June 3, 1929, *Eastwood 17694, in part* (CA); Verde Valley, April 15, 1920, *Jones 119* (G); between Prescott and Ash Fork, May 12, 1931, *McKelvey 2190* (G); Fort Verde, 1884, *Mearns 203, in part* (NY); loose gypsum soil near Montezuma Castle National Monument, May 21, 1935, *Nelson & Nelson 2039* (M). GILA CO.: mesa near Rock and Rye creeks, 990–1050 m. alt., *Collom 74* (M, NY); Roosevelt Dam, April 19, 1917, *Eastwood 6282* (CA); Roosevelt Dam, May 17, 1919, *Eastwood 8734* (CA); San Carlos, April 1, 1935, *Eifrig* (F); hillsides, Globe-Cooley Road, May 6, 1925, *Nelson 10374* (RM, UC); rocky slopes near Roosevelt Lake, May 6, 1935, *Nelson & Nelson 1792* (M, NY); mesas at the foot of the Mazatzal Mts., May 19, 1935, *Nelson & Nelson 1984* (M); San Carlos, April, 1932, *Palmer* (CA); 9 mi. n. of Winkelman, Globe Road, April 28, 1922, *Wiegand & Upton 3046* (F). MOHAVE CO.: vicinity of Kingman, Spring, 1927, *Braem* (D); road to Clay Springs, 900–1200 m. alt., May 15, 1935, *Braem* (D, P); on road to Peach Springs, from Kingman, May 17, 1931, *Eastwood 18463* (CA); Yucca, April 21, 1884, *Jones* (P); Peach Springs, May 26, 1884, *Jones* (P); Chemehuevis, 750 m. alt., April 21, 1903, *Jones* (P); Peach Springs, June, 1884, *Lemmon & Lemmon* (UC). COUNTY NOT DETERMINED: on road to the Mercury Mine, region of Apache Trail, May 6, 1929, *Eastwood 16883* (CA).

NEVADA. CLARK CO.: brushy flat, juniper belt, Kyle Canyon, Charleston Mts., 2100 m. alt., May 10, 1936, *Clokey 7040* (Clokey); same locality, 1400 m. alt., May

15, 1937, *Clokey 7481* (Clokey, M, O); in brush, juniper belt, Harris Springs Road, Charleston Mts., 1800 m. alt., May 17, 1937, *Clokey 7483* (Clokey, M, O); wash, *Covillea* belt, Trout Creek Fan, Charleston Mts., 1700 m. alt., May 8, 1936, *Clokey & Anderson 7139* (Clokey, M, O); in the underbrush, Muddy Range, April 10, 1905, *Goodding 2215* (M, RM); Goodsprings, April 30, 1905, *Jones* (CA, NY, P); Las Vegas into Charleston Mts., 1500 m. alt., May 2, 1934, *Stone 115* (NY). NYE CO.: Rhyolite, 1140 m. alt., April 26, 1907, *Jones* (P). ESMERALDA CO.: Grapevine Mts., June 2, 1891, *Coville & Funston 978* (NY). COUNTY NOT DETERMINED: red sand, St. Joe, 420 m. alt., April 7, 1894, *Jones 5029* (CA, P); between Boulder City and Rhyolite, April 24, 1935, *McCracken* (CA).

CALIFORNIA. INYO CO.: Daylight Pass, May, 1932, *Harrison 5477* (M); twining among shrubs, on ridge above Keane Spring, Amargosa Range, 1140 m. alt., May 9, 1932, *Munz 12595* (M, P, UC, UM); open hill-slopes above spring, Keane Spring, Funeral Mts., 1320 m. alt., May 9, 1932, *Peirson 9942* (UC); Boundary Canyon, California-Nevada Line, May 3, 1937, *Rountree* (CA); Death Valley, April, 1907, *Smith* (UC). RIVERSIDE CO.: rocky slope in high canyon, vicinity of Corn Springs, Chuckwalla Mts., Colorado Desert, 660 m. alt., April 9–12, 1922, *Munz & Keck 4838* (P).

24. Calochortus Dunnii Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 147. 1901.

Calochortus Palmeri var. *Dunnii* Jepson & Ames in Jepson Fl. Calif. **1**: 294. 1921.

Bulb ovoid, with membranaceous coats; stem erect, often branched, not bulbiferous; leaves 1 cm. or less broad, tapering to the tip, reduced upward; inflorescence monochasially 1–4-flowered, its internodes usually very short; flowers broadly campanulate, erect, white or flushed with pink, with a reddish brown spot on each petal above the gland, and sometimes with a smaller, similar spot on each sepal near the base; sepals shorter than the petals, lanceolate, acuminate, usually glabrous; petals obovate, cuneate, usually rounded above, sparsely invested near the gland with short yellow hairs; gland not depressed, more or less circular, densely covered with yellow, hair-like processes; anthers oblong, acute, white, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, 3-angled, erect; seeds not known.

This species differs from its immediate allies in its hair-like gland processes and white petals, which are spotted above the gland. In size and habit, it resembles *C. splendens,* with which it grows, and with which it occasionally hybridizes.

DISTRIBUTION. On dry, stony ridges near Julian, San Diego County, California, southward to the Guadalupe Mountains in northern Lower California.

CALIFORNIA. SAN DIEGO CO.: on chaparral ridges, between Julian and Cuyamaca, June 22, 1903, *Abrams 3810* (G, M, NY, PA); west side of road on rocky, bushy hillside, 2 mi. from Descanso, off the Campo Road, June 15, 1906, *Brandegee* (UC); near Descanso, June 20, 1904, *Brandegee* (UC); Cuyamaca Mts., July 5, 1898, *Dunn* (CA), TYPE COLLECTION; dry, stony slope, "Desert View," s. of Julian, June 29, 1923, *Munz & Harwood 7314* (NY, P); rocky hilltop, 3 mi. s. e. of Julian, June 24, 1938, *Ownbey & Ownbey 1664* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); Cuyamaca, 1350 m. alt., June 11, 1919, *Spencer 1356* (CA, G, NY, P).

LOWER CALIFORNIA. "Northern Lower California," July 10, 1884, *Orcutt 532* (US); Guadalupe Mts., June, 1883, *Orcutt 839* (G).

25. Calochortus Palmeri Watson in Proc. Am. Acad. **14**: 266. 1879.

Calochortus splendens var. *montanus* Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 143. 1901.

Calochortus invenustus var. *montanus* Parish in Bull. So. Calif. Acad. **1**: 124. 1902.

Calochortus montanus Davidson, *ibid.* **9**: 54. 1910.

Calochortus paludicola Davidson, *ibid.* 53.

Calochortus Palmeri var. *paludicolus* Jepson & Ames in Jepson, Fl. Calif. **1**: 294. 1921.

Bulb ovoid, with membranaceous coats; stem erect, often branched, bulbiferous; leaves linear, attenuate, reduced upward; inflorescence monochasially 1–4-flowered, its internodes usually very short; flowers broadly campanulate, white to lavender, sometimes with a brownish spot near the base of each sepal, or on each petal about the gland; sepals equalling or exceeding the petals, lanceolate, acuminate, the tip often curled back, glabrous; petals obovate, cuneate, usually rounded above, sparsely invested near the gland with yellow, flexuous hairs; gland not depressed, more or less circular, densely covered with short, thick, distally knobbed, but unbranched, yellowish processes; anthers oblong, acute or obtuse, white, usually equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, 3-angled, erect; seeds unknown.

Notwithstanding the formidable array of synonyms, *C. Palmeri* is morphologically quite uniform, and is easily distinguished by its characteristic gland processes. It is perhaps most closely allied to *C. splendens,* but its white anthers and consistently bulbiferous habit, as well as the gland characters, mark it at once. The name, *C. Palmeri,* however, has usually been misapplied to another entity, *C. striatus,* an interpretation which is not in accord with the specimens on which it was based.

DISTRIBUTION. California: in low meadows, "cienegas," Tehachapi, San Gabriel, San Bernardino and San Jacinto mountains.

CALIFORNIA. KERN CO.: Tehachapi, June 24, 1889, *Greene* (UC). LOS ANGELES CO.: in adobe of a cienega, Leonis Valley, May 9–24, 1896, *Davy 2608* (UC). SAN BERNARDINO CO.: flat and low hills, Squint's Ranch, 1600 m. alt., June 5, 1935, *Clokey 6539* (Clokey); openings on flats and slopes, Horsethief Canyon, 1000 m. alt., June 5, 1935, *Clokey & Anderson 6538* (Clokey, F, M, NY, P); wet meadow, Bear Valley, July, 1909, *Davidson 2171* (D), type collection of *C. paludicola* Davidson; moist area under pines, near lake, about 1 mi. w. of Fawnskin, July 6, 1924, *Johnston* (P); grassy swale, south side of Big Bear Lake, San Bernardino Mts., June 29, 1938, *Ownbey & Ownbey 1675* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); Mojave River District, May 25, 1876, *Palmer 527* (F, G TYPE, M, NY, UC); borders of stream, Cox Ranch, north side of San Bernardino Mts., June 14, 1886, *Parish 1857* (G, UC); upper Mojave River, northern base of San Bernardino Mts., May, 1882, *Parish & Parish 1341* (F, G, PA, UO). RIVERSIDE CO.: Strawberry Valley, San Jacinto Mts., 1650 m. alt., June 21, 1910, *Condit* (UC); San Jacinto Mts., 2100 m. alt., Aug., 1880, *Parish & Parish 586* (G); San Jacinto Mts., June, 1897, *Reinhardt* (UC).

26. Calochortus splendens Douglas ex Bentham in Trans. Hort. Soc. Lond. Ser. II. **1**: 411, *pl. 15, fig. 1.* 1834.

Calochortus splendens var. *atroviolaceus* Hort. in Gard. Chron. Ser. III. **18**: 14. 1895; Purdy & Bailey in Bailey & Miller, Cyclop. Am. Hort. **1**: 221. 1900.

Calochortus splendens var. *ruber* Hort. ex Purdy & Bailey, *l. c.*

Calochortus splendens var. *major* Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 143. 1901.

Calochortus splendens var. *rubra* Purdy, *l. c.* 144.

Calochortus Davidsonianus Abrams, Illust. Fl. Pac. States **1**: 441. 1923.

Bulb ovoid, with membranaceous coats; stem erect, often branched, rarely bulbiferous; leaves linear, attenuate, reduced upward; inflorescence monochasially 1–4-flowered, its internodes usually very short; flowers erect, campanulate, lavender, often with a purple spot near the base of each sepal and sometimes with a similar spot on each petal about the gland; sepals shorter than the petals, lanceolate, acuminate, glabrous; petals obovate, cuneate, usually rounded and erose-dentate above, sparsely invested below the middle with slender, more or less flexuous hairs; gland not depressed, naked or usually densely covered with distally much-branched ("fungoid") processes; anthers linear-lanceolate to linear-oblong, obtuse to short apiculate, purple to blue, usually shorter than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, 3-angled, erect; seeds strongly flattened with light-colored, cellular coats.

Calochortus splendens is usually easily distinguished by its characteristic gland processes, but the occasional absence of these is equally characteristic. Both forms are frequently found growing together, and are otherwise indistinguishable. Specimens of this species from Santa Barbara County and southward have fewer, shorter hairs on the face of the petals, but do not appear to differ constantly in any other way. This element has been described as *C. Davidsonianus,* but its single quantitative difference seems hardly of taxonomic significance.

DISTRIBUTION. Dry hills, Colusa County, California, southward in the Coast Ranges to northern Lower California; also on Santa Catalina and the Coronados Islands.

CALIFORNIA. COLUSA CO.: clay soil, above Middle Fork of Stony Creek, 2.5 mi. e. of Bonnie View, e. base of Snow Mt., 510 m. alt., May 14, 1939, *Constance 2491* (UC); on mountains near Fouts Springs, June, 1884, *Rattan 60* (D, G). LAKE CO.: between Burns Valley and Borax Lake, June 9, 1938, *Hoover 3552* (UC). SANTA CLARA CO.: near Llagas Creek, June 6-10, 1909, *Dudley* (D). SAN BENITO CO.: loose soil in sandstone, east slope, *Pinus Sabiniana* belt, 2 mi. n. of Idria, San Carlos Range, South Coast Ranges, 600 m. alt., May 25, 1938, *Constance & Morrison 2265* (O, WS); near Hepsedam Peak, 1899, *Dudley* (D); San Benito, May 16, 1918, *Eastwood 6945* (CA); Loco Flat, San Benito River, 600 m. alt., May 29, 1915, *Hall 9957* (G, UC); Hernandez, June 7, 1903, *Lathrop* (D). MONTEREY CO.: head of Paloma Canyon, about 8 mi. above its confluence with the Arroyo Seco, Santa Lucia Mts., July 1, 1923, *Bacigalupi* (D); Tularcitos Ranch, Carmel Valley, May 15, 1924, *Bacigalupi* (D); San Antonio River, May 7, 1861, *Brewer 568* (UC); Stone Canyon, June 13, 1910, *Condit* (UC); locality uncertain, but presumably near Monterey, "California," *Douglas* (G, NY), TYPE COLLECTION; dry bank by road, above Mission San Antonio, May 13, 1895, *Dudley* (D); grade s. of Tularcitos

Ranch, Santa Lucia Mts., June 10, 1901, *Dudley* (D); Tassajara Hot Springs, June, 1901, *Elmer 3217* (CA, D, M, UO); Santa Lucia Camp, Arroyo Seco River, Santa Lucia Mts., May 23, 1931, *Howell 6533* (CA). SAN LUIS OBISPO CO.: Paso Robles, June 10, 1917, *Abrams 6501* (D); Atascadero, April 30, 1861, *Brewer 507* (G, M, UC, WS); Paso Robles, May 4, 1926, *Eastwood 13811* (CA); 3½ mi. n. e. of Black Mt., S. 1, T. 29 S., R. 15 E., 540 m. alt., May 24, 1937, *Hendrix 212* (UC); roadsides, near Templeton, May 9, 1926, *Wiggins 2056* (D). SANTA BARBARA CO.: Blochman's Ranch, near Santa Maria, June 17, 1906, *Eastwood 488* (CA); Mono Flat Ranger Station, Santa Barbara Forest Reservation, 450 m. alt., July 3, 1923, *Grant 1687, in part* (M, P); Santa Barbara, *Meiere* (CA). VENTURA CO.: dry, sandy soil, Quatal Canyon, near Mt. Pinos, July 2, 1938, *Ownbey & Ownbey 1685* (G, M, O, UC). LOS ANGELES CO.: Bouquet Canyon, 450 m. alt., May 13, 1930, *Clokey, Clokey & Templeton 4627* (Clokey); Topanga Canyon, Santa Monica Mts., June 3, 1916, *Hiatt* (P); Claremont, May 7, 1910, *Pease* (G); Claremont, 450 m. alt., *Steffa* (P); dry, sunny, clay hillside, Liveoak Canyon, San Gabriel Mts., 480 m. alt., April 27, 1934, *Wheeler 2570* (CA, D, UCLA). SANTA CATALINA ISLAND: without exact locality, *Brandegee* (UC); without exact locality, May 15, 1890, ex herb. *Brandegee* (G); grassy slope, Empire Landing, 60 m. alt., May 12, 1928, *Dunkle 1922* (P); Isthmus, May 29, 1927, *Jones* (P); without exact locality, June 12, 1921, *Knopf 213* (F); Isthmus, June, 1922, *Knopf 446* (F); open fields at the Isthmus, May 16, 1920, *Nuttall 216* (F); highlands between Summit and Middle Ranch Canyon, June 4, 1920, *Nuttall 598* (F); dry, high hills, Avalon, May, 1896, *Trask* (M, NY, UC). SAN BERNARDINO CO.: brushy flat, Devore Cutoff, 460 m. alt., May 19, 1935, *Clokey 6540* (Clokey, F, M, NY, P); Arrowhead Springs, May 10, 1891, *Fritchey 39* (M); Mill Creek Canyon, near Skinner, June 15, 1901, *Grant* (D); Arrowhead Hot Springs, San Bernardino Mts., May 24, 1906, *Grant 6647* (D); Redlands, May, 1906, *Greata 446* (CA); between Victorville and Mojave, May 24, 1926, *Hart 26* (CA); Cajon Canyon, June, 1928, *Jones* (F, P); hills near Old San Bernardino, May 10, 1889, *Parish 2075* (F); dry mesas, San Bernardino Valley, n. of San Bernardino, 300 m. alt., June 8, 1917, *Parish 11334* (UC); Mentone, May, 1903, *Williamson* (PA). RIVERSIDE CO.: Elsinore, May, 1901, *Abrams* (D); near Idylwild, June 24, 1932, *Epling* (UCLA); 4 mi. above Corona, Temescal Canyon, June, 1933, *Epling & Ewan* (D, M, UC, UCLA); canyon of the San Jacinto River, San Jacinto Mts., 900 m. alt., June 8, 1901, *Hall 2014* (UC); dry hillside, San Jacinto River Canyon, May 30, 1917, *Jenkins & Street 1953* (D, P); Banning, 690 m. alt., May 11, 1903, *Jones* (P); Menifee, May, 1893, *King* (UC); dry soil near road, mouth of San Jacinto Canyon, 450 m. alt., May 19, 1922, *Munz & Johnston 5411* (P); dry ridge, Glen Ivy Trail to Santiago Peak, Santa Ana Mts., 1440 m. alt., June 14, 1923, *Munz & Keck 7094* (P). ORANGE CO.: Trabuco Canyon, June 16, 1901, *Abrams 1798* (D); El Modena, March, 1899, *Bowman* (D); Laguna Beach, May, 1921, *Campbell 1* (CA); bluffs along shore, Laguna Beach, May 5, 1916, *Crawford* (D, P); hillsides, Santa Ana River Canyon, May 3, 1919, *Munz, Street & Williams 2625* (D, P, PA); open, dry slopes and hillsides, Arch Beach, May, 1903, *White 3* (UC). SAN DIEGO CO.: grassy slopes, between Onofre Mts. and the sea, April 19, 1903, *Abrams 3275* (G, M, NY, P, PA), type collection of *C. Davidsonianus* Abrams; Mission Hills, San Diego, May 5, 1903, *Abrams 3401* (D, G, M, NY, P, PA); on dry ridges, Jacumba, May 31, 1903, *Abrams 3666* (D, NY); grassy slopes, Cuyamaca P. O., 1410 m. alt., June 23, 1903, *Abrams 3817*

(D, G, M, NY); Del Mar, May 11, 1905, *Brandegee* (UC); hillsides and mesas, San Diego, May, 1906, *Brandegee* (UC); Descanso, June 16, 1906, *Brandegee* (UC); in hard soil, San Diego, May 20, 1903, *Brandegee 3420* (F, G, M, NY, P, UC); Warners Hot Springs, July, 1913, *Buttle* (CA); Otay, April 24, 1904, 7 m. alt., *Chandler 5111* (NY); old clearings, foothills, Bird Rock, April 11, 1914, *Clements & Clements 281* (F, G, M, NY, PA); Las Paderes Ranch, Sweetwater Valley, June 6, 1888, *Deane* (G); Tia Juana, April 24, 1913, *Eastwood 2933* (CA); Descanso, June 26, 1919, *Eastwood 9182* (CA, G); Descanso, June 20, 1932, *Epling, Darsie, Knox & Robison* (D, M, NY, UC, UCLA); Harper Ranch, near Cuyamaca Lake, June 23, 1932, *Epling, Darsie, Knox & Robison* (CA, D, M, RM, UC, UCLA); Hell Hole Canyon, near Borego, April 5–7, 1932, *Epling & Robison* (D, UC, UCLA); Guatay Mt., June 26, 1935, *Epling & Robison* (UCLA); wooded hills, open spaces, near Julian, 1300 m. alt., June 6, 1932, *Fosberg 8283* (P); Ostrich Farm, San Diego, May 5, 1906, *Grant* (D); Santa Ysabel, May 20, 1893, *Henshaw* (G); at edge of chaparral, San Onofre Canyon, 165 m. alt., May 16, 1929, *Hitchcock* (P); sandy flats, 4 mi. e. of Pala, May 11, 1930, *Howell 4857* (CA); mountain trail, La Jolla, May 25, 1911, *Jenks* (UCLA); Cuyamaca Lake, May 30, 1926, *Jones* (CA, P); Santa Ysabel, June 11, 1932, *Jones* (UC); Cuyamaca Lake, June 11, 1932, *Jones* (UC); Pala, May 10, 1934, *Jones* (P); Jacumba, Laguna Mts., June 10, 1917, *McGregor 996* (D); Escondido, April, 1927, *Meyer 110* (UC); burn in chaparral, Tecate Mt., May 10, 1924, *Munz 8033* (P); dry ridge, Palomar Mts., 1500 m. alt., June 22, 1924, *Munz 8218* (P); dry slope, Doane Valley, Palomar Mts., 1500 m. alt., June 23, 1924, *Munz 8321* (G, P); dry chaparral burn, 6 mi. n. of Santa Ysabel, May 20, 1925, *Munz 9807* (P); dry hillside, near Fallbrook, 225 m. alt., May 15, 1920, *Munz & Harwood 3855* (D, P, PA, RM); dry, gentle slope, 8 mi. n. of Descanso, June 27, 1923, *Munz & Harwood 7170* (P); dry, gravelly, brush-covered hills, 3 mi. n. w. of Pine Valley, June 24, 1938, *Ownbey & Ownbey 1660* (CA, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UM, UO, US, WS); hillsides, Soledad Mt., near La Jolla, May 1, 1935, *Purer 6523* (M); hillside, near Ramona, June 8, 1935, *Purer 6676* (M); dry soil, Camp Kearney Mesa, May 29, 1937, *Purer 7267* (M); Point Loma, May 16, 1897, *Reed* (P); La Jolla, April 26, 1895, *Snyder* (F); on sunny, sandy slopes, vicinity of San Diego, 90 m. alt., April 21, 1916, *Spencer 18* (G, UC); dry hills, Mesa Grande, 1005 m. alt., May 29, 1919, *Spencer 1153* (CA, G, NY, P); dry hills, Mesa Grande, 990 m. alt., June 1, 1919, *Spencer 1354* (G); in desert sand, Colorado Desert, May 16, 1920, *Spencer 1590* (P); dry slopes above Descanso Creek, 3½ mi. above Descanso, 1110 m. alt., May 30, 1931, *Wolf 2206* (D); San Luis Rey River, ½ mi. below Henshaw Dam, 1780 m. alt., May 30, 1931, *Wolf 2225* (UC), *2226* (D).

Lower California. Coronados Islands, *Anthony* (UC); Valledenos Creek, May 4, 1893, *Brandegee* (UC); clay and rock hillside, 15 mi. n. of Ensenada, 300 m. alt., April 3, 1925, *Canby* (P); north end of east island, top of dry ridge, Coronados Islands, 210 m. alt., March 29, 1921, *Cowles 1* (P); gravelly plains, San Quintin, April 8, 1936, *Epling & Stewart* (D, UCLA); All Saints Bay, April, 1882, *Fish* (G); Tecate, April 10, 1923, *Gallegos 925* (US); ranch, 29 mi. s. w. of Tia Juana, April 13, 1925, *Jones* (P).

27. Calochortus striatus Parish in Bull. So. Calif. Acad. **1**: 122. 1902.

? *Calochortus comosus* A. Nelson in Bot. Gaz. **47**: 425. 1909.[34]

Bulb ovoid, with membranaceous coats; stem erect, sometimes short, usually branched, not bulbiferous; leaves linear, attenuate, reduced upward; inflorescence 1–5-flowered, subumbellate; flowers campanulate, erect, lavender with conspicuous purple veins; sepals shorter than the petals, lanceolate, acuminate, glabrous; petals obovate, cuneate, usually rounded and erose above, sparsely invested near the gland with slender, flexuous hairs; gland not depressed, oblong, densely covered with slender, hair-like processes; anthers oblong, obtuse or acute, yellowish, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, 3-angled, erect; seeds strongly flattened, with light-colored, hexagonally reticulate coats.

This species is distinguished by its striate petals and hair-like gland processes. In the California manuals and floras it is described as *C. Palmeri,* but that name was originally applied to a different entity.

DISTRIBUTION. In low alkaline meadows about springs, near Las Vegas, Nevada, and on the Mojave Desert in southern California, particularly along its southern edge.

NEVADA. CLARK CO.: Las Vegas, 300 m. alt., April 29, 1905, *Jones* (D, P).

CALIFORNIA. KERN CO.: dry soil, Steban Miranda's Rancheria, 2 mi. n. e. of Weldon, 900 m. alt., June 1, 1933, *Voegelin 221* (UC). LOS ANGELES CO.: dry places about Lancaster, May, 1909, *Brandegee* (UC); Lancaster, June, 1902, *Elmer 4164* (D). SAN BERNARDINO CO.: in cienega, Cushenbury Spring, June 17, 1923, *Berry* (D); Twenty Nine Palms, May 17, 1902, *Brandegee* (UC); in slightly alkaline meadow about springs, Rabbit Springs, Lucerne Valley, Mojave Desert, 870 m. alt., June 10, 1930, *Johnston 3777* (P); Whiskey Spring, Cushenbury Canyon, May 12, 1926, *Jones* (CA, D, NY, P); alkaline meadow, Cushenbury Spring, Mojave Desert, 1260 m. alt., June 13, 1922, *Munz 5740* (Clokey, P, UC); dry meadow, Cushenbury Spring, Mojave Desert, June 30, 1938, *Ownbey & Ownbey 1677* (G, Kew, M, O, RM, UC); alkaline meadows, Rabbit Springs, Mojave Desert, 810 m. alt., June 1, 1901, *Parish 5000* (D, G, NY, P); Rabbit Springs, Mojave Desert, May, 1882, *Parish & Parish 1342* (F, G, M, PA), TYPE COLLECTION; along mesa above springs, Box S Springs, 1065 m. alt., May 14, 1924, *Peirson 4563* (D); alkaline meadow, Cushenbury Spring, May 24, 1922, *Pierce* (P).

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[34] The type specimen of *C. comosus* has not been located, but, from the original description, it seems likely to be this species.

28. Calochortus monanthus Ownbey, n. sp.[35]

Bulb ovoid, with membranaceous coats; stem erect, unbranched, bulbiferous; leaves a centimeter or less broad, attenuate, reduced upward; inflorescence 1-flowered, the bracts opposite and linear-attenuate; flower turbinate-campanulate, long-pedicellate, pinkish, with a Λ-shaped, dark red spot on each petal above the gland; sepals shorter than the petals, narrowly lanceolate, attenuate, glabrous; petals obovate, cuneate, rounded and erose above, or with a short acumination, invested near the gland with a few flexuous hairs; gland not depressed, oblong, densely covered with slender, hair-like processes; anthers linear-lanceolate, short-apiculate, longer than the basally dilated filaments; ovary linear, not winged, tapering to a trifid stigma; fruit and seeds not known.

Calochortus monanthus is a fourth unique and unquestionably valid species from the Siskiyou Region of northern California and adjacent Oregon. Like the others, *C. Greenei, C. Howellii* and *C. persistens,* it is apparently very restricted in its distribution, having been collected but once, over sixty years ago. Like them, also, it apparently has no immediate allies. Its one-flowered habit, long pedicels, turbinate-campanulate flowers, and particularly the nature of the gland, distinguish it at once.

DISTRIBUTION. California: known only from the type locality.

CALIFORNIA. SISKIYOU CO.: meadow along the Shasta River, near Yreka, June 24, 1876, *Greene 887* (F, G, M TYPE, PA).

29. Calochortus venustus Douglas ex Bentham in Trans. Hort. Soc. Lond. Ser. II. **1**: 412, *pl. 15, fig. 3.* 1834.

[35] **Calochortus monanthus** sp. nov., bulbo ovoideo membranaceo-tunicato; caule erecto simplici bulbifero; foliis usque ad 1 cm. latis attenuatis superioribus reductis; inflorescentia uniflora, bracteis oppositis lineari-attenuatis; flore turbinato-campanulato longe-pedicellato roseolo, in quoque petalo supra glandulam macula Λ-formi rubida; sepalis petalis brevioribus anguste lanceolatis attenuatis glabris; petalis obovatis cuneatis, apice rotundis erosisque aut brevi-acuminatis, prope glandulam pilis paucis flexuosis praeditis; glandula non depressa oblonga, processis gracilibus filiformibus dense vestitis; antheris lineari-lanceolatis brevi-apiculatis, filamentis basilariter dilatatis longioribus; ovario lineari non alato, stigmate trifido; capsula seminibusque ignotis.

Calochortus venustus var. *purpureus* Baker in Gard. Chron. N. S. **8**: 72. 1877; Van Eeden, Album, *t. 75, fig. 5.* 1877.

Calochortus venustus var. *purpurascens* Watson in Proc. Am. Acad. **14**: 266. 1879; Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 141. 1901.

Calochortus purpurascens Purdy, *l. c.* 139, as synonym.

Calochortus venustus var. *Caroli* Cockerell in Nature **67**: 235. 1903.

Calochortus venustus var. *roseus* Reuthe in Gartenflora **35**: 116. 1886.

Calochortus roseus Hort. in Gard. Chron. Ser. III. **18**: 14. 1895.

Calochortus venustus var. *pictus* Hort., *l. c.*

Calochortus pictus Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 141. 1901, as synonym.

Calochortus venustus var. *sanguineus* Hort. ex Purdy & Bailey in Bailey & Miller, Cyclop. Am. Hort. **1**: 221. 1900.

Calochortus venustus var. *eldorado* Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 141. 1901.

Calochortus venustus var. *sulphureus* Purdy, *l. c.*

Bulb ovoid, with membranaceous coats; stem erect, usually branched, bulbiferous; leaves linear, attenuate, reduced upward; inflorescence 1–3-flowered, subumbellate; flowers erect, campanulate, white to yellow, purple or dark red, each petal marked with a conspicuous, median, dark red blotch, and often with a second, paler blotch above the first; sepals about equalling the petals, narrowly lanceolate, attenuate, curled back at the tip, glabrous; petals obovate, cuneate, usually rounded and obtuse above, sparingly invested near the gland with slender hairs; gland not depressed, more or less quadrate in outline, densely covered with short, hair-like processes; anthers linear-lanceolate to linear-oblong, acute or obtuse, usually about as long as the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, acute, 3-angled, erect; mature seeds unknown.

Calochortus venustus is infinitely variable in the color and markings of the flowers, but appears to represent a very natural entity. In a given locality, one variant may occur more frequently, but usually not to the exclusion of all others, while a few miles away, another form may predominate. The species is quite constantly distinguished by its quadrate gland, but some color forms are otherwise very close to *C. superbus.*

DISTRIBUTION. California: usually in light, sandy soil, Sierra Nevada, from Eldorado County to Kern County, and in the Coast Ranges from the vicinity of San Francisco Bay to Los Angeles County.

CALIFORNIA. AMADOR CO.: Jackson, 1892, *Hansen 1126* (UC); Pine Grove, 750 m. alt., June, 1895, *Hansen 1251* (D, M). CALAVERAS CO.: hillside above North Fork of Calaveras River, 3 mi. w. of San Andreas, 300 m. alt., May 21, 1927, *Stanford 314* (P, RM); near Milton, May 14, 1923, *Steinbeck* (CA). TUOLUMNE CO.: Keltz Mine, June 7, 1895, *Blasdale* (UC); foot of grade below Confidence, June 15, 1937, *Hoover 2453* (O); near Confidence, July 1, 1923, *Steinbeck* (CA); in sunny places, Bear Creek, 300 m. alt., May 6, 1919, *Williamson 41* (CA, Clokey, D, NY, P, RM). MARIPOSA CO.: El Portal, May 20, 1925, *Augsburg* (CA); between Colfax Springs and Crockers, Yosemite National Park, 900-1350 m. alt., July, 1901, *Evans* (UC); Wawona Road, near Alder Creek, Yosemite National Park, 1500 m. alt., June 18, 1911, *Hall 8988* (UC); Meadow Road, Wawona, 1200 m. alt., July 25, 1923, *Howell 156* (CA); Wawona Road to Yosemite, at Alder Creek, Yosemite Park, 1500 m. alt., June 15, 1924, *Howell 413* (CA); above Coulterville, May, 1932, *Seale* (CA). MADERA CO.: rocky, sandy loam, Clark Administrative Site, Sierra National Forest, S. 28, T. 8 S., R. 22 E., 750 m. alt., June 15, 1933, *Hormay H-155* (UC). FRESNO CO.: Pine Ridge, June, 1910, *Brandegee* (UC); thin, rocky soil, with granite boulders and bushes, grassy north slope, *Quercus Douglasii-Aesculus* association, 1 mi. n. w. of Squaw Valley, on road to General Grant Park, Sierra Nevada Foothills, 510 m. alt., May 9, 1938, *Constance 2227* (O, WS); Base Camp, junction of North and South Forks of Kings River, April 10, 1923, *Duncan 76* (D); Cascada, 1500 m. alt., June 25, 1917, *Grant 1007, in part* (D); Pine Ridge, 1500 m. alt., June 15–25, 1900, *Hall & Chandler 245* (D, UC). TULARE CO.: vicinity of Homers Nose, region of Sequoia National Forest, 2700 m. alt., July 11, 1897, *Dudley 1775* (D). KERN CO.: Grapevine Grade, Tejon Pass, April 30, 1927, *Abrams 11667* (Clokey, D, P); Tejon Mts., July 7, 1891, *Coville & Funston 1176* (D), *1177* (NY); hill near Guerilla Creek, vicinity of Poso Creek Valley, July 9, 1895, *Dudley 578* (D); field on Taylor's Ranch, near Gorman's, Tejon Pass, Mt. Pinos Region, June 16, 1896, *Dudley & Lamb 4551* (D); Cuddy Canyon, Mt. Pinos Region, June 18, 1896, *Dudley & Lamb 4582* (D); pass to San Emigdio, Mt. Pinos Region, June 18, 1896, *Dudley & Lamb 4584* (D); south slope, Tejon Pass, 1260 m. alt., June, 1905, *Hall 6265a, 6265b* (UC); dry soil, east slope, Greenhorn Range, 1350 m. alt., June 2–10, 1904, *Hall & Babcock 5064* (UC); rocky wash, Kern Canyon, 7 mi. above Kernville, 720 m. alt., May 13, 1930, *Howell 5055* (CA); Kernville, May, 1876, *Kennedy* (F, G, type of *C. venustus* var. *purpurascens* Watson); baked roadside, near Isabella, June 1, 1935, *MacFadden 14163* (CA); sandy soil in pine-sagebrush association, north of Mt. Pinos, July 2, 1938, *Ownbey & Ownbey 1686* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); pine-sagebrush association, near head of Cuddy Valley, T. 9 N., R. 21 W., July 3, 1938, *Ownbey & Ownbey 1689* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); grassy hillsides, Fort Tejon, June, 1887, *Parish* (F, G, NY); adobe soil, from Lebec through the San Emigdio Range to Maricopa, 900–1250 m. alt., June 19, 1937, *Silvear* (UC); dry hills, 2 mi. n. of Weldon, 900 m. alt., May 20, 1933, *Voegelin 211* (UC). SAN JOAQUIN CO.: Linden, May, 1896, *Gunnison* (UC). CONTRA COSTA CO.: near spring, 4½ mi. from summit, Mt. Diablo, May 25, 1921, *Abrams 8054* (D); Mt. Diablo, May 30, 1915, *Eastwood 4445* (CA); Nortonville, May 12, 1931, *Howell 6471* (CA); Mt. Diablo, May 15, 1899, *Purdy* (G, NY, UO). ALAMEDA CO.: Lake Chabot, San Leandro, June, 1899, *Carruth* (CA); Mocho Creek (Cedar Mt.), May, 1903, *Elmer 4366* (CA, D, M, NY, UO); grassy hill-slopes, between Corral Hollow and Tesla, May 17, 1930, *Ferris 7879* (D, P, UC); grassy hill-slope, Tesla, May 17, 1930, *Ferris 7886* (D). SAN MATEO CO.: serpentine, back of Redwood City, June 1, 1930, *Abrams 7499* (D); Portola, July, 1903, *Elmer 4763* (D, M, NY, UC); serpentine, back of Redwood City, June 1, 1920, *Hichborn 275* (M); hills near Redwood City, June 5, 1932, *Seale* (CA); dry ground, Crystal Springs Lake, June 30, 1913, *Suksdorf 371* (G). STANISLAUS CO.: Del Puerto Canyon, May 13, 1938, *Hoover 3414* (O). SANTA CLARA CO.: San Jose, May, 1901, *Abrams* (D); Pachecos Pass, June 25, 1862, *Brewer 1295* (G, M, UC, WS); Mt. Hamilton, June, 1900, *Carruth* (CA); Palo Alto, 1893, *Dudley* (D); San Juan Hills, May 27, 1895, *Dudley 4012* (D); near Coyote Creek, May 31, 1895, *Dudley 4122* (D); serpentine hills, near Coyote, 60 m. alt., May 17, 1918, *Ferris 823* (D); Mt. Hamilton Road, near Grand View, 450 m. alt., May 30, 1907, *Heller 8601* (D, F, G, M, NY, PA); serpentine, Jasper Ridge, June 4, 1921, *Mason* (D); San Juan Hills, near San Jose, May 7, 1895, *Patterson* (D); dry slope, San Antonio Creek, Burnt Hills, Mt. Hamilton Range, 600 m. alt., May 26, 1935, *Sharsmith 3204* (O); Alum Rock Canyon, 300 m. alt., May, 1905, *Williamson* (PA). SANTA CRUZ CO.: Santa Cruz, June, 1881, *Jones* (P); Adobe Creek Road, 1 mi. below Mt. Herman, 600 m. alt., June, 1910, *Pendleton 1480* (UC). SAN BENITO CO.: Panoche Pass, April 29–March 1, 1921, *Abrams & Borthwick 7939* (D, NY, P, RM); New Idria, April 29–March 1, 1921, *Abrams & Borthwick 7971* (D, P); near New Idria, May 31, 1899, *Dudley* (D); Lone Tree Road, lower canyon of Arroyo Dos Picachos, May 28, 1938, *Hoover 3488* (O); Arroyo Dos Picachos, May 28, 1938, *Howell 13814* (CA); Hernandez, May 25, 1903, *Lathrop* (D); Pinnacles, May 16, 1926, *Rodde* (CA); The Pinnacles, May 31, 1926, *Sutliffe* (CA). MONTEREY CO.: Nacimiento River, May 7, 1861, *Brewer 538* (CA, G, M, UC, WS); locality uncertain, but presumably near Monterey, "Nova California," 1833, *Douglas* (G, NY), TYPE COLLECTION; Santa Lucia Mts., near Jolon, May 13, 1895, *Dudley* (D); sandy flat, 12.5 mi. s. e. of Jolon, Santa Lucia Mts., 320 m. alt., May 10, 1935, *Keck & Stockwell 3228* (D); Santa Lucia Mts., June, 1898, *Plaskett 148* (NY). SAN LUIS OBISPO CO.: Paso Robles, May 7, 1899, *Barber* (P, UC); Santa Lucia Mts., May 22, 1899, *Barber* (UC); Paso Robles, June, 1906, *Carruth* (CA); Trout Creek, May 31, 1908, *Condit* (UC); roadside, Morro, June 13, 1911, *Condit* (UC); Cholame, May 5, 1926, *Eastwood 13905* (CA); along old road to Poyo, May 17, 1928, *Eastwood 15144* (CA); Pettitts Canyon, May 19, 1928, *Eastwood 15169* (CA); *Pinus Sabiniana-Juniperus californica* association, La Panza, April 26, 1934, *Keck 2815* (D, F, M, P, UC); Paso Robles, June, 1887, *Lemmon* (G, UC); Paso Robles, *Purdy* (G, P, UC); San Luis Valley, June 10–30, 1882, *Summers 844* (UC), *844a* (D). SANTA BARBARA CO.: trail to Zaca Peak, June 21, 1906, *Eastwood 595* (CA); Zaca Peak Ridge, June 28, 1906, *Eastwood 753* (CA); near Santa Barbara, *Miles* (NY). VENTURA CO.: Sulphur Mt. Spring, Sulphur Mt., 300–600 m. alt., June 1, 2, 1908, *Abrams & McGregor 44* (D, G, NY, P); brushy hillside, Cuyama River, 1150 m. alt., May 22, 1935, *Clokey & Anderson 6543* (Clokey); Griffins, July, 1902, *Elmer 3812* (D, M, NY, P); hard-baked adobe ground, mouth of Matilija Canyon, Ojai Valley, April 18, 1932, *Fosberg 7986* (M, UCLA); Mt. Pinos, July 4, 1922, *Hart 18* (CA); near Frazer Mt. Park, May 27, 1928, *Hilend 319* (UCLA); Camarilla, April 27, 1926, *Jones* (D); Cuyama Canyon, April 28, 1926, *Jones* (D); dry flat, Upper Sespe Creek, n. of Wheelers Hot Springs, 1050 m. alt., May 1, 1934, *Munz 13224* (P). LOS ANGELES CO.: Liebre Mt., 1440 m. alt., June 20–23, 1908, *Abrams & McGregor 361* (D, NY); Newhall, May 15, 1916, *Evermann* (CA); grassy slope of oak glade, mouth of Pico Canyon, near Newhall, 360 m. alt., May 17, 1930, *Ewan 5514* (D); road to Mt. Pinos, 1 mi. w. of juncture with Ridge Route, May 27, 1928, *Hitchcock* (P); Castaic, Ridge Road, April 29, 1934, *Jones* (P); near Power Plant No. 1, San Francisquito Canyon, June 12, 1922, *Moxley 1114* (RM); dry slope, Mint Canyon, n. of San Gabriel Mts., May 25, 1923, *Munz 6791* (NY, P, UC); burned-over area in chaparral, Bouquet Canyon, near Saugus, 990 m. alt., June 9, 1923, *Munz 6927* (NY, P); dry hillside, Ranger Station, Ridge Road, s. of Tejon Pass, June 9, 1923, *Munz 6927a* (P); dry slope, southern end of Ridge Route to Bakersfield, May 15, 1922, *Pierce* (P); Grapevine Canyon, near San Fernando, May 13, 1915, *Trowbridge* (CA).

30. Calochortus superbus Purdy ex Howell in Leafl. West. Bot. **1**: 11. 1932.

Calochortus venustus var. *citrinus* Baker in Journ. Linn. Soc. Lond. Bot. **14**: 310. 1874.

Calochortus luteus var. *citrinus* Watson in Proc. Am. Acad. **14**: 265. 1879, as to name-bringing synonym.

Calochortus venustus var. *lilacinus* Baker in Gard. Chron. N. S. **8**: 70. 1877; Van Eeden, Album, *t. 75, fig. 1.* 1877.

Calochortus luteus var. *oculatus* Purdy & Bailey in Bailey & Miller, Cyclop. Am. Hort. **1**: 220. 1900; Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 138. 1901, not Watson, 1879.

Calochortus venustus var. *oculatus* Hort. acc. Purdy & Bailey in Bailey & Miller, Cyclop. Am. Hort. **1**: 220. 1900, as synonym.

Calochortus luteus var. *robusta* Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 139. 1901.

Calochortus venustus var. *robusta* Hort. acc. Purdy, *l. c.* as synonym.

Calochortus venustus var. *superbus* Bailey & Bailey, Hortus, p. 113. 1930.

Calochortus superbus var. *pratensis* Purdy ex Howell in Leafl. West. Bot. **1**: 12. 1932.

Bulb ovoid, with membranaceous coats; stem erect, often branched, bulbiferous; leaves linear, attenuate, reduced upward; inflorescence 1–3-flowered, subumbellate; flowers erect, campanulate, white to yellowish or lavender, the petals and sepals usually pencilled with purple below, and marked with a conspicuous, median, reddish brown or purple blotch, surrounded by a zone of bright yellow; sepals usually shorter than the petals, lanceolate, attenuate, glabrous; petals obovate, cuneate, usually rounded and obtuse above, sparingly invested near the gland with short hairs; gland not depressed, linear, more or less Λ-shaped, densely covered with short, hair-like processes; anthers linear-lanceolate to linear-oblong, acute or obtuse, about as long as the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, acute, 3-angled, erect; mature seeds unknown.

Calochortus superbus is closely related to *C. luteus* and *C. Vestae*, but is usually readily distinguished by its flower-color and Λ-shaped gland. It hybridizes with the former in localities where the two come into contact, but neither species seems to have been greatly influenced by hybridization. In flower-color, it often closely resembles certain phases of *C. venustus*, but seems constantly different in gland-shape.

DISTRIBUTION. California: in dry meadows, Sierra Nevada, from Shasta County southward to Kern County, and in the North Coast Ranges, from Shasta County southward to Lake County; also apparently in the Palomar Mountains, San Diego County.

CALIFORNIA. SHASTA CO.: fields in digger pine belt, Round Mt., June 23, 1929, *Applegate 5847* (D, UC); Ridge Road, near Oak Run, May 5, 1900, *Baker* (UC); Oak Run, May 21, 1894, *Baker & Nutting* (UC); Morleys Station, May 22, 1894, *Baker & Nutting* (D, RM, UC); Montgomery Creek, June 7, 1923, *Bethel* (CA); Goose Valley, June 29–July 11, 1912, *Eastwood 795* (CA, Clokey, G, NY); dry, gravelly hills, western part of Redding, May 25, 1905, *Heller 7845* (D, F, G, M, NY, PA, UC); near Redding, May, 1931, *Rose* (CA); Anderson, May 28, 1913, *Smith 323* (CA, G); Redding, May 21, 1914, *Smith 708* (CA); Anderson, May, 1915, *Smith* (CA). TEHAMA CO.: Red Bluff, May 19, 1915, *Smith* (CA); Red Bluff, June, 1917, *Wickes* (CA). BUTTE CO.: De Sabla, June 6, 1917, *Edwards* (Clokey, D, NY, P, UO). YUBA CO.: Brownsville, ex herb. *Birmingham* (NY). NEVADA CO.: Lake City, Sierra Nevada, July, 1867, *Davis 67* (NY); Nevada City, June 20–22, 1912, *Eastwood 595* (CA, Clokey, G, M, NY). PLACER CO.: Applegate, June, 1899, *Smith*

(RM). AMADOR CO.: near Plymouth, June 6, 1903, *Gross 223* (D); New York Falls, Agricultural Station, 600 m. alt., June, 1895, *Hansen 1250* (D); Sutter Creek, May 15, 1918, *Wood* (D). CALAVERAS CO.: Reservoir, May 18, 1887, *Smith* (PA). TUOLUMNE CO.: 3 mi. n. of Keystone, June 3, 1937, *Hoover 2369* (O); foot of grade below Confidence, June 15, 1937, *Hoover 2454* (O); dry meadow, Mather, 1350 m. alt., July 15, 1923, *Munz 7337* (P); mountain meadow, Mather, July 15, 1927, *Price* (D). MARIPOSA CO.: meadow near Sentinel Hotel, Yosemite Valley, Yosemite National Park, 1200–1350 m. alt., July 6, 1911, *Abrams 4645* (D, G, NY, P); Yosemite Valley, Yosemite National Park, Summer, 1902, *Bacon* (D); Hell Hollow, near Bagby, Merced River Canyon, May 11, 1929, *Branson* (CA TYPE, UC); Yosemite Valley, 1500–2400 m. alt., July 6, 1901, *Grant* (D); meadows near Stoneman Bridge, Yosemite Valley, Yosemite National Park, 1170 m. alt., July, 1911, *Hall* (UC); Yosemite Meadows, Yosemite National Park, 1200 m. alt., July 15, 1911, *Hall 9122* (UC); meadows, vicinity of Hog Ranch, Yosemite National Park, 1410 m. alt., July, 1902, *Hall & Babcock 3307* (UC); in dryish meadow, near Indian Bridge, Wawona, 1200 m. alt., July 22, 1923, *Howell 130* (CA); grassy opening in pine-oak forest, 5 mi. from Mariposa, on road to Briceburg, June 8, 1931, *Howell 6675* (CA, type of *C. superbus* var. *pratensis* Purdy); damp meadow, Yosemite Valley, Yosemite National Park, 1200 m. alt., June 30, 1925, *Keck 173* (P). MADERA CO.: 2 mi. n. e. of Raymond, May 29, 1938, *Hoover 3520* (O); near Raymond, May 29, 1938, *Howell 13863* (CA). FRESNO CO.: Base Camp, junction of North and South Forks of Kings River, May 5, 1923, *Duncan* (Clokey); Big Sandy Creek, June, 1915, *McDonald* (CA); Big Creek Region, July, 1915, *McDonald* (CA); Big Sandy Valley, June 1, 1932, *McDonald* (CA). TULARE CO.: Lemon Cove, Three Rivers Road, 3 mi. w. of Three Rivers, April 20, 1925, *Bacigalupi 1187* (D, P); near Milo, April 5, 1900, *Dudley* (D); road to Mineral King, about 10 mi. from the General's Highway, May 22, 1933, *Holman* (UC). KERN CO.: decomposed granite, 15 mi. n. of Bakersfield, Greenhorn Range, 360 m. alt., April 10, 1932, *Benson 3255* (D, UC); hills near Glenville, Greenhorn Range, 960 m. alt., May 15, 1930, *Howell 5161* (CA); Greenhorn Mts., May 20, 1926, *Weston 151* (CA). SAN DIEGO CO.: edge of dry meadow, Doane Valley, Palomar Mts., 1500 m. alt., June 23, 1924, *Munz 8319* (P). MENDOCINO CO.: hills near Covelo, June 5, 1928, *Eastwood 15187, in part* (CA, F); Potter Valley, June 15, 1921, *Holman* (D); Ridgewood Grade on the Redwood Highway, 570 m. alt., May 24, 1927, *Kildale 3173* (D). LAKE CO.: Siegler Springs, May 18, 1924, *Blankinship* (CA); open hillsides, Dells of Cold Creek, Kelseyville, June 10, 1929, *Blankinship* (M). COUNTY UNCERTAIN: "California," *Bridges 284* (Kew, type of *C. venustus* var. *citrinus* Baker).

31. Calochortus Vestae Hort. in Gard. Chron. Ser. III. **18**: 14. 1895 (spelled "*Vesta*"); Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 139. 1901.

Calochortus venustus var. *Vesta* Hort. in The Garden **46**: 394, *pl. 986, fig. 2.* 1894; Purdy & Bailey in Bailey & Miller, Cyclop. Am. Hort. **1**: 221. 1900.

Calochortus luteus var. *Vestae* Jepson, Fl. Calif. **1**: 295. 1921.

Calochortus venustus var. *brachysepalus* Regel in Gartenflora **25**: 130, *t. 865.* 1876.

Calochortus luteus var. *oculatus* Watson in Proc. Am. Acad. **14**: 265. 1879, as to probable type.

? *Calochortus oculatus* Hort. in Gard. Chron. Ser. III. **18**: 14. 1895.

Bulb ovoid, with membranaceous coats; stem erect, stout, often branched, strongly bulbiferous; leaves linear, attenuate, reduced upward; inflorescence 1–3-flowered, subumbellate; flowers erect, campanulate, white to purplish, the petals pencilled with red or purple below, and marked with a conspicuous, median, reddish brown blotch, surrounded by a pale yellow zone; sepals usually shorter than the petals, narrowly lanceolate, attenuate, glabrous; petals obovate, cuneate, usually rounded and obtuse above, sparingly invested near the gland with short hairs; gland not depressed, transverse, more or less doubly lunate, densely covered with short, hair-like processes; anthers linear-oblong, obtuse or acute, about as long as the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, acute, 3-angled, erect; mature seeds unknown.

This species is distinguished from *C. superbus,* its nearest ally, by its larger size, more strongly bulbiferous habit, and particularly by its doubly lunate gland. The petal-markings in the two species are occasionally identical, but for the most part, *C. Vestae* has a much larger blotch which sometimes extends entirely across the petal. Cytologically, *C. Vestae* is a tetraploid (2n = 28), but its differences do not seem to be entirely due to the doubling of the chromosome complement.

DISTRIBUTION. California: in heavy clay soils, North Coast Ranges, from Humboldt County southward to Napa and Sonoma counties.

CALIFORNIA. HUMBOLDT CO.: near Bridgeville, June, 1882, *Rattan* (D); northwest slope, lower foothills of Buck Mt., 750 m. alt., June 17, 1913, *Tracy 4147* (UC); Laribee Creek, Bosworth's Ranch, 450 m. alt., June 19, 1916, *Tracy 4713* (UC). MENDOCINO CO.: Bell Springs, July 10, 1916, *Abrams 5944* (D, NY); Low Gap Road to Mendocino City, 6 mi. from Ukiah, June 21–24, 1922, *Abrams 8124* (D, M, P, RM); Potter Valley, May 19, 1925, *Eastwood 12664* (CA); ferry over Eel River, on road to Mt. Sanhedrin, May 25, 1925, *Eastwood 12664a* (CA); hills near Covelo, June 5, 1928, *Eastwood 15187, in part* (UC); Round Valley, June, July, 1906, *Goddard 616, 627* (UC); grassy slope, clay soil, yellow pine belt, between Laytonville and Willitts, July 10, 1923, *Heller 13800* (D, F, M, NY). LAKE CO.: Binkley Ranch, between Cobb Mt. and Adams Springs, June 27, 1933, *Jussel 270* (CA); between Clear Lake and Lower Lake, May 30, 1926, *Kildale 2033, in part* (D); foot of Mt. Sanhedrin, June, 1917, *Reynolds* (CA). NAPA CO.: Pope Creek Bridge, s. of Walters Springs, May 29, 1933, *Keck 2364* (D). SONOMA CO.: Skaggs Springs, July 4, 1892, *Michener & Bioletti* (NY). COUNTY UNCERTAIN: cultivated at the Botanic Garden of Harvard University, 1873 (G, probable type of *C. luteus* var. *oculatus* Watson).

32. Calochortus luteus Douglas ex Lindley in Bot. Reg. **19**: *t. 1567*. 1833.

Calochortus luteus var. *citrinus* Watson in Proc. Am. Acad. **14**: 265. 1879, as to description, but not as to name-bringing synonym; Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 138. 1901.

Calochortus citrinus Hort. in Gard. Chron. Ser. III. **18**: 14. 1895, not Baker, 1875.

Calochortus venustus var. *citrinus* Hort. ex Bonstedt in Pareys Blumengärt. **1**: 273. 1931, not Baker, 1874.

Bulb ovoid, with membranaceous coats; stem erect, rather slender, sometimes branched, bulbiferous; leaves linear, attenuate, reduced upward; inflorescence 1–4-flowered, subumbellate; flowers erect, campanulate, deep yellow, the petals usually pencilled below with radiating, reddish brown lines, and often with a median blotch of the same color; sepals shorter than the petals, narrowly lanceolate, attenuate, glabrous; petals obovate, cuneate, usually rounded or truncate above, with or without a short apiculation, sparsely invested near the gland with slender hairs; gland not depressed, transversely more or less lunate, densely covered with short, hair-like processes; anthers linear-oblong, obtuse or acute, about as long as the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit narrowly lanceolate, acute, 3-angled, erect; seeds strongly flattened, with hexagonally reticulate coats.

Calochortus luteus is exceedingly variable in size and in the markings on the petals, but relatively constant in color and in the shape of the gland. In the Coast Ranges, from the region of San Francisco Bay to Santa Barbara, it is quite uniformly dwarfed, and the petals are merely pencilled. This is the typical element of the species. Northward in the Coast Ranges, and in the interior, the plants are larger and usually have a conspicuous blotch on each petal. This form has, for years, passed as the variety *citrinus,* but that name was originally applied to a different entity. The coastal race seems to be cytologically triploid, while that from the interior is diploid. The frequency of morphological intermediates, however, and the incompleteness of our cytological knowledge, does not allow their taxonomic separation at the present time. The diploid race frequently hybridizes with *C. superbus,* but with the exception of these hybrid intermediates, the two species are readily distinguished on color and gland characters.

DISTRIBUTION. California: usually in heavy soils, in the interior from Tehama County southward to Tulare County, and in the Coast Ranges from Mendocino County to Santa Barbara County; also on Santa Cruz Island.

CALIFORNIA. BUTTE CO.: Chico Creek, May, 1896, *Austin 26* (M, UC); near Clear Creek, May 1–15, 1897, *Brown 206* (D, F, M, NY, PA, RM); Little Chico, April, 1897, *Bruce 2119* (P); Chico, April, 1899, *Copeland* (D); near Pentz, 150 m. alt., May 25, 1913, *Heller 10760* (D, G, M, NY, PA); low, treeless, grassy hills, below the *Quercus Douglasii* belt, 8 mi. n. of Oroville, April 24, 1914, *Heller 11322* (CA, D, F, G, M, NY, PA, UC); Berry Canyon, near Clear Creek, May 8, 1902, *Heller & Brown 5494* (D, F, G, M, NY, P, PA, RM); 5 mi. e. of Oroville, on road to Bangor, May 31, 1933, *Keck 2416* (D, P); Durham, May 1, 1932, *Morrison* (CA). YUBA CO.: Smartsville, May 22, 1923, *Crambie* (CA); Los Vergils, May 22, 1921, *Eastwood 10546* (CA). ELDORADO CO.: along road from Tahoe to Placerville, May, 1928, *Rodda* (CA). AMADOR CO.: Jackson Gate, 450 m. alt., May, 1895, *Hansen 589* (D, M); New York Falls, 450 m. alt., June 7, 1896, *Hansen 589* (P); 3½ mi. w. of Buena Vista, T. 5 N., R. 9 E., 120 m. alt., May 6, 1935, *Roseberry 150* (UC). CALAVERAS CO.: Copperopolis, May 18–30, 1895, *Davy 1327* (UC); Reservoir, May 18, 1887, *Smith* (PA); dry fields, near Valley Springs, 150 m. alt., May 21, 1927, *Stanford 313* (P, RM). TUOLUMNE CO.: heavy soil, French Flat, 435 m. alt., May, 1919, *Williamson 116* (CA, Clokey, D, NY, P, RM). MARIPOSA CO.: Hell Hollow, near Bagby, Merced River Canyon, May 11, 1929, *Branson* (CA); Hayward, 5½ mi. e. of La Grange, S. 30, T. 3 S., R. 15 E., 180 m. alt., April 14, 1936, *Carlson 298* (UC); ½ mi. s. of Ward Mt., S. 32, T. 6 S., R. 18 E., 540 m. alt., May 2, 1935, *Schlobohm 82* (UC). MADERA CO.: along Southern Pacific Right-of-Way, 1 mi. s. of Berenda, April 22, 1925, *Bacigalupi 1225* (D, P); Madera, May 9, 1925, *Eastwood 12624* (CA); open plains, heavy soil, 4 mi. n. of Madera, May 8, 1933, *Keck 2280* (D, P); W. Lane's Bridge, May 11, 1902, *Thompson* (D, P). FRESNO CO.: Cascada, 1500 m. alt., June 25, 1917, *Grant 1007, in part* (G). TULARE CO.: near Tulare, April 14, 1934, *Jones* (P); fields along the highway, Lind Cove, April, 1930, *Parks & Parks 0580* (D, F, G, M, NY, P, RM, UC, UCLA). TEHAMA CO.: Red Bluff, April, 1893, *Cannon* (CA); Susanville Road, 5 mi. e. of Red Bluff, May 9, 1930, *Gillespie 9266* (D); 4 mi. s. of Cottonwood, May 21, 1936, *Hoover 1179* (O); Red Bluff, May 27, 1915, *Smith* (CA); Red Bluff, June, 1917, *Wickes* (CA). COLUSA

CO.: near College City, May 20, 1902, *Heller* (M); near College City, Sacramento Valley, 1905, *King* (UC). LAKE CO.: Lower Lake, June 3, 1917, *Bentley* (D); Lower Lake, May 9, 1902, *Bowman* (D); Sulphur Banks, May, 1902, *Bowman 127* (D). SUTTER CO.: Marysville Buttes, May 17, 1903, *Copeland 3187* (G, M, NY, P); western base of Marysville Buttes, April 22, 1926, *Ferris 6386* (D). NAPA CO.: White Sulphur Spring, St. Helena, May 30, 1907, *Chandler 7602* (UC); Calistoga, June 5, 1915, *Eastwood 4629* (CA); grassy opening in chaparral, Gordon Valley, Napa Range, May 30, 1929, *Howell 4258* (CA); grassy banks in chaparral, 20 mi. n. of Napa, June 7, 1934, *Maguire, Maguire & Maguire 15076* (UM); Calistoga, May, 1895, *Merrill* (P); head of Moores Creek, 3–4 mi. e. of Angwin's, Howell Mt., 360 m. alt., June 19, 1899, *Tracy 449* (UC). SACRAMENTO CO.: arid slopes at the edge of the foothills, near Alder Creek, May 21, 1938, *Copeland* (O); dry, sandy, rolling ground, Carmichael, near Sacramento, May 11, 1917, *Ramaley 11228* (UC). SOLANO CO.: near Vacaville, May 2–6, 1891, *Jepson* (D). SAN JOAQUIN CO.: Linden, May, 1896, *Gunnison* (UC); near Stockton, April, 1923, *Steinbeck* (CA). MERCED CO.: Merced Falls, April 23, 1915, *Eastwood 4385* (CA); dry, rocky soil on edge of foothills, San Joaquin Valley, near Merced, May 12, 1923, *Howell 8* (CA). MENDOCINO CO.: Ukiah, June 13, 1913, *Eastwood* (CA); Ukiah, May 4, 14, 1869, *Kellogg & Harford 1001* (G, NY); Hopland Grade, s. of Hopland, 150 m. alt., May 24, 1927, *Kildale 3174* (D). SONOMA CO.: near Healdsburg, April 31, 1918, *Abrams 7067* (D); Kenwood, July, 1893, *Bioletti* (NY); near Santa Rosa, May 8, 1905, *Brandegee* (UC); Skaggs Springs, June 3, 1915, *Hawver* (CA); Windsor, June 23, 1918, *Jepson 7656* (D); mountains w. of Calistoga, May, 1894, *Kraus* (D); grassy, dry hillslopes, near Mark West Springs, June 2, 1929, *Mexia 2389* (UC); El Verano, May 30, 1892, *Michener & Bioletti* (NY); Los Guilicos, May, 1893, *Michener & Bioletti* (F, NY, P, PA, UC). MARIN CO.: Tamalpais, June 18, 1905, *Brandegee* (UC); Tiburon, June 9, 1912, *Eastwood 308* (CA, Clokey, G, NY); Mt. Tamalpais, July 5, 1902, *Jones* (P). ALAMEDA CO.: Oakland Hills, *Bolander 409* (NY); East Oakland Hills, June, 1900, *Carruth* (CA); Mocho Creek (Cedar Mt.), May, 1903, *Elmer 4353* (CA, D, M, P, UO, WS); Sunol, May 5, 1900, *Grant* (D); Oakland Hills, June 6, 1868, *Kellogg & Harford 1002* (M, NY); Pleasanton, May, 1912, *Sanford* (P). SAN MATEO CO.: near Lake Pilarcitos, June 20, 1905, *Brandegee* (UC); dry foothills, May 22, 1932, *Demaree 9159* (M); from Woodside to Crystal Springs Lake, May 18, 1894, *Dudley* (D, P); Crystal Springs, May, 1896, *Eastwood* (UC); Los Trancos Creek, May 25, 1920, *Hichborn 260* (M); fields, near Los Trancos Creek, May 17, 1920, *Kimber & Roush* (P); along San Francisquito Creek, near St. Michaels Church, June 14, 1895, *Lamb* (D); Kings Mt. Road, June, 1907, *Randall 222* (D); open, dry hills, Crystal Springs Lake, June 23, 1933, *Rose 33255* (M, NY, UM); Sand Hill Road, vicinity of Stanford University, June 30, 1917, *Roush* (M); dry ground, Crystal Springs Lake, June 23, 1913, *Suksdorf 317* (G); Woodside, June 9, 1919, *Walther* (CA). SANTA CLARA CO.: Stanford University, May, 1901, *Abrams 1656* (D, M); Stanford University, April, 1900, *Atkinson* (D); hill above Palo Alto Stock Farm, April 24, 1895, *Burnham* (P); near Stock Farm, Stanford University, June 8, 1893, May 14, 1894, *Dudley* (D); Pine Ridge, Mt. Hamilton Range, May 29, 1895, *Dudley 4024* (CA, D, G, UC); road to Madrone Springs, June 5, 1937, *Eastwood & Howell 4526* (CA); Stanford University, May, 1900, *Elmer 2037* (M, NY); Los Gatos, May, 1901, *Elmer 2971* (M); fields near Coyote River, along Cochran Road, 3½ mi. from Madrone Station, May 17, 1918, *Ferris 845* (D); foothills w. of Los Gatos, May 7, 1904, *Heller 7387* (D, F, G, M, NY, PA, RM, UC); open, grassy places, above Smith Creek, Mt. Hamilton, 900 m. alt., May 31, 1907, *Heller 8630* (D, F, G, M, NY, PA); Raymonds Ranch, Los Gatos, June 18, 1914, *Newell* (CA); San Juan Hills, near San Jose, May 8, 1895, *Patterson* (D); grassy slope, above Smith Creek, 780 m. alt., May 31, 1907, *Pendleton 915* (UC); Stanford University, May 27, 1907, *Randall 221* (D); rolling hills at north end of San Antonio Valley, Mt. Hamilton Range, 690 m. alt., May 18, 1935, *Sharsmith 3087* (WS); dry, grassy slope of Mt. Day Ridge, Mt. Hamilton Range, 960 m. alt., May 21, 1936, *Sharsmith 3697* (O). SANTA CRUZ CO.: Santa Cruz, June 23, 1881, *Jones* (P); Santa Cruz, June 22, 1903, *Thompson* (D, M). SAN BENITO CO.: Lone Tree Road, lower canyon of Arroyo Dos Picachos, May 28, 1938, *Hoover 3491* (O). MONTEREY CO.: Monterey, ex herb. *Abbott* (CA); pine forest, Pacific Grove, July 10, 17, 1905, *Coleman* (D); locality uncertain, but presumably near Monterey, "Nova California," 1833, *Douglas* (G, NY), TYPE COLLECTION; Carmel Trail, Carmel Valley, June 25, 1905, *Dudley* (D); Carmel Bay, June, 1903, *Elmer 4600* (CA, D, M, NY, P, UC, UO); pine woods, Monterey, July 8, 1880, *Engelmann* (M); Carmel Valley, near Carmel, May 22, 1931, *Howell 6496* (CA); Pacific Grove, June 11, 1907, *Patterson & Wiltz* (D); Reservoir, Pacific Grove, June 14, 1907, *Patterson & Wiltz* (D, UC); Highlands Road, Carmel, June 24, 1929, *Rountree* (P). SAN LUIS OBISPO CO.: hills, near Pettitts, May 19, 1928, *Eastwood 15173* (CA); near San Luis Obispo, May, 1879, *Summers* (UC); Los Osos Valley, June 24, 1882, *Summers* (UC); hillsides, 2–3 mi. e. of Templeton, May 9, 1926, *Wiggins 2066* (D). SANTA CRUZ ISLAND: dry bank, interior, June 15, 1930, *Hoffmann* (P); without exact locality, June 6, 1918, *Miller* (CA); without exact locality, June 11, 1930, *Rand 10* (CA).

32x. Calochortus luteus x C. superbus.

The following collections appear to represent hybrid populations between *C. luteus* and *C. superbus.* The variation shown is much greater than in either of the parent species, and very rarely are two specimens alike.

CALIFORNIA. TEHAMA CO.: 3 mi. w. of Paynes Creek, April 22, 1934, *Eastwood & Howell 1876* (CA); Red Bluff, June, 1917, *Wickes* (CA). BUTTE CO.: Colby, July, 1896, *Austin 29* (M); gravelly north slope, *Quercus Douglasii* belt, near Richardson Springs, May 22, 1914, *Heller 11424* (CA, D, F, G, NY, PA, UC); Durham, May 8, 1932, *Morrison* (CA). YUBA CO.: Los Vergils, May 22, 1921, *Eastwood* (CA). ELDORADO CO.: near New York Ravine, 7 mi. above Folsom, May 30, 1907, *Brandegee* (UC). CALAVERAS CO.: Mokelumne Hill, *Blaisdell* (CA). LAKE CO.: 3 mi. e. of Houghs Springs, May 7, 1928, *Abrams 12552* (D); meadow on Pope Valley-Middletown Road, 3 mi. n. w. of county line, June 2, 1933, *Bacigalupi, Ferris & Wiggins 6706* (D, UC); open, gravelly places, yellow pine belt, valley of a tributary of Cache Creek, 5 mi. e. of Houghs Springs, May 10, 1919, *Heller 13145* (CA, D, F, G, M, NY, PA); hillside, between Clear Lake and Lower Lake, 450 m. alt., May 30, 1926, *Kildale 2033, in part* (D); 5 mi. e. of Houghs Mineral Springs, May 7, 1928, *Kildale 4981* (D).

33. Calochortus Leichtlinii J. D. Hooker in Bot. Mag. Ser. III. **26:** *t. 5862.* 1870.

Calochortus Nuttallii var. *Leichtlinii* Smiley in Univ. Calif. Publ. Bot. **9**: 139. 1921.

Calochortus Nuttallii Torrey & Gray in Rept. Pac. R. R. Surv. **2** [Bot. Beckwith's Rept. p. 124]. 1855, excl. syn., not Torrey, 1852.

Calochortus Nuttallii var. *subalpinus* Jones, Contrib. West. Bot. No. 12, p. 78. 1908.

Bulb ovoid, with membranaceous coats; stem erect, sometimes very short, usually unbranched, with a large, solitary bulblet in the pouch-like sheath of the lowest cauline leaf; leaves linear, reduced upward; inflorescence 1–5 (usually 2–4)-flowered, subumbellate; flowers erect, campanulate, white or smoke-colored, often tinged with pink or lavender, with a red to nearly black spot on each petal above the gland; sepals usually much shorter than the petals, lanceolate, acute or acuminate, glabrous; petals obovate, cuneate, usually obtuse and rounded above, invested near the gland with a few short hairs; gland slightly depressed, irregular, but more or less triangular-ovate, densely covered with short, hair-like processes which are directed downward; anthers linear-oblong, more or less sagittate at the base, often strongly so, longer than the basally dilated filaments, ovary linear, not winged, tapering to a persistent, trifid stigma; fruit narrowly lanceolate, acute, erect; seeds flattened, with conspicuously inflated, hexagonally netted coats.

Calochortus Leichtlinii is well separated from its allies by reason of its sagittate anthers and inflated seed-coats. In the petal markings, it approaches *C. Nuttallii,* but is distinguished from that species by its lack of a gland-membrane, as well as by the anther character. In color, it is quite variable, but the various color races do not seem to be of taxonomic significance. At high elevations, it is often nearly acaulescent, but under favorable conditions is nearly as tall as any of its allies.

DISTRIBUTION. At middle and high elevations on the mountains about Lake Tahoe, Nevada, and in the Warner Mountains and Sierra Nevada of California, from Modoc County southward to Tulare County.

NEVADA. WASHOE CO.: Peavine Mt., June 22, 1909. *Heller 9755* (D, G, NY, PA); Third Creek, near Mt. Rose, 2550–3150 m. alt., Aug. 3, 1938, *Howell 14113* (CA).

ORMSBY CO.: Kings Canyon, 1700–2000 m. alt., June 21, 1902, *Baker 1108* (G, M, NY, P). MINERAL CO.: among aspens, Sweetwater Mts., near Sweetwater, 2100 m. alt., July 1, 1919, *Tidestrom 10180* (NY).

CALIFORNIA. MODOC CO.: Mill Creek Meadows, west slope of Warner Mts., July 31, 1932, *Applegate 7958* (D); dry, open slope, Warren Peak, Warner Mts., Aug. 1, 1932, *Applegate 8004* (D); arid summit of Warner Mts., near and s. of Warren Peak, 2400 m. alt., Aug. 1, 1932, *Applegate 8042* (D); North Fork of Barber Creek, Warner Mts., 1800 m. alt., June 13, 1934, *Howell 12101* (CA); on sandy ridge, head of North Fork of Parker Creek, Warner Mts., 2250 m. alt., July 13, 1910, *Taylor & Bryant* (UC). LASSEN CO.: Pine Creek, July 12, 1894, *Baker & Nutting* (UC); Susanville, July 2, 1892, *Brandegee* (D); Perkin's Ranch, Diamond Mt., Susanville, 1800–2100 m. alt., June 28, 1897, *Jones* (M, P). SHASTA CO.: Lassen Peak, 1800 m. alt., July 8, 1897, *Jones* (D, P). PLUMAS CO.: Lights Canyon, 1871, *Ames* (NY); Quincy, May 28, 1920, *Clemens* (CA); Forest Lodge, Greenville, U. S. Forest Reserve, June, 1927, *Eastwood 14569* (CA); in woods, on road from Chilcott, U. S. Forest Reserve, June 27, 1927, *Eastwood 14882* (CA); Jameson Creek, 1890 m. alt., July 7, 1912, *Hall 9311* (UC); in gravelly soil, Feather River Region, July 25, 1920, *Head* (CA); Campbells Hot Springs, Feather River Region, June 22, 1921, *Head* (CA); Lake Center Camp, Feather River Region, July 15, 1921, *Head* (CA); ridge e. of Red Clover Valley, July 4, 1907, *Heller & Kennedy 8719* (CA, D, F, G, M, NY, P, PA); Drakesbad, Mt. Lassen National Forest, June 17–30, 1928, *Hollis* (UCLA); 5 mi. w. of Prattville, 1350 m. alt., July 6, 1897, *Jones* (P); Greenville, July, 1920, *Kelley* (CA); 3.25 mi. s. e. of Beckwith Butte, S. 27, T. 22 N., R. 14 E., 1560 m. alt., June 4, 1935, *Sawyer 70* (UC); southwest slopes and ridge crest, Red Rock, n. of Engelmine, 2120–2180 m. alt., July 9, 1937, *Stebbins & Jenkins 2243* (UC). TEHAMA CO.: Mill Creek Canyon, near Morgan, 1500 m. alt., July 1, 2, 1903, *Hall & Babcock 4355* (UC). BUTTE CO.: on bare or open stony outcrops and ridges, above Jonesville, 2000 m. alt., July 17, 1929, *Copeland 352* (CA, D, F, G, M, NY, P, RM, UC, UCLA, UO); on open, gravelly slopes about rocks, in granite, yellow pine belt, Little Summit, Sierra Nevada, 1350 m. alt., June 10, 1915, *Heller 11953* (CA, D, F, G, M, NY). SIERRA CO.: Packer Lake, 1950 m. alt., July 3, 1926, *Barker 32* (D); Salmon Lake, July, 1918, *Sutliffe* (CA). NEVADA CO.: southeastern approaches to Castle Peak, July 31, 1903, *Heller 7062* (D, G, M, NY, P, PA, RM, UC); Soda Springs, 2100 m. alt., July 21, 1881, *Jones 2418* (P); Donner Lake, near Truckee, July 12, 1882, *Sonne* (UC); sandy soil, Truckee, July, 1890, *Sonne 317* (M). PLACER CO.: Emigrant Gap, June 27, 30, 1882, *Jones* (P); Summit, Sierra Nevada, 2400 m. alt., July 26, 1900, *Jones* (P, type of *C. Nuttallii* var. *subalpinus* M. E. Jones); High Mt., near Donner Pass, Sierra Nevada, 1865, *Torrey 519(a)* (G, NY). ELDORADO CO.: dry, gravelly soil, Tallac, Lake Tahoe, 1950 m. alt., June, 1918, *Abrams 7326* (D); Fallen Leaf Lake, near Lake Tahoe, July 1, 1904, *Baker* (UC); Fallen Leaf Lake, Lake Tahoe Region, June 28, 1920, *Campbell* (RM); Glen Alpine Springs Hotel, June 28, 1900, *Dudley* (D); Deer Park, Lake Tahoe Region, 1909, *Eastwood 252* (CA); Camp Agassiz, Glen Alpine Region, July 23, 1906, *Eastwood 994* (CA); Upper Echo Lake, 2400 m. alt., July 19, 1928, *Essig* (UC); 1 mi. below Phillips, July, 1920, ex herb. *Evans* (UC); Tallac, vicinity of Lake Tahoe, 1800–2400 m. alt., Aug. 1, 1906, *Grant* (D); Aspengrove, Lake Tahoe Region, Aug., 1911, *Hawver* (CA); Armstrong's, Emerald Bay, Lake Tahoe, 1860 m. alt., June 30, 1925, *Howell 1264* (CA); between Fallen Leaf Camp and Lake Tahoe, July 2, 1925, *Howell 1347* (CA); near Fallen Leaf Lake, July 12, 1909, *Lathrop* (D); Grass Lake Trail, Glen Alpine, 2170 m. alt., July 23, 1907, *Pendleton & Reed 1003* (UC); Lily Lake to Glen Alpine, 1995 m. alt., July 25, 1907, *Pendleton & Reed 1250* (UC); Lake Tahoe, June, 1917, *Rock* (CA); Glen Alpine, vicinity of Lake Tahoe, 1867–2700 m. alt., July 6–21, 1901, *Setchell & Dobie* (UC); slope back of mill, Tallac Sawmill, Tahoe, 1920 m. alt., July 17, 1913, *Smiley 141* (G); near Suzy Lake, Tahoe, 2280 m. alt., July 18, 1913, *Smiley 167* (G). ALPINE CO.: Blue Lakes, 2550 m. alt., Aug., 1892, *Hansen 1252* (D, M); 1½ mi. n. e. of Lake Alpine, S. 35, T. 8 N., R. 18 E., 2430 m. alt., July 20, 1935, *Howden 33* (UC); open summit of ridge, about 2 mi. n. of the lake, Lake Alpine Region, 2520 m. alt., July 25, 1935, *Peirson 11588* (UC); Hope Valley, Summer, 1923, *Wright* (CA). AMADOR CO.: Panther Creek, 1500 m. alt., May, 1895, *Hansen 1070* (D, M); Panther Creek, 1440 m. alt., June 13, 1895, *Hansen 1070* (P). CALAVERAS CO.: Salt Spring Reservoir, June, 1923, *Steinbeck* (CA). MONO CO.: among rocks, in dry situations, Timberline Station, south-facing wooded slope above cabin, Slate Creek Basin, e. of Mt. Conness, Aug. 24, 1933, *Clausen 815* (NY); gravelly, deep soil, south slope, north side of Slate Creek Valley, Slate Creek Basin, e. of Mt. Conness, 3050–3200 m. alt., Aug. 22, 1932, *Coulter 6* (D, NY, P, RM, UCLA, UM); Leevining, *Ehlers 828* (UC); among bushes of *Artemisia tridentata*, east-facing slope, 2 mi. n. of Mono Lake P. O., 2028 m. alt., June 17, 1937, *Grinnell & Grinnell 1064a, 1064b* (UC); Tioga Road, near Mono Lake, Summer, 1923, *Wright* (CA). TUOLUMNE CO.: along Tioga Road, Aug. 14, 1907, *Eastwood 321* (CA); Camp Baxter, North Fork of Stanislaus River, 1650 m. alt., June 27, 1930, *Jussel* (CA); Camp Baxter, 20 mi. from Dorrington, 1680 m. alt., June 28, 1930, *Jussel* (UM); Mather, Sierra Nevada, 1400 m. alt., June 6, 1931, *Keck 1217* (CA); open, lava-rocky hills, s. e. of Grizzly Meadows, Stanislaus National Forest, June 3, 1934, *Quick 1278* (CA); Pikes Peak, 2175 m. alt., June 20, 1937, *Quick 1828* (CA); Upper Cow Creek, 2130 m. alt., June 29, 1937, *Quick 1858* (CA); Tiltill Trail, n. of Tiltill Valley, 2100 m. alt., July 30, 1938, *Sharsmith 3738* (O, WS); sandy soil among granite rocks, Camp Baxter, 1650–1710 m. alt., June 30, 1929, *Stanford 1076* (D); Leland Meadows, 4 mi. above Strawberry, July 4, 1925, *Steinbeck* (CA); Sonora, June 7, 1931, *Van Dyke* (CA); open hillside, ½ mi. above Lyon's Dam, along road connecting with Sonora Pass Highway, June 15, 1934, *Wiggins 6865* (D); open ridge, 3½ mi. above Pine Crest, on road to Belle Meadow, July 8, 1934, *Wiggins 6902* (D). MARIPOSA CO.: Yosemite Valley, Yosemite National Park, 1200–1350 m. alt., June 20, 1911, *Abrams 4432* (D, G, NY, P, UC); Yosemite Valley, 1200 m. alt., July, 1926, *Beller* (UCLA); between Aspen Valley and Lake Tenaya, Yosemite Park, July 16, 1935, *Epling & Robison* (UCLA); Little Yosemite Valley, Yosemite National Park, 1860 m. alt., July 7, 1911, *Hall 9058* (UC); sandy, rocky soil, along river, Wawona Valley, 1200 m. alt., June 25, 1923, *Howell 91* (CA); Lightning Trail to the Big Trees, Wawona Valley, 1260 m. alt., June 22, 1924, *Howell 435* (CA); creek above Inspiration Point, Yosemite Valley, July 5, 1913, *Kennedy 3027* (CA); Yosemite Valley, June, 1906, *Saunders* (CA); sunny slope, Snow Creek Trail, Yosemite National Park, June 25, 1935, *Schreiber 1705* (UC); sunny, sandy slope, Maclure Fork of the Merced River, Yosemite National Park, July 29, 1935, *Schreiber 1895* (D, UC). MADERA CO.: rocks, granite, Shuteye Mt., Sierra National Forest, 1950 m. alt., July 26, 1907, *Murdoch 2560* (F, NY). FRESNO CO.: Rowell Meadow, Upper Kings River, Aug. 23, 1904, *Dudley* (D); Collins Meadow, 2250 m. alt., July, 1900, *Hall & Chandler 453* (D, M, NY, PA, UC);

Huntington Lake, 2100 m. alt., July 26, 1917, *Grant 1142* (D). TULARE CO.: Kern-Kaweah Canyon, 2790 m. alt., July 29, 1927, *Bacigalupi 1770* (D, P); dry ground, Kern River, vicinity of Lloyd Mt., 1800 m. alt., July 21, 1895, *Dudley 830* (D); trail from Halsted Meadow to Clover Creek, region of Mt. Silliman, 2700–3000 m. alt., July 27, 1896, *Dudley 1455* (D); Balanced Rock Trail, General Grant National Park, July 4, 1927, *Jussel* (CA); Marble Fork of Kaweah River, near Lodgepole Camp, Sequoia National Park, July 3, 1931, *Larson* (CA).

Subsection 6. MACROCARPI.[36]

Inflorescences subumbellate; sepals usually greatly exceeding the petals, narrowly lanceolate, attenuate; petals oblanceolate, cuneate, acuminate, sparingly invested near the gland with slender hairs; glands slightly depressed, triangular-oblong, more or less sagittate, surrounded with a broad, fringed membrane, and densely covered with slender, simple or distally branched processes; anthers linear-lanceolate to linear, obtuse; fruits linear-lanceolate, acuminate, 3-angled; seeds strongly flattened, with conspicuously inflated, hexagonally reticulate coats.

The single species referred to the subsection MACROCARPI is easily recognized by its very long sepals and linear or nearly linear anthers. It has a Columbian Plateau distribution, reaching British Columbia on the north, Montana and Idaho on the east, and Nevada and California on the south. On the west it is limited by the Cascade Range (Map 6). Its chromosome base number is seven.

34. Calochortus macrocarpus Douglas in Trans. Hort. Soc. Lond. **7**: 276, *pl. 8.* 1828.

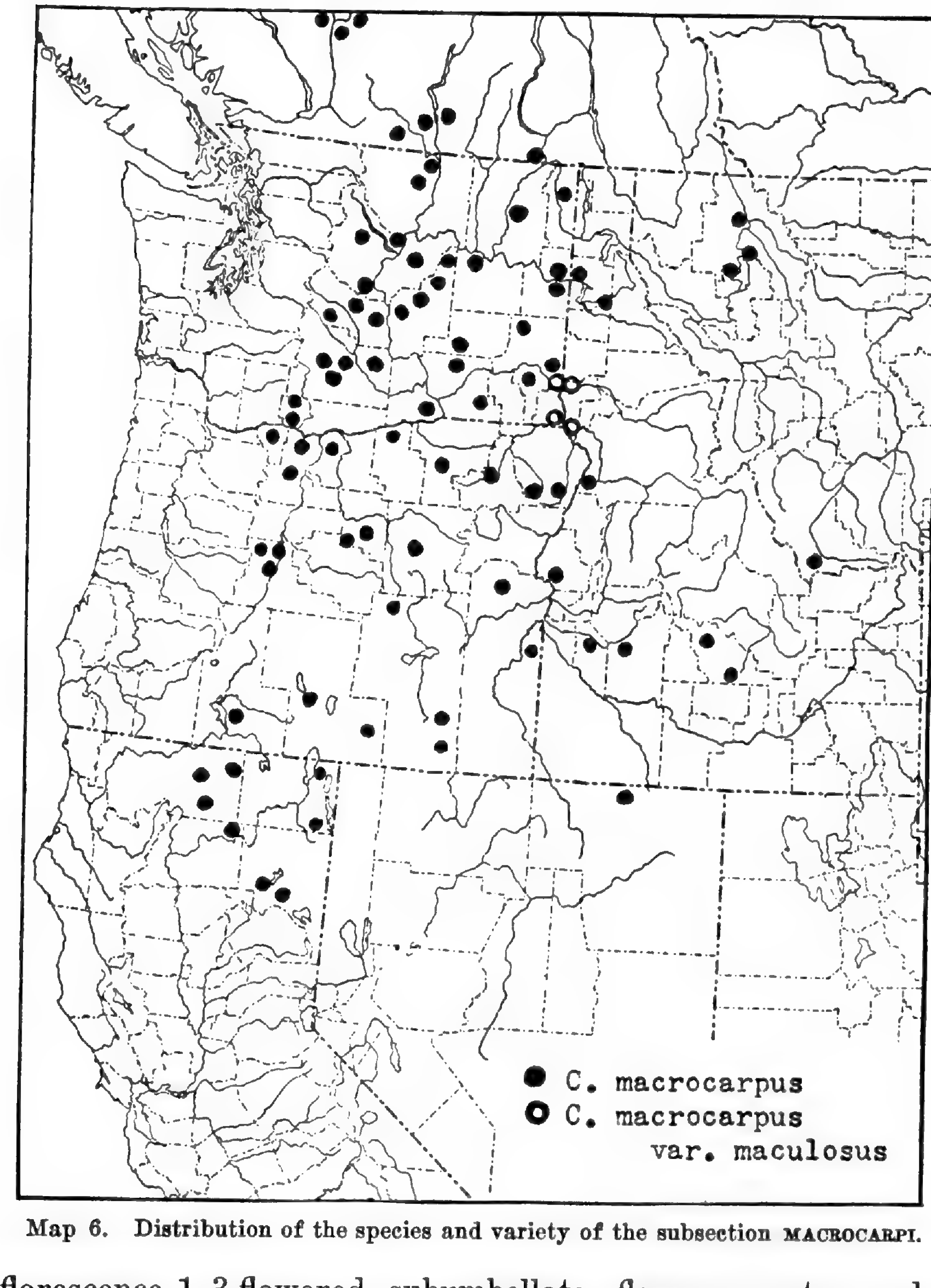
Calochortus acuminatus Rydberg in Bull. Torr. Bot. Club **24**: 189, *pl. 301.* 1897.

Calochortus cyaneus A. Nelson in Bot. Gaz. **53**: 219. 1912.

Calochortus macrocarpus var. *cyaneus* Macbride in Contrib. Gray Herb. N. S. No. 56, p. 14. 1918.

[36] MACROCARPI subsect. nov., inflorescentiis subumbellatis; sepalis petalis plerumque multo longioribus anguste lanceolatis attenuatis; petalis oblanceolatis cuneatis acuminatis, prope glandulam pilis gracilibus parce praeditis; glandulis subdepressis triangulari-oblongis plus minusve sagittatis, membrana lata fimbriata circumdatis, processis gracilibus simplicibus aut apice ramosis dense vestitis; antheris lineari-lanceolatis vel linearibus obtusis; capsulis lineari-lanceolatis acuminatis triangulatis; seminibus valde complanatis, testis insigniter inflatis hexagono-reticulatis.

Bulb ovoid, with membranaceous coats; stem stout, erect, usually unbranched, often bulbiferous; leaves linear, reduced upward, becoming strongly involute and curled at the tip; in-



Map 6. Distribution of the species and variety of the subsection MACROCARPI.

florescence 1–3-flowered, subumbellate; flowers erect, purple, each petal with a median, longitudinal, green stripe, and sometimes with a transverse, dark purple band above the gland;

sepals usually exceeding the petals, narrowly lanceolate, long-attenuate, glabrous; petals oblanceolate, acuminate, moderately bearded just above the gland with slender hairs; gland slightly depressed, triangular-oblong, more or less sagittate, surrounded by a broad, usually continuous, fringed membrane, and densely covered with slender processes which are usually somewhat branched distally; anthers linear-lanceolate to linear, obtuse, exceeding the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-lanceolate, acuminate, 3-angled, erect; seeds strongly flattened, with conspicuously inflated, hexagonally netted coats.

This species is distinguished by its large, purple, green-striped petals, narrow, attenuate sepals, and long, slender anthers. It has no close allies.

DISTRIBUTION. Dry hills, usually in loose, volcanic soil, western Montana to southern British Columbia, southward, east of the Cascade Mts., to northern Nevada and northeastern California.

BRITISH COLUMBIA. Dry, open country, Penticton, Cariboo Co., July 24, 1902, *Anderson* (WS); Ashcroft, June 28, 1907, *Cowles 222* (F, M); plains, Clinton, Cariboo Co., June, 1897, *Foster 15a* (WS); Kamloops, June 30, 1887, *Fowler* (M, NY); Kamloops, June 17, 1889, *Macoun* (M); Kamloops, June 22, 1889, *Macoun* (F); Waneta, Columbia River, near International Boundary, Aug. 1, 1902, *Macoun 70200* (G, P); Similkameen River, June 14, 1905, *Macoun 70211* (F); Kamloops, June 28, 1916, *Sanson 163* (NY); dry foothills of the mountains, Skaha Lake, June 25, 1934, *Went 18* (UC).

MONTANA. FLATHEAD CO.: Bigfork, July 23, 1908, *Butler 918, 919, 920, 921* (NY); Bigfork, vicinity of Flathead Lake, July 15, 1908, *Clemens* (D, F, G, PA); Bigfork, 900 m. alt., July 23, 1908, *Jones 9216* (P, UM); dry plains, Flathead Valley, 1000 m. alt., July 25, 1901, *MacDougal 765* (NY, UM); Columbia Falls, July 31, 1892, *Williams* (NY). BEAVERHEAD CO.: Lima, 2700 m. alt., Aug. 5, 1895, *Rydberg 2600* (M, NY, type of *C. acuminatus* Rydberg); dry hills, Lima, Aug. 5, 1895, *Shear 3127* (NY). COUNTY NOT DETERMINED: hillsides, west shore of Flathead Lake, July 21, 1883, *Canby 327* (G); plains of the Flathead Valley, July, *Elrod 18* (RM).

IDAHO. KOOTENAI CO.: about Post Falls, July 14–17, 1892, *Heller 660* (PA, UC); Wiessners Peak, July 8, 1892, *Sandberg, MacDougal & Heller 1043* (D, F, G, NY, P). IDAHO CO.: rocky north slope, on Government Trail, between Squaw and Granite creeks, Seven Devils Mts., 510 m. alt., June 13–30, 1937, *Packard 247* (WS). WASHINGTON CO.: Weiser, 660 m. alt., July 5, 1899, *Jones* (P). BLAINE CO.: Ketchum, *Brodhead* (P); sagebrush slopes, Tikura, 1350 m. alt., July 22, 1911, *Macbride 1286* (RM); sagebrush slopes, along Hyndman Creek, Sawtooth Range, 1800 m. alt., July 31, 1936, *Thompson 13646* (M). ELMORE CO.: stony slope, lava rock among sagebrush, Rattlesnake Creek, 1200 m. alt., June 23, 1916, *Macbride &*

Payson 2845 (CA, D, G, M, NY, P, RM, UC). ADA CO.: dry lava hills, Boise, 864 m. alt., June 24, 1911, *Clark 68* (D, F, G, M, RM, UC); dry slopes, Boise, 864 m. alt., June 18, 1910, *Macbride 268* (G, M, RM, type of *C. cyaneus* Nelson). COUNTY NOT DETERMINED: Curlew Gulch, July, 1892, *Mulford* (G, M, NY).

WASHINGTON. PEND OREILLE CO.: Box Canyon, Pend Oreille River, Aug. 3, 1902, *Kreager 391* (Clokey, G, NY, WS). STEVENS CO.: dry, open bunch-grass slope, First Thought Mt., Aug. 2, 1927, *Lockhart* (WS). SPOKANE CO.: rocky, open hillsides, near Spokane, July 13, 1930, *Palmer 37846* (G); Spokane, July 18, 1894, *Piper* (WS); Spokane, 1892, *Tucker* (G); Trent, July 21, 1913, *Turesson* (RM). LINCOLN CO.: dry soil, Congdons Ferry and vicinity, June 22, 1902, *Griffiths & Cotton 415* (NY, WS); dry soil, 15 mi. n. of Wilbur, near Columbia River, July 7, 1923, *Spiegelberg* (WS). WHITMAN CO.: Wawawai, June, 1898, *Elmer* (M); e. of Dusty, June 20, 1934, *Otis 1945* (WS); grassy hillside, Rock Lake, July 21, 1927, *Wittman 95* (WS). ADAMS CO.: Hatton, June 27, 1906, *Cullen* (WS). FRANKLIN CO.: Connell, May, 1902, *Elmer 44* (NY). GARFIELD CO.: Ilia, June 25, 1892, *Lake & Hull* (WS); WALLA WALLA CO.: dry south slopes, Waitsburg, June 12, 1897, *Horner 463* (G, WS). OKANOGAN CO.: Oroville, June 26, 1911, *Jones* (P); Loomis, July 1, 1911, *Jones* (P). DOUGLAS CO.: near Egbert Spring, 390 m. alt., July 7, 1893, *Sandberg & Leiberg 409* (G, NY, UC, UO, WS). CHELAN CO.: Chelan, July 5, 1911, *Jones* (P); Lake Chelan, Cascade Mts., 327 m. alt., July 1–Sept. 15, 1915, *Kammerer 108* (M, NY); dry southern exposure, Old Darby Place, North Fork of Twentyfive Mile Creek, south side of Lake Chelan, 420 m. alt., June 29, 1936, *Kelly 9* (WS); dry, open plains near Chelan, June 25, 1931, *Thompson 6906* (D, G, M); dry sagebrush slopes, n. of Wenatchee, June 23, 1932, *Thompson 8529* (D, M); Wenatchee Flat, July 7, 1900, *Whited 1269* (WS). GRANT CO.: sage lands, Coulee City, June 25, 1923, *St. John 7645* (WS); Alkali Lake, 600–900 m. alt., July, 1892, *Sandberg & Leiberg* (WS); sandy sagebrush plains, near Quincy, June 15, 1931, *Thompson 6773* (D, G, M, PA); sandy sagebrush plains, in Grand Coulee, near Soap Lake, June 15, 1935, *Thompson 11625* (D, NY, P); dry soil, Steamboat Rock, Grand Coulee, July 10, 1902, *MacKay 21* (G, M, NY, PA, WS). KITTITAS CO.: dry, stony soil, northeast Kittitas Valley, July 10, 1903, *Cotton 1339* (PA, RM, WS); sandy soil, among sagebrush, Ellensburg, June, 1897, *Elmer 393* (M, NY, RM, WS); Ellensburg, July 9, 1897, *Piper* (WS); mouth of Rye Grass Coulee, Ginkgo Petrified Forest Park, May 30, 1936, *Smith 726* (WS); up Natches River, above Ellensburg, 1889, *Vasey* (WS). YAKIMA CO.: Yakima Region, June, 1882, *Brandegee* (M); sand plains, n. of Rattlesnake Mts., May 31, 1901, *Cotton 393, in part* (WS); North Fork of Cowichie Creek, July 21, 1901, *Cotton 462* (WS); Fort Simcoe, S. 14, T. 10 N., R. 15 E., 360 m. alt., July 22, 1932, *Heidenreich 195* (WS); Simcoe Hills, July, 1860, *Lyall* (G). BENTON CO.: Horseheaven Hills, 15 mi. s. w. of Kennewick, June 21, 1927, *St. John 8638* (WS). KLICKITAT CO.: Falcon Valley, Aug., 1882, *Howell* (PA); dry, exposed slopes, about 2 mi. e. of Bingen, June 18, 1938, *Meyer 1500* (WS); Trout Lake, Aug. 2, 1911, *Streator* (UCLA); White Salmon, 1879, *Suksdorf* (G); low, dry grounds and hillsides, "W. Klickitat Co.," Aug., 1882, *Suksdorf* (F, NY, PA, UC). COUNTY NOT DETERMINED: near the Great Falls on the Columbia and on undulating grounds of the interior at the junction of Lewis and Clarks River [with the Columbia], *Douglas*, photographs of the TYPE in the Hooker Herbarium at Kew (G, NY, P, PA, WS).

OREGON. WALLOWA CO.: brushy hillside, coniferous woods, southwest end of Wallowa Lake, Wallowa Mts., 1320 m. alt., Aug. 1, 1935, *Constance & Jacobs 1316*

(M, UC, WS); dry soil, Joseph, June 16, 1891, *Drake & Dickson* (F); brushy slopes and coniferous woods, along Adams Creek, 4 mi. s. w. of Wallowa Lake, Aug. 9, 1938, *Ownbey & Ownbey 1850* (CA, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UM, UO, WS); dry slope, Imnaha Canyon, 22 mi. above Imnaha, July 13, 1933, *Peck 17656* (WU); dry, grassy slope, Wallowa Lake, July 8, 1934, *Peck 18425* (D, NY, WU). UNION CO.: mountainside above La Grande, July 29, 1910, *Peck 1374* (WU). MALHEUR CO.: loose soil, high above Sucker Creek, between Adrian and Rockville, June 30, 1936, *Andrews 740* (UO); Brogan, 1910, *Cooper* (WU); along irrigation ditch, Brogan, June 24, 1910, *Peck 1373* (WU); dry bank, Sucker Creek Canyon, June 21, 1928, *Peck 16087* (WU). UMATILLA CO.: open, dry, grassy hills, Pilot Rock, Blue Mts., June 16, 1910, *Cusick 3433* (UO, WS). MORROW CO.: among sagebrush, near Boardman, June 14, 1928, *Thompson 4777* (D, M). GRANT CO.: dry, grassy hills, above the John Day River, John Day, July 1, 1919, *Ferris & Duthie 668* (D, RM); sagebrush hills, Middle and Upper John Day, s. of the canyon, June 20, 1925, *Henderson 5393* (CA, D, G, M). HARNEY CO.: sagebrush slope above Three Mile Camp, Catlow Valley, July 6, 1937, *Drews* (UO); dry sage plains or fans, Alvord Ranch, east base of Steens Mts., July 1, 1927, *Henderson 8829* (CA, UO); Alvord Ranch, July 5, 1930, *Jones 25182* (M, P); dry ground, upper Emigrant Creek, July 31, 1912, *Peck 1375* (WU); dry slope, lower Willow Creek Canyon, June 23, 1936, *Peck 18983* (WU). SHERMAN CO.: Rock Creek Canyon, near Moro, June, 1921, *Lawrence 2929* (D); Moro, May, 1894, *Morrison* (NY). WASCO CO.: ravine up Mill Creek, 4 mi. from The Dalles, July 2, 1927, *Thompson 2838* (D); dry hillside, near Tygh, June 24, 1928, *Thompson 4955* (D, G, M, P, PA); dry, rocky ground, Siwash Flats, near Mosier, July 6, 1929, *Thompson 5151* (PA). HOOD RIVER CO.: Hood River, July, 1888, *Drake & Dickson* (F); near Columbia River, Hood River, July, 1922, *Epling 5725* (UCLA); very dry ground, open oak woods or prairies, Hood River Valley, Aug. 10, 1880, *Henderson* (UO); dry ground under oaks, or prairies, Hood River Valley, July 6, 1889, *Henderson* (UO); dry prairies and pine lands, Hood River Valley, July 16, 1896, *Henderson* (RM); dry pine woods and prairies, July 10, 1924, *Henderson 806* (G, M); near Hood River, July 27, 28, 1886, *Howell* (NY, PA). WHEELER CO.: open pine woods, headwaters of Marks Creek, Ochoco National Forest, July 29, 1938, *Ownbey & Ownbey 1801* (G, Kew, M, O, UC); dry slope, Mitchell, July 8, 1921, *Peck 10106* (WU); moist slope, 10 mi. e. of Mitchell, July 20, 1934, *Peck 18632* (WU). DESCHUTES CO.: dry ground, Sisters, July 22, 1914, *Peck 3202* (WU); on the desert, Redmond, July 21, 1912, *Whited A86* (D, G, M, NY); dry desert, Forked Horn Butte, vicinity of Laidlaw, July 22, 1907, *Whited 3080a* (UO). LAKE CO.: in sagebrush, Rock Creek, north slope of Hart Mt., July 16, 1932, *Applegate (?) 7761* (D); dry hillsides, Paisley, July 9, 1928, *Constance (Henderson 9962)* (PA, UO, WS). KLAMATH CO.: base of hills below McCormack Ranch, Klamath Lake, July 15, 1925, *Applegate 4413* (D, UC); dry, rocky hillsides, Algoma, a few mi. n. of Klamath Falls, July 10, 1930, *Henderson 12880* (UO).

NEVADA. ELKO CO.: dry lava rock slopes, Rowland, 1350 m. alt., July 31, 1912, *Nelson & Macbride 2149* (G, RM).

CALIFORNIA. MODOC CO.: sagebrush plains, Surprise Valley, 5 mi. s. of Fort Bidwell, July 9, 1932, *Applegate 7621* (D); yellow pine woods and sagebrush, near and above Jess Valley, South Fork of Pit River Region, Warner Mts., Aug. 4, 1932, *Applegate 8149* (D); Davis Creek, Aug., 189–, *Austin 489* (D, P); sandy ground in the sagebrush, 15 mi. n. of Alturas, Warner Mts., July 18, 1930, *Benson*

2233 (M, NY); Goose Lake Valley, Aug., 1899, *Bruce* (D); near Fort Bidwell, Summer, 1930, *Kelly 8* (CA); Camp Bidwell, 1879, *Matthews* (G). SISKIYOU CO.: Soda Springs, Little Shasta River, July 6, 1876, *Greene 913* (G); lava slopes, Lava Beds National Monument, July 8, 1936, *Thompson 13153* (NY, PA); Sheep Rock, Mt. Shasta, July, 1902, *Wilson* (UC). LASSEN CO.: Eagle Lake, 1500 m. alt., July 21, 1894, *Baker* (UC); Susanville, July 1, 1892, ex herb. *Brandegee* (UC); Perkin's Ranch, Susanville, 1500 m. alt., July 1, 1897, *Jones* (G, M, P). SHASTA CO.: open, rocky slopes of Saddle Mt., w. of Fall River Mills, T. 37 N., R. 4 E., 1320–1470 m. alt., July 16, 1937, *Stebbins & Jenkins 2391* (D).

34a. Calochortus macrocarpus var. **maculosus** (Nelson & Macbride) Nelson & Macbride ex Macbride in Contrib. Gray Herb. N. S. No. 56, p. 14. 1918.

Calochortus maculosus Nelson & Macbride in Bot. Gaz. **56**: 471. 1913.

Petals white or nearly so, with a conspicuous, reddish purple crescent above the gland; otherwise as in the species.

This is probably not more than a well-marked color form, but apparently locally constant, and easily distinguished.

DISTRIBUTION. Dry hills, Nez Perce County, Idaho, and adjacent southeastern Washington.

IDAHO. NEZ PERCE CO.: near Lewiston, June 24, 1902, *Beattie* (WS); mouth of Salmon River, June 27, 1925, *Eastwood 13320* (CA); Lewiston Grade, June 22, 1925, *Eastwood 13413* (CA, WS); in rather loose, disintegrated or volcanic soil, near Lewiston, June 17, 1894, *Henderson 2727* (G, RM TYPE).

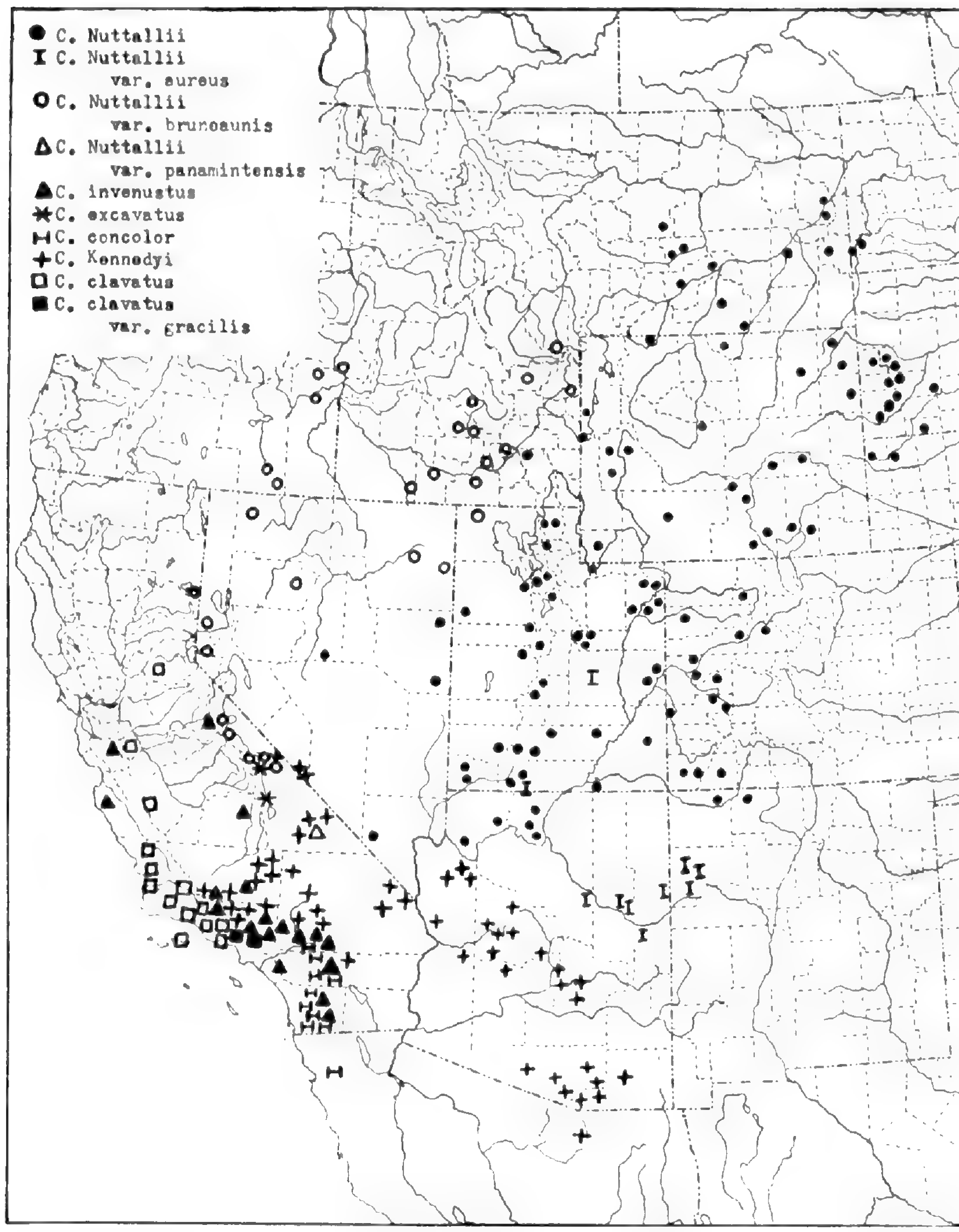
WASHINGTON. WHITMAN CO.: Pullman, July 31, 1892, *Hull* (WS); Pullman, Aug. 4, 1893, *Piper 1681* (G, WS). ASOTIN CO.: near mouth of Joseph Creek, 360 m. alt., June 1, 1897, *Sheldon 8221* (NY).

Subsection 7. NUTTALLIANI.[37]

Inflorescences subumbellate; sepals usually shorter than the petals, lanceolate, acute to acuminate; petals obovate, cuneate, rounded and obtuse to acuminate, usually invested near the gland with filiform or distally thickened hairs; glands depressed, circular, surrounded with a conspicuous, fringed

[37] NUTTALLIANI subsect. nov., inflorescentiis subumbellatis; sepalis petalis plerumque brevioribus lanceolatis acutis vel acuminatis; petalis obovatis cuneatis rotundo-obtusis vel acuminatis, prope glandulam pilis filiformibus aut apice crassatis plerumque praeditis; glandulis depressis circularibus, membrana conspicua fimbriata circumdatis, processis simplicibus aut apice ramosis dense vestitis; antheris anguste oblongis obtusis aut acutis; capsulis lineari-lanceolatis acutis vel acuminatis triangulatis; seminibus valde complanatis, testis insigniter inflatis hexagono-reticulatis.

membrane, and densely covered with simple or distally branched processes; anthers narrowly oblong, obtuse or acute; fruits linear-lanceolate, acute to acuminate, 3-angled; seeds



Map 7. Distribution of the species and varieties of the subsection NUTTALLIANI.

strongly flattened, with conspicuously inflated, hexagonally reticulate coats.

The NUTTALLIANI are distinguished by their circular, depressed glands which are surrounded by a usually broad membrane. The species, for the most part, are closely related and very difficult of delimitation. The chromosome base number, in all known instances, is eight. A single variety is known to be tetraploid. Although most of the species are confined to California and adjacent states, one, *C. Nuttallii,* crosses the deserts of the Southwest, and reaches the northern Great Plains (Map 7).

35. Calochortus Nuttallii Torrey in Stansbury, Exped. Utah, p. 397. 1852.

Calochortus luteus Nuttall in Journ. Acad. Philad. **7**: 53. 1834, not Douglas, 1833.

Fritillaria alba Nuttall, Gen. N. Am. Pl. **1**: 222. 1818, probably in part.[38]

Amblirion album Sweet, Hort. Brit., ed. 2, p. 538. 1830.

Calochortus albus Hort. in Notizblatt Bot. Gart. Mus. Berl. **2**: 318. 1899, not Douglas, 1834.

Calochortus Watsoni Jones, Contrib. West. Bot. No. 14, p. 26. 1912.

Calochortus rhodothecus Clokey in Bull. So. Calif. Acad. **37**: 1. 1938.

Bulb ovoid, with membranaceous coats; stem erect, usually unbranched, often bulbiferous near the base; leaves linear, reduced upward, becoming involute; inflorescence 1–4-flowered, subumbellate, the bracts congested, unequal; flowers erect, campanulate, white, tinged with lilac, or occasionally magenta, the petals yellow at the base and marked with a reddish brown or purple band or spot above the gland, sepals similarly marked; sepals usually shorter than the petals, lanceolate, acuminate, glabrous; petals broadly obovate, cuneate, usually short-acuminate, sparsely invested near the gland with slender hairs; gland circular, depressed, surrounded with a conspicuous, fringed membrane, and densely covered with short, simple

[38] Nuttall apparently confused the species now known as *Calochortus Nuttallii* and *Fritillaria atropurpurea* in his concept of *F. alba.* The type has not been located, and is probably no longer extant. For the most part, the description is of a *Fritillaria,* and the final disposition of the name must await a monographic treatment of that genus.

or distally branched processes; anthers oblong, obtuse, yellowish or pinkish, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-lanceolate, acuminate, 3-angled, erect; seeds strongly flattened, with loose-fitting, hexagonally reticulate coats.

As here defined *Calochortus Nuttallii* is a quite constant and easily recognized entity. It is the most widespread species in the genus and not without some minor variants, but these do not appear to be of taxonomic significance. It is not always easily distinguished from its variety *bruneaunis*, and this, in turn, connects it with *C. invenustus* and *C. excavatus*. On morphological characters alone, the inclusion of these various elements under a single species might be justified, but such a treatment would obscure the fact that they are recognizably distinct natural entities, each with a characteristic geographical range.

DISTRIBUTION. Dry soil, from the northern Great Plains of western North and South Dakota and eastern Montana, southwestward across northwestern Nebraska, Wyoming, southeastern Idaho, and Utah, to southern Nevada and northwestern Arizona; southward through western Colorado to northwestern New Mexico; apparently separated from its variety *bruneaunis* on the northwest by the Snake River and Salt Lake deserts.

NORTH DAKOTA. BILLINGS CO.: Bad Lands, Little Missouri, June 30, 1883, *Canby 326* (G); bluff sides in red soil, Bad Lands, Marmarth, June 10, 1914, *Moyer 523* (NY).

SOUTH DAKOTA. MEADE CO.: open talus slopes, cliff, limestone gulches, w. of Tilford, June 19, 1924, *McIntosh 307* (RM); rocky, open ground, near Piedmont, June 8, 1929, *Palmer 37032* (G, M). LAWRENCE CO.: rocky, open slopes, near Tilford, June 16, 1929, *Palmer 37322* (G). PENNINGTON CO.: foot of Great Wall, 3½ mi. from Interior, Bad Lands, Black Hills, 1927, *Hayward 711* (F); red-bed foothills, east-facing, Rapid City, June 12, 1927, *Hayward 798* (RM); foothills, Rockerville, Black Hills, June 15–30, 1909, *White* (M). CUSTER CO.: red-bed foothills, Fairburn, Black Hills, 1927, *Hayward 1477* (F); red-bed foothills, Buffalo Gap, Black Hills, 1927, *Hayward 1515* (F). SHANNON CO.: Pine Ridge, June 20, 1901, *Bates* (G). FALL RIVER CO.: Hot Brook Creek, Hot Springs, Black Hills, 1927, *Hayward 1616* (F); red-bed foothills, Hot Springs, Black Hills, June 28, 1927, *Hayward 1622* (F, RM); Fall River Falls, Black Hills, 1000 m. alt., June 19, 1892, *Rydberg 1047* (NY).

NEBRASKA. SIOUX CO.: on dry slopes and in gumbo, 1927, *Kramer 80* (M); Munro Canyon, Harrison, June 20, 1930, *Osterhout 7215* (RM). DAWES CO.: White River, near Crawford, 1200 m. alt., June 8, 1901, *MacDougal 116* (NY).

MONTANA. DAWSON CO.: Glendive, June, 1907, *Butler 5015* (NY); Intake, June

17, 1937, *Twedt 29* (UM). FALLON CO.: Plevna, June 18, 1937, *Sparks 992* (UM). CUSTER CO.: Miles City, June 8, 1937, *Roberts 934* (M, UM); sandy loam, No. 3 Well, 705 m. alt., June 2, 1936, *Woolfolk* (UM). FERGUS CO.: Grass Range, July 29, 1937, *Munson 1021* (UM). MUSSELSHELL CO.: Gage, June 17, 1937, *Lackey 629* (UM); rocky soil, Roundup, 1020 m. alt., June 14, 1937, *Syblon 973* (UM). YELLOWSTONE CO.: Custer, June 8, 1890, ex herb. *Blankinship 61* (G, M); dry bluff, Billings, June 29, 1905, *Whited 2661* (UO). BIG HORN CO.: plains near Decker, May 23, 1934, *Rollins 451* (WS); Fort Custer, June, 1890, *Tweedy* (NY).

WYOMING. CROOK CO.: foothills, Inyan Kara Creek, 17 mi. s. of Sundance, Black Hills, July 14, 1927, *Hayward 2113* (F, RM); dry hillsides, w. of Hulett, June 13–23, 1938, *Ownbey 404* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS). WESTON CO.: western foothills, Newcastle, July 9, 1927, *Hayward 2037* (F, RM). CAMPBELL CO.: sagebrush slopes, Gillette, July, 1928, *Beatty 7* (RM). CONVERSE CO.: dry plains, 6 mi. w. of Douglas, 1440 m. alt., July 2, 1935, *Ownbey 788* (O, RM); same locality and date, *Williams 2312* (M, UC, WS). ALBANY CO.: gulches among *Artemisia cana*, Rock River, 2100 m. alt., July 5, 1914, *Macbride 2752* (RM); stony sagebrush slopes, Chug Creek, June 29, 1900, *Nelson 7304* (RM). SHERIDAN CO.: Big Horn Mts., 2250 m. alt., July, 1899, *Tweedy 2560* (NY). NATRONA CO.: dry foothills, Casper Mt., 3 mi. s. of Casper, 1650 m. alt., July 6, 1933, *Hermann 4564* (G). CARBON CO.: dry, rocky hillsides, Indian Creek, June 24, 1901, *Goodding 96* (D, F, G, M, NY, P, RM, UC); rocky areas, sagebrush and grassland, Red Valley, near Muddy Gap, June 16, 1932, *Hanna 999* (M); Elk Mt., 2550 m. alt., June 28–Aug. 1, 1899, *Little & Stanton 166* (M, NY); Seminole Mts., July 21, 1898, *Nelson 4926* (RM); Cow Creek, 11 mi. n. of Encampment, July 2, 1922, *Payson & Payson 2521* (RM). PARK CO.: sandy, rocky plain, Little Rocky, Clarks Fork Valley, 1500 m. alt., June 23, 1924, *Pearson & Pearson 52* (RM). FREMONT CO.: in sagebrush draws, Birds Eye, June 24, 1910, *Nelson 9345* (M, RM, UC), *9346* (RM, UC). SUBLETTE CO.: sagebrush flat, 20 mi. w. of Big Piney, July 9, 1922, *Payson & Payson 2623* (G, M, RM, UC); sagebrush slope, Horse Creek, 7 mi. w. of Merna, July 17, 1922, *Payson & Payson 2736* (G, M, NY, P, PA, RM, UC); sagebrush slopes, near Cora, 2280 m. alt., July 10, 1925, *Payson & Payson 4342* (G, M, PA, RM, WS). SWEETWATER CO.: dry soil, near Leucite Hills, July 1, 1901, *Merrill & Wilcox 789* (G, NY, RM). TETON CO.: dry flats, Teton Pass Mts., e. of Victor, Idaho, 2100 m. alt., July 22, 1920, *Payson & Payson 2093* (CA, G, M, NY, RM). LINCOLN CO.: dry hillside, Alpine, on the Snake River, near the Idaho Boundary, July 10, 1923, *Payson & Armstrong 3435* (G, M, P, PA, RM). UINTA CO.: Bridger Butte, July 7, 1873, *Porter* (PA).

COLORADO. ROUTT CO.: Hayden, June 24, 1914, *Osterhout 5097* (RM). EAGLE CO.: sagebrush slopes, Route 11, 2 mi. s. of State Bridge, 2160–2190 m. alt., June 27, 1938, *Pennell & Schaeffer 22279* (PA). RIO BLANCO CO.: south side of White River, 2 mi. s. e. of mouth of Wolf Creek, 1680 m. alt., June 2, 1935, *Graham 9076* (M). GARFIELD CO.: Glenwood Springs, June 20, 1895, *Meredith 4535* (PA); Glenwood Springs, June 17, 1899, *Osterhout 1967* (RM). MESA CO.: Grand Junction, May, 1891, *Eastwood* (F, WS); Gunnison Mesa, Grand Junction, May 15, 1916, *Eastwood 5129* (CA); Grand Junction, *Eastwood* (D); Grand Junction, May 22, 1895, *Jones* (D, P); De Beque, May 26, 1910, *Osterhout 4257* (RM). DELTA CO.: hill, Surface and Dry creeks, Grand Mesa, 1830 m. alt., June, 1892, *Purpus 59* (F). MONTROSE CO.: Cimarron, 2070 m. alt., June 29, 1901, *Baker 285* (G, M, NY, P, RM, UC); dry hillsides, Montrose, May 15, 1911, *Payson 8* (RM); rocky soil, hilltop, 10 mi. s. of Montrose, 1800 m. alt., May 24, 1938, *Rollins 2132* (O); dry, rocky foothills, Paradox, 1860 m. alt., July 10, 1912, *Walker 214* (RM). LA PLATA CO.: Durango, May 21, 1916, *Eastwood 5347* (CA). MONTEZUMA CO.: sage plains, Mancos, June 22–July 8, 1898, *Baker, Earle & Tracy 1125, in part* (G, RM); just e. of Cortez, 1800–1950 m. alt., May 25, 1934, *McKelvey 4646* (G); Wickiup Canyon, Mesa Verde National Park, 1920 m. alt., May 30, 1925, *Schmoll 1634* (RM); sandstone, between Cortez and Mancos, 1890 m. alt., May 25, 1934, *Stone 479* (NY); Mancos, 2100 m. alt., May 27–June 8, 1901, *Vreeland 838* (NY, UM).

NEW MEXICO. RIO ARRIBA CO.: open woods, Dulce, June 18, 1932, *Castetter 2038* (RM). SAN JUAN CO.: Bloomfield, 1892, *Waring 37* (PA).

IDAHO. BANNOCK CO.: Pocatello, May 15, 1935, *Davis* (G, M, O); Pocatello, June 7, 1910, *Heller* (CA); Pocatello, June 11, 1902, *Jones* (P); Pocatello, Spring, 1921, *Soth P-57* (RM).

UTAH. UINTAH CO.: Davis Hollow, Taylor Mt., 15 mi. n. of Vernal, Uinta Basin, 2550 m. alt., June 24, 1931, *Graham 6361* (F); Vernal-Manila Road, n. of Vernal, Uinta Basin, 1950 m. alt., June 19, 1933, *Graham 8166* (M); among prickly pears, about 15 mi. s. of Jensen, Uinta Basin, 1650 m. alt., May 27, 1935, *Graham 9000* (F, G, M); along Highway 40, 10 mi. e. of Jensen, Uinta Basin, 1500 m. alt., May 31, 1935, *Graham 9029* (G); bench, 5 mi. e. of Vernal, Diamond Mt. Road, Uinta Basin, 1650 m. alt., June 8, 1935, *Graham 9139* (M); Red Wash, just n. w. of mouth of Split Mt. Canyon, above Island Park, Uinta Basin, 1560 m. alt., June 10, 1935, *Graham 9158* (M); Ouray, 1650 m. alt., May 22, 1908, *Jones* (P); dry, heavy or limy soil, among sagebrush, foothills of the Uinta Mts., 18 mi. n. of Vernal, Uinta Basin, 2100 m. alt., June 14, 1937, *Rollins 1691* (G, M, NY, O); desert, w. of Vernal, June 12, 1932, *Williams 609* (CA, M, NY, RM). GRAND CO.: Cisco, May 2, 1890, *Jones* (M, NY, P, UC); Westwater, May 20, 1901, *Jones* (D, G, P). SAN JUAN CO.: in fields and among junipers, 5 mi. n. of Blanding, June 22, 1938, *Cutler 2344* (M, O); yellow pine zone, Navajo Mt., 2700 m. alt., June, July, 1933, *Darsie* (UCLA). SUMMIT CO.: dry ground amongst sagebrush, near Bear River, 2460 m. alt., July 9, 1931, *Goodman 1868* (G, M, NY); edge of drying lake, West Fork of the Bear River, Uinta Mts., 2490 m. alt. July 9–13, 1930, *Goodman & Hitchcock 1549* (D, M, NY, UC). CARBON CO.: gravel, Castle Gate, 1800 m. alt., June 23, 1894, *Jones 5486* (P); Scofield, 2700 m. alt., 1905, *Jones* (P); Miller Creek, 1800 m. alt., June 8, 1910, *Jones* (D, P, UM). GARFIELD CO.: in yellow pine and sagebrush, Ruby's Inn, near checking station, Bryce Canyon National Park, July 8, 1937, *Ferris & Lorraine 9344* (D); 6 mi. w. of Panguitch Lake, 2700 m. alt., July 17, 1930, *Goodman & Hitchcock 1588* (CA, D, F, M, NY, PA, RM, UC, UM); Bryce Canyon, July 10, 1932, *Hawver* (CA); gravel, Mt. Ellen, Henry Mts., 2850 m. alt., July 25, 1894, *Jones 5684* (P); gravel, Bromide Pass, Mt. Ellen, Henry Mts., 3000 m. alt., July 27, 1894, *Jones 5695* (P); Bryce Canyon, June 27, 1913, *Jones* (D); Bryce Canyon, June, 1923, *Rodda* (CA); Aquarius Plateau, at the head of Poison Creek, Aug. 4, 1905, *Rydberg & Carlton 7434* (NY, RM). KANE CO.: summit of rim above Johnson, June 21, 1890, *Jones* (P); red sand, Kanab, 1590 m. alt., May 22, 1894, *Jones 5276* (M, NY, P, UC); Pahnah, 1883, *Siler* (M, PA); sandstone, 2 mi. n. e. of Kanab to Red Canyon, 1560 m. alt., May 14, 1934, *Stone 277* (NY). CACHE CO.: Mendon, June 17, 1898, *Mulford 119* (M); College Bench, Logan, June 2, 1910, *Smith 2169* (D); e. of Utah Agricultural College, Logan, May 28, 1910, *Zundel 211* (D, NY). WEBER CO.: Ogden, July 1, 1880, *Engelmann* (M); Ogden, June 5, 1871, *Hayden* (PA). SALT LAKE CO.: Salt Lake City, 1290 m. alt., June 10, 1880, *Jones 1766* (CA, F, NY, P); foot of Oquirrh Mts., July 3, 1917, *Moore* (PA); hills and mountains n. of Salt Lake City, June 9, 1905, *Rydberg 6004* (G, NY). UTAH CO.: American Fork Canyon, June 16, 1933, *Eastwood & Howell 556* (CA). SEVIER CO.: Manti Stock Company Pasture, Fish Lake Forest, 2900 m. alt., July 18, 1919, *Eggleston 15281* (F); gravel, 4 mi. up Salina Canyon, 1590 m. alt., June 14, 1894, *Jones 5419* (P); stony loam among junipers and sagebrush, Route 10, Salina Canyon, s. e. of Salina, 1860–1920 m. alt., June 21, 1938, *Pennell & Schaeffer 21977a* (PA); Richfield, 1500 m. alt., June 5, 1875, *Ward* (G). TOOELE CO.: Johnsons Pass, Cottonwood, 1680 m. alt., June 6, 1900, *Jones* (P); Mt. Ibapah, 2100 m. alt., July 17, 1903, *Jones* (P); summit of Oquirrh Mts., Aug. 3, 1917, *Jones 344* (G). JUAB CO.: under low shrubs, 2 mi. s. of Tintic, June 26, 1938, *Cutler 2431* (M, O); sagebrush land, Juab, June 9, 1902, *Goodding 1056* (RM). MILLARD CO.: Leamington, 1500 m. alt., May 8, 1911, *Jones* (P). IRON CO.: high mountains, e. of Cedar City, 1874, *Parry 255* (F, M, (PA). WASHINGTON CO.: dry desert, Belveau, 990 m. alt., June 1, 1929, *Cottam, Stanton & Harrison 3992* (P); on way to Pine Valley, near St. George, June 27, 1933, *Eastwood & Howell 1212* (CA, UM); red loam, among junipers, w. of Pine Valley, 1710–1770 m. alt., June 15, 16, 1938, *Pennell & Schaeffer 21748* (PA).

ARIZONA. COCONINO CO.: Bright Angel Trail, Grand Canyon of the Colorado River, June 15, 1916, *Eastwood 5654* (CA); Kaibab Forest, July 7, 1927, *Jaeger* (P); Kaibab, June 17, 1930, *Jones 25179* (P); Kaibab, June 18, 1929, *Jones 26103* (P); stony limestone, among junipers and pinyons, Route 89, n. of Jacob Lake, Kaibab Plateau, 2010–2040 m. alt., June 10, 1938, *Pennell 21633* (PA). MOHAVE CO.: oak association, dry hillside, Mt. Delenbaugh, 2100 m. alt., June 6, 1929, *Cottam, Stanton & Harrison 4150* (P); Trumbull, 1877, *Palmer 452* (G, NY).

NEVADA. WHITE PINE CO.: Muncy, July 2, 1891, *Jones* (M); gravelly sagebrush, along Steptoe Creek, e. of Shell Creek Mts., 2100–2250 m. alt., July 15, 1938, *Pennell & Schaeffer 23079* (PA); sagebrush, along Lehman Creek, below Mt. Wheeler, 2220–2280 m. alt., July 15–18, 1938, *Pennell & Schaeffer 23094* (PA). CLARK CO.: Kyle Canyon, Charleston Mts., 2270 m. alt., July 5, 1936, *Clokey 7043* (Clokey); Charleston Park, Charleston Mts., 2270 m. alt., July 11, 1936, *Clokey 7047* (Clokey); same locality, July 21, 1937, *Clokey 7479* (M), type collection of *C. rhodothecus* Clokey; Kyle Canyon to Deer Creek, Charleston Mts., 2400 m. alt., July 17, 1937, *Clokey 7480* (Clokey, M, O); Harris Springs Road, Charleston Mts., 1800 m. alt., June 17, 1937, *Clokey 7482* (Clokey); Lee Canyon, Charleston Mts., 2000 m. alt., July 3, 1936, *Clokey & Clokey 7044* (Clokey); Kyle Canyon to Deer Creek, Charleston Mts., 2425 m. alt., July 3, 1936, *Clokey & Clokey 7045* (Clokey); Griffith's Mine Road, Charleston Mts., 2425 m. alt., July 7, 1936, *Clokey & Clokey 7046* (Clokey, M, O); Kyle Canyon, Charleston Mts., 2700–3300 m. alt., July 22, 1930, *Goodman & Hitchcock 1672* (CA, D, M, NY, PA, UC, UM); stony ground, pinyon association, Kyle Canyon, 2250 m. alt., June 6, 1921, *Jaeger* (P, UCLA); Trout Creek, west base of Charleston Mts., 2100 m. alt., June 26, 1926, *Jaeger* (P). LANDER CO.: Bunker Hill Canyon, Toiyabe Range, July 29, 1913, *Kennedy 4095* (D); Birch Creek, Toiyabe Range, July 31, 1913, *Kennedy 4580* (D).

STATE NOT DETERMINED. "Towards the sources of the Columbia," *Wyeth* (NY, PA), TYPE COLLECTION.

35a. Calochortus Nuttallii var. **bruneaunis** (Nelson & Macbride) Ownbey, n. comb.

Calochortus bruneaunis Nelson & Macbride in Bot. Gaz. **55**: 372. 1913.

Calochortus discolor Davidson in Bull. So. Calif. Acad. **14**: 11. 1915.

Petals usually narrowly oblanceolate and conspicuously acuminate, with a median, longitudinal, green stripe and a dark red or purple spot above the gland, glabrous or occasionally with a few short hairs near the gland; anthers yellowish, bluish or reddish brown; otherwise as in the species.

The morphological characters which distinguish this variety from *C. Nuttallii* are not great, but, when supplemented by its geographical distribution, seem to merit taxonomic recognition.

DISTRIBUTION. Dry soil, southwestern Montana, southwestward across Idaho and southeastern Oregon to Nevada and adjacent California.

MONTANA. MADISON CO.: Cliff Lake, 2100 m. alt., July 27, 1897, *Rydberg & Bessey 3873* (NY).

IDAHO. FREMONT CO.: Henrys Fork, Snake River, 1872, *Coulter 585* (PA); among *Artemisia* bushes, in a draw, near Ashton, July 8, 1937, *Detling 2237* (UO). CLARK CO.: 3 mi. s. w. of Small, 1620 m. alt., June 29, 1937, *Pennell 20614* (PA). BINGHAM CO.: Aberdeen, June 23, 1923, *Piper* (WS). CUSTER CO.: gravelly sagebrush slopes, Bear Canyon, Mackay, 2010 m. alt., July 31, 1911, *Nelson & Macbride 1425* (RM). BLAINE CO.: field along stream, Little Wood River, e. of Gannett, June 19, 1930, *Applegate 6329* (UC); Wapi, July 3, 1917, *Jones* (WS); dry, gravel flat, Bellevue, 1530 m. alt., June 30, 1916, *Macbride & Payson 2957* (CA, D, G, M, NY, P, UC); among sagebrush on dry slopes, Picabo, 1470 m. alt., July 1, 1916, *Macbride & Payson 3004* (G, M, NY, RM). CASSIA CO.: Albion, 1893, *Lyles* (UM). TWIN FALLS CO.: Twin Falls, *Armstrong 955* (NY); open slopes, Shoshone Falls, June 4, 1912, *Bennitt 118* (RM). WASHINGTON CO.: Weiser, May 12, 1914, *Stillinger* (UCLA). OWYHEE CO.: chipped-lava canyon sides, Hot Hole, East Bruneau, July 2, 1912, *Nelson & Macbride 1881* (G, RM TYPE).

UTAH. BOXELDER CO.: Copper Mt., 1800 m. alt., July 7, 1929, *Cottam 4553* (P).

OREGON. MALHEUR CO.: hills near the Malheur River, June 6, 1901, *Cusick 2544* (F, G, M, NY, P, RM, UC, UO); dry hills, John Day Highway, 4 mi. beyond Brogan, May 25, 1927, *Henderson 8827* (CA, UO); grassy hillsides, Mathew Valley, near Harper Ranch, 1100 m. alt., June 10, 1896, *Leiberg 2236* (F, G, UC). HARNEY CO.: flats, base of Steens Mts., near Alvord Desert, June 9, 1927, *Henderson 8828* (CA, PA, UO, WU); dry slopes, Cooney's Mine, Pueblo Mts., 1800 m. alt., July 3, 1927, *Henderson* (UO); Steens Mts., June, 1927, *Leach* (WU); dry ground, 7 mi. s. of French Glen, June 21, 1936, *Peck 18963* (WU); dry slope, lower Willow Creek Canyon, June 23, 1936, *Peck 18982* (WU).

NEVADA. ELKO CO.: Clover Mts., near Deeth, 1980 m. alt., July 22, 1908, *Heller 9087* (NY, PA); Star Canyon, s. e. of Deeth, 1710 m. alt., July 10, 1912, *Heller 10580* (D, G, NY); Wendover [town in Utah, but specimen labelled "Nevada"], June 24, 1929, *Jones 26104* (P); Lone Mt., 2250 m. alt., Aug. 5, 1913, *Kennedy 4471* (D, PA); East Humboldt Mts., 2400 m. alt., Aug., 1868, *Watson 1173, in part* (NY). HUMBOLDT CO.: ridge of Pine Forest Mts., 1500 m. alt., June 21, 1909, *Taylor & Richardson 69* (UC). PERSHING CO.: Unionville, 1500 m. alt., June, 1868, *Watson 1172* (G, NY). WASHOE CO.: Reno, May 24, 1901, *Cowgill* (RM, UC); Peavine Mt., June 22, 1909, *Heller 9753* (D, UC); Reno, *Hillman* (P); Newcomb Lake, June 8, 1901, *Kennedy 13* (UC); Verdi, May 20, 1888, *Sonne* (UC); with *Artemisia tridentata* and pinyon pine, hills near Steamboat Springs, June 7, 1930, *Van Dyke* (CA). ORMSBY CO.: Empire City, June 19, 1882, *Jones* (P); Carson City, 1500 m. alt., May 29, 1897, *Jones* (P); south of Carson City, 1500 m. alt., June 2, 1897, *Jones* (D, NY).

CALIFORNIA. LASSEN CO.: Honey Lake, July 24, 1892, ex herb. *Brandegee* (UC). MONO CO.: 3 mi. from Mammoth Camp, July 19, 1918, *Ferris 1427* (D); Mono Lake, July 2, 1917, *Wright* (CA). INYO CO.: Andrews Camp, Bishop Creek, July, 1911, *Davidson 2672* (M), type collection of *C. discolor* Davidson; open hillside among bushes, Westgard Pass, 2190 m. alt., June 11, 1937, *Grinnell & Grinnell 1043a* (UC); coarse granite sand, foothills w. of Bishop, May 23, 1906, *Heller 8328* (CA, D, F, G, M, NY).

35b. Calochortus Nuttallii var. panamintensis Ownbey, n. var.[39]

Stem slender, tall; petals without a spot, white or faintly lilac, with a median, longitudinal, green stripe; anthers bluish or reddish; otherwise as in the species.

This variety seems to be a constant and easily distinguishable local variant.

DISTRIBUTION. California: dry slopes, Panamint Mountains, Inyo County.

CALIFORNIA. INYO CO.: Wild Rose Canyon, Water Canyon, above Thorndyke's Ranch, Panamint Mts., 2250–2550 m. alt., July 7, 1937, *Epling* (UCLA); Telescope Peak, near saddle at fork of Eagle Spring Trail, Panamint Mts., 3000 m. alt., July 8, 1937, *Epling* (UCLA); rocky slopes above Wild Rose Canyon, Panamint Mts., June 20, 1931, *Hoffmann 477* (CA); sandy soil among rocks, south side of Surprise Canyon, near Panamint City, Panamint Mts., 2400 m. alt., June 14, 1928, *Howell 3900* (CA); dry slope, Thorndyke's Canyon, upper Wild Rose Canyon, Panamint Mts., 2310 m. alt., July 7, 1937, *Munz 14856* (M, P TYPE).

35c. Calochortus Nuttallii var. aureus (Watson) Ownbey, n. comb.

Calochortus aureus Watson in Am. Nat. **7**: 303. 1873.

[39] **Calochortus Nuttallii** var. **panamintensis** var. nov., caule gracili alto; petalis sine macula albis aut sublilacinis, linea viridi mediana longitudinali; antheris subcaeruleis aut subrubris; aliter similis speciei.

Petals lemon-yellow, with a maroon blotch above the gland; stems usually short, with a large bulblet near the base; otherwise exactly as in the species.

This variety is hardly more than a color form, but it is easily separated, and seems to have a distinct geographical range.

DISTRIBUTION. Northwestern New Mexico, across southern Utah and northern Arizona.

NEW MEXICO. MCKINLEY CO.: in fields, 7 mi. w. of Ramah, June 19, 1938, *Cutler 2117* (M, O); Gallup, June 14, 1916, *Eastwood 5606* (CA); Fort Wingate, May, *Kimball* (M); not far w. of Gallup, May 22, 1934, *McKelvey 4595, 4600* (G); Fort Wingate, 1881, *Matthews 23* (G).

UTAH. EMERY CO.: dry hillside, King Ranch, 1500 m. alt., April 30, 1931, *without collector 5575* (M). KANE CO.: Kanab, *Thompson* (G, TYPE). COUNTY NOT DETERMINED: "S. Utah," 1873, *Bishop* (G); "S. Utah," 1874, *Siler* (G).

ARIZONA. APACHE CO.: desert region, s. of Petrified Forest, May 27, 1935, *Nelson & Nelson 2168* (M, NY); sandstone, near Lupton, New Mexican Line, 1800 m. alt., May 22, 1934, *Stone 450* (NY). NAVAJO CO.: n. of Holbrook, May, 1931, *Braem 36* (D); between Holbrook and Lupton, May 22, 1934, *McKelvey 4586, 4592* (G); 5 mi. e. of Holbrook, 1650 m. alt., May 22, 1934, *Stone 436* (NY). COCONINO CO.: Moqui Village, Aug., 1891, *Owens* (G). COUNTY NOT DETERMINED: Bat Woman Canyon, Navajo Reservation, 2100 m. alt., June, July, 1933, *Darsie* (UCLA).

36. Calochortus invenustus Greene, Pittonia 2: 71. 1890.

Calochortus Nuttallii var. *australis* Munz, Man. So. Calif. Bot. pp. 94, 597. 1935.

Bulb ovoid, with membranaceous coats; stem slender, erect, rarely branched, usually with a large, solitary bulblet in the pouch-like sheath of the lowest cauline leaf; leaves linear, reduced upward, becoming involute; inflorescence 1–5-flowered, subumbellate, the bracts congested, unequal; flowers erect, campanulate, white or dull lavender to greenish gray, sometimes with a purple spot on the claw of each petal; sepals shorter than the petals, lanceolate, acute to acuminate, glabrous or with a few hairs at the base; petals obovate, cuneate, obtuse to short-acuminate, invested near the gland with a few short hairs; gland small, circular, slightly depressed, surrounded with a more or less continuous, fringed membrane, and densely covered with short, usually distally branched processes; anthers oblong, obtuse, purplish or yellowish, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-lanceolate, acute, 3-angled, erect; seeds flattened, with loose-fitting, hexagonally reticulate coats.

Calochortus invenustus is closely allied to *C. Nuttallii,* with which it has been confused. While the morphological differences are not great, it is readily distinguished by the absence of a spot on the petals above the gland, the color of the petals, its different habit and its geographical range.

DISTRIBUTION. California: in dry soil, in the mountains, from Santa Clara County southward to San Diego County; also in the southern Sierra Nevada; infrequent north of the Tehachapi Range, but common southward.

CALIFORNIA. TUOLUMNE CO.: Tioga Road, w. of Lake Tenaya, 2370 m. alt., Aug. 23, 1916, *Smiley 875* (G). TULARE CO.: Little Kern, July 7, 1916, *Campbell* (CA); Little Kern River, Aug. 2, 1904, *Culbertson 4331* (G, M, P); Soda Creek, head of Kern River, 1950–2250 m. alt., July 17, 1897, *Dudley 1940* (D); Natural Bridge of Volcano Creek, basin of the upper Kern River, 2250 m. alt., July, 1904, *Hall & Babcock 5426* (UC); 1 mi. e. of Long Meadow, Sierra Nevada, 2250 m. alt., July 17, 1911, *Taylor* (UC) SANTA CLARA CO.: rock outcrop above Colorado Creek, Red Mts., Mt. Hamilton Range, 750 m. alt., May 25, 1936, *Sharsmith 3804* (O). MONTEREY CO.: Tassajara Springs, May 30, 1926, *Durbrow* (CA); Tassajara Hot Springs, June, 1901, *Elmer 3216* (D, M, UO); in pine woods, Santa Lucia Mts., 1416 m. alt., June 27, 1929, *Rountree* (P). KERN CO.: in the mountains back of Fort Tejon, July 7, 1891, *Coville & Funston* (UC); gravel bank, Tehachapi Trail, Brook Glen, region of Tehachapi Peak, Tehachapi Mts., 1800–2400 m. alt., June 24, 1895, *Dudley 327* (D, NY, UC); dry slope, under pines, head of Cuddy Valley, Mt. Pinos, T. 9 N., R. 21 W., July 3, 1938, *Ownbey & Ownbey 1690* (CA, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UM, UO, WS). VENTURA CO.: below old saw mill, Mt. Pinos, 2100 m. alt., June 19, 1896, *Dudley & Lamb 4603* (D, UC); Griffins, Mt. Pinos, July, 1902, *Elmer 3981* (D, F, G, M, NY, P); Mt. Pinos, June 8, 1931, *Epling & Dunn* (UCLA); Mt. Pinos, 2250 m. alt., June 27, 1931, *Epling & Dunn* (F, M, PA, UC, UCLA); Seymour Creek, Mt. Pinos, 2250 m. alt., July, 1905, *Hall 6506* (UC); Mt. Pinos, July 4, 1922, *Hart 19* (CA). LOS ANGELES CO.: North Baldy Mt., San Gabriel Mts., 2400 m. alt., July 3, 1908, *Abrams & McGregor 602* (D); Swartout Canyon, desert slopes of San Gabriel Mts., 1800 m. alt., July 5, 1908, *Abrams & McGregor 635* (D); Summit Mt., San Gabriel Range, July 11, 1897, *Barber 253* (UC); south slope of Mt. San Antonio, San Gabriel Mts., 2850 m. alt., July 28–30, 1930, *Goodman & Hitchcock 1723* (M); Barley Flats, San Gabriel Mts., 1680 m. alt., July 8, 1917, *Grinnell* (D, P); San Antonio Peak, 2700 m. alt., Aug. 8, 1926, *Jones* (P); on dry slopes, among sagebrush and pines, Swartout Valley, San Antonio Mts., 1800 m. alt., June 17, 1921, *Munz 4651* (P); summit of San Antonio Mts., 2979 m. alt., Aug., 1914, *Surr* (D); above Pine Flats, North Fork of San Gabriel Canyon, July 12, 1930, *West, Sweet & Crow* (P). SAN BERNARDINO CO.: dry ridges, Coldwater Canyon, San Antonio Mt., 2100 m. alt., July 12, 1902, *Abrams 2719* (NY); Deep Creek, San Bernardino Mts., 1800 m. alt., July 8, 1908, *Abrams & McGregor 730* (D); open pine forest, Hunsacker Flat, San Bernardino Mts., 1500 m. alt., July 23, 1897, *Chandler* (UC); Mare Flats, San Bernardino Mts., 2400 m. alt., July 6, *Crawford* (P); Bear Valley, San Bernardino Mts., June 1, 1916, *Edwards* (P); rocky slope, Gold Mt., above Baldwin Lake, 2200 m. alt., June 19, 1932, *Fosberg 8503* (P); dry hillsides, Fish Creek, San Bernardino Mts., 1950 m. alt., June 26, 1905, *Grinnell 29* (UC); black oak belt, Fish Creek, San Bernardino Mts., 2100 m. alt., June 30, 1906, *Grinnell & Grinnell 253* (CA); Hunsacker Flat and Deep Creek, San Bernardino Mts., 1800 m. alt., July 20, 1899, *Hall* (NY); Lytle Creek Canyon, San Antonio Mts., 1800 m. alt., June 1–3, 1900, *Hall 1452* (D, M, UC); near South Fork Meadows, Santa Ana Canyon, San Bernardino Mts., 2340 m. alt., Aug. 3, 1906, *Hall 7655* (UC); dry ground, Big Bear Valley, 1950 m. alt., July 4, 1920, *Harwood 4354* (P); Bear Valley, San Bernardino Mts., June 22, 1926, *Hilend 78* (UCLA); upper Holcomb Valley, San Bernardino Mts., June 25, 1930, *Hilend 571* (UCLA); around the east end of Big Bear Lake, San Bernardino Mts., 2010 m. alt., July 10, 1927, *Howell 2733* (CA); dry ridge, Bear Flats Trail to Baldy, San Antonio Mts., 2100–2550 m. alt., July 4, 1917, *Johnston 1379* (D, UC); bare ridge, Ontario Peak, San Antonio Mts., 2550 m. alt., July 30, 1917, *Johnston 1606* (D, P, UC); Bear Valley, San Bernardino Mts., 1980 m. alt., July 19, 1900, *Jones* (P); Bear Lake, San Bernardino Mts., June 24, 1926, *Jones* (D); dry, rocky slope at east end of Baldwin Lake, Bear Valley, San Bernardino Mts., 2100 m. alt., June 13, 1922, *Munz 5749* (P); on dry, pine-covered slopes, Kelly's Cabin, near Ontario Peak, San Gabriel Mts., 2430 m. alt., July 18, 1922, *Munz 6073* (P, UC); in meadow, Coldwater Fork of Lytle Creek, San Gabriel Mts., 2100 m. alt., July 19, 1922, *Munz 6109* (P); dry slopes at east end of Bear Lake, 1980 m. alt., June 22, 1926, *Munz 10469* (P); dry slope, Fredalba, San Bernardino Mts., 1500 m. alt., June 8, 1919, *Munz & Johnston 2919* (P); under pines, divide above Big Meadows, San Bernardino Mts., 2430 m. alt., July 16, 1924, *Munz & Johnston 8636* (P); canyon above Big Meadows, San Bernardino Mts., 2160 m. alt., July 16, 1924, *Munz & Johnston 8651* (P, type of *C. Nuttallii* var. *australis* Munz); dry slopes, Van Dusen Canyon, near Big Bear Lake, San Bernardino Mts., June 29, 1938, *Ownbey & Ownbey 1670* (CA, D, F, G, Kew, M, NY, O, P, PA, RM, UC); Lone Valley, San Bernardino Mts., 1800 m. alt., June 17, 1894, *Parish 3158* (M); Bear Valley, San Bernardino Mts., 1950 m. alt., June 18, 1894, *Parish 3159* (G, M, NY, PA, UC); Bear Valley, June, 1895, *Parish* (D); dry canyon bed, Coldwater Fork of Lytle Creek, San Antonio Mts., June 21, 1922, *Pierce* (P); Bear Valley, San Bernardino Mts., June 26, 1922, *Pierce* (P); dry hills, San Bernardino, 300 m. alt., May 7, *Spencer 1353a* (G, NY); San Bernardino Mts., June, 1928, *Van Dyke* (CA); Forest Home, San Bernardino Mts., 1590 m. alt., July, 1928, *Van Dyke* (CA); dry woods, Glen Martin, 1500 m. alt., Aug., 1904, *Williamson* (PA). RIVERSIDE CO.: on trail to Tahquitz Peak, San Jacinto Mts., 1740 m. alt., July 2, 1925, *Bacigalupi 1243* (D); San Jacinto Mts., 2550 m. alt., June 22, 1910, *Condit* (UC); above Marion Camp, Mt. San Jacinto, June 30, 1935, *Epling & Robison* (UCLA); Strawberry Valley, San Jacinto Mts., 1800 m. alt., June 17, 1897, *Hall 642* (UC); in open pine forests, vicinity of Strawberry Valley, San Jacinto Mts., 1560–1800 m. alt., June, July, 1901, *Hall 2297* (D, UC); in meadows and bogs of Tahquitz Valley, San Jacinto Mts., 2670 m. alt., July, 1901, *Hall 2475* (UC); west slope of San Jacinto Peak, 2850 m. alt., July 26, 1928, *Meyer 546* (UC); dry benches near creek, Santa Rosa, Santa Rosa Mts., 1980 m. alt., June 27, 1922, *Munz 5856* (P, UC); dry slope under pines, Dark Canyon, San Jacinto Mts., 2250 m. alt., July 27, 1924, *Munz*

& Johnston 8776 (P); in open woods, Idyllwild, San Jacinto Mt., 1590 m. alt., June 20, 1919, *Spencer 1353* (CA, G, NY, P); on wooded hills, near Idyllwild, San Jacinto Mt., 1680 m. alt., June 16, 1922, *Spencer 2035* (P); near Round Valley, San Jacinto Mt., 2700 m. alt., July 18, 1923, *Spencer 2249* (P); Idyllwild, July 22–28, 1928, *Van Dyke* (CA). ORANGE CO.: Santiago Peak, June 15, 1901, *Abrams 1848* (D, P); dry, rocky summit, Santiago Peak, Santa Ana Mts., 1590 m. alt., June 14, 1923, *Munz & Keck 7093* (P). SAN DIEGO CO.: Laguna Mts., June 20, 1904, *Brandegee* (UC); near Garnet Peak, Laguna Mts., May 30, 1936, *Gander 2442* (P); Cuyamaca Mts., 900 m. alt., May, 1899, *Hall 1212a* (D); dry, gentle slopes, Laguna Camp, Laguna Mts., 1500 m. alt., June 25, 1924, *Munz 8380* (NY, P); in open woods, Laguna Mts., 1800 m. alt., June 20, 1920, *Spencer 1153* (G, P).

37. Calochortus excavatus Greene, Pittonia **2**: 71. 1890.
Calochortus campestris Davidson in Bull. So. Calif. Acad. **14**: 12. 1915.

Bulb ovoid, with membranaceous coats; stem slender, erect, unbranched, often bulbiferous near the base; leaves linear, reduced upward, the basal one persistent at anthesis; inflorescence 1–4-flowered, subumbellate, the bracts congested, unequal; flowers erect, broadly campanulate, apparently lavender, often with a purple spot at the base of each sepal and petal; sepals shorter than the petals, lanceolate, acute to acuminate, glabrous; petals broadly obovate, cuneate, usually obtuse or rounded above, invested near the gland with a few short hairs; gland circular, depressed, surrounded with a conspicuous, fringed membrane, and densely covered with short, distally branched processes; anthers oblong, obtuse, reddish brown, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-lanceolate, acute, 3-angled, erect; mature seeds unknown.

Calochortus excavatus is closely allied to *C. Nuttallii* and *C. invenustus.* From the former, it differs in its lack of a spot on the petals above the gland, its more slender habit, and different habitat. It may be separated from the latter by its leafier stems, persistent basal leaf, and smaller bulblets. The species of the subsection NUTTALLIANI are not distinguished by clear-cut morphological characters, and *C. excavatus* is perhaps the most unsatisfactory of the lot. The arguments for recognizing it as a species are: (1) It is a quite constant, morphologically distinguishable, and apparently natural entity. (2) It has a distinct geographical range. (3) Its habitat is unlike that of any other species of the subsection NUTTALLIANI. (4) Its inclusion under *C. Nuttallii,* even as a variety, would necessitate the similar inclusion of *C. invenustus,* and make the delimitation of species in the NUTTALLIANI even more difficult.

DISTRIBUTION. California: in grassy meadows, along Bishop and Lone Pine creeks, Inyo County.

CALIFORNIA. INYO CO.: Lone Pine Creek, Alabama Hills, April 26, 1936, *Cassel 158* (D); meadow of Lone Pine Creek, 1350 m. alt., May 27, 1906, *Hall & Chandler 7187* (UC); damp, grassy meadows near Bishop, May 30, 1906, *Heller 8350* (CA, D, F, G, M, NY, PA, UC); Lone Pine, 1800 m. alt., May 14, 1897, *Jones* (D, NY, P); Bishop Creek, May 30, 1886, *Shockley 427* (G, UC), TYPE COLLECTION.

38. Calochortus concolor (Baker) Hort. acc. Purdy & Bailey in Bailey & Miller, Cyclop. Am. Hort. **1**: 220. 1900, as synonym; Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 135. 1901.

Calochortus luteus var. *concolor* Baker in The Garden **48**: 440, *pl. 1043.* 1895.

Bulb ovoid, with membranaceous coats; stem slender, erect, usually unbranched, rarely bulbiferous; leaves linear, becoming involute and curled at the tip, reduced upward; inflorescence 1–4-flowered, subumbellate, the bracts congested, unequal; flowers erect, campanulate, lemon-yellow, usually marked with a dark red blotch near the base of each sepal and a band on each petal above the gland; sepals shorter than the petals, lanceolate, acute to acuminate, glabrous; petals obovate, cuneate, rounded and obtuse above or abruptly acuminate, sparsely bearded above the gland with long, flexuous hairs; gland usually small, circular, depressed, surrounded by a broad, deeply fringed membrane, and densely covered with slender, usually unbranched processes; anthers oblong, obtuse, yellowish, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-lanceolate, acuminate, 3-angled, erect; mature seeds unknown.

This species closely resembles *Calochortus Nuttallii* var. *aureus,* and if the two were not widely separated geographically they might be easily confused. It is usually a much larger plant, however, with more densely hairy petals, and is rarely bulbiferous.

DISTRIBUTION. Dry slopes, southern face of the San Bernardino Mountains, San Bernardino County, California, southward to northern Lower California.

CALIFORNIA. SAN BERNARDINO CO.: Crafton, April, *Lemmon* (F, UC); Mill Creek Canyon, San Bernardino Mts., July 2, 3, 1892, *Parish 2524* (D, F, NY); Crafton Hills, July 1, 1903, *Williamson* (PA); Forest Home, San Bernardino Mts., 1590 m. alt., July, 1921, *Van Dyke* (CA). RIVERSIDE CO.: open south hillsides, El Toro Mt., San Jacinto Mts., 2490 m. alt., July 30, 1897, *Hall 962* (UC); eastern base of San Jacinto Mts., along the borders of the Colorado Desert, June, 1901, *Hall 2103* (D, M, NY, UC); exposed south slopes, vicinity of Chalk Hill, San Jacinto Mts., 1500 m. alt., June, 1901, *Hall 2285* (UC); McMullen Trail, San Jacinto Mts., June, 1921, *Jaeger* (P); 20 mi. n. of Idyllwild, June 20, 1926, *Jones* (P); dry rock crevices, Pipe Creek, Hemet Valley, San Jacinto Mts., 1440 m. alt., June 24, 1922, *Munz 5811* (P); dry and rocky slopes, between pines, Santa Rosa, Santa Rosa Mts., 1950 m. alt., June 30, 1922, *Munz 5917* (P, UC); dry slope, 10 mi. s. w. of Coahuila, May 21, 1927, *Munz 10875* (P); at the margins of the woods, Idyllwild, San Jacinto Mts., 1680 m. alt., June 16, 1922, *Spencer 2036* (P). SAN DIEGO CO.: dry ridges, 2 mi. w. of Jacumba, June 1, 1903, *Abrams 3682* (D, G, NY, P, PA); San Vicente Rancho, near Ramona, June, 1901, *Brandegee* (UC); Laguna Mts., June 20, 1904, *Brandegee* (UC); Warners Hot Springs, July, 1913, *Buttle* (CA); stony places among bushes, edge of desert, July 9, 1885, *Cleveland* (UC); Green Valley, near San Diego, June 27, 1915, *Collins & Kempton 197* (NY); Cuyamaca, June 25, 1919, *Eastwood 9141* (CA); Descanso, June 20, 1932, *Epling, Darsie, Knox & Robison* (UCLA); e. of Julian, May 30, 1926, *Jones* (NY, P); Descanso, May 31, 1926, *Jones* (P); Jacumba, May 31, 1926, *Jones* (P); Jacumba, Laguna Mts., June 10, 1917, *McGregor 990* (D); Banner, May 24, 1928, *Meyer 399* (UC); dry slope, Doane Valley, Palomar Mts., 1500 m. alt., June 22, 1924, *Munz 8313* (G, NY, P); high, dry slope, Laguna Camp, Laguna Mts., 1650 m. alt., June 25, 1924, *Munz 8355* (P); dry, stony slope, Vallecito Canyon, Laguna Mts., 1200 m. alt., May 17, 1925, *Munz 9724* (P); Campo, June 15, 1915, *Seitz* (CA); in the chaparral, Pine Hills, 1260 m. alt., June 24, 1917, *Spencer 602* (G, NY, P); in open woods, Laguna Mts., 1800 m. alt., June 20, 1920, *Spencer 1153A* (G, P); Santa Isabel Creek, June 10, 1895, *Stephens* (UC).

LOWER CALIFORNIA. Road between Ojos Negros and Alamos, 1110 m. alt., June 10, 1905, *Goldman 1137* (US); Nachoguero Valley, June 1, 1894, *Mearns 3377* (D, NY); Nachoguero Valley, June 4, 1894, *Mearns & Schoenefeldt 3471* (D); Hanson's Ranch, July 10, 1884, *Orcutt* (F, G).

39. Calochortus Kennedyi Porter in Bot. Gaz. **2**: 79. 1877.

Calochortus speciosus Jones, Contrib. West. Bot. No. 14, p. 27. 1912.

Calochortus Kennedyi var. *Munzii* Jepson, Man. Fl. Pl. Calif. p. 236. 1923.

Bulb ovoid, with membranaceous coats; stem erect, often very short, usually unbranched, rarely bulbiferous; leaves glaucous, linear, attenuate, reduced upward; inflorescence 1–6-flowered, subumbellate, the bracts congested, unequal; flowers erect, campanulate, pale yellow, orange or vermillion, usually marked with dark purple or black near the base of the sepals and petals; sepals shorter than the petals, lanceolate, acute, usually glabrous; petals obovate, cuneate, usually rounded and obtuse above, invested near the gland with a few, distally thickened hairs; gland circular, slightly depressed, surrounded with a broad, fringed membrane, and densely covered with slender, simple or distally branched processes; anthers narrowly lanceolate, obtuse or acute, yellowish, dark purple or reddish brown, longer than the basally dilated filaments; ovary linear-lanceolate, not winged, tapering to a persistent, trifid stigma; fruit linear-lanceolate, acuminate, 3-angled, erect, longitudinally striped with purple; seeds strongly flattened, with loose-fitting, hexagonally netted coats.

Calochortus Kennedyi is closely allied to *C. Nuttallii,* but is distinguished by its smaller gland, yellow to vermillion flowers and more southerly distribution. In the western part of its range the flowers are uniformly vermillion, or sometimes orange, but eastward, the yellow form (variety *Munzii)* becomes more frequent, until in Arizona it is the prevailing form. The two color forms appear distinct in California, but in Arizona are not infrequently found growing together.

DISTRIBUTION. In dry, often rocky soil, deserts of central and southern Arizona and northern Sonora, to southeastern California.

ARIZONA. COCHISE CO.: Dragoon Mts., June, 1899, *Eby* (M). GILA CO.: near Apache Lodge, Roosevelt, Apache Trail Region, May 6, 1929, *Eastwood 16882* (CA); Apache Trail, near Roosevelt, May 5, 1929, *McKelvey* (CA). PINAL CO.: Oak Flats, between Miami and Superior, May 9, 1935, *Nelson & Nelson 1850* (M, NY). PIMA CO.: talus of lava butte, 15 mi. s. e. of Vail, April 7, 1932, *Fosberg 7937* (UCLA); dry hills, Covered Wells, April 7, 1932, *Fosberg 7938* (P, UC, UCLA); desert below White House Canyon, Santa Rita Mts., 1050 m. alt., April 16, 1928, *Graham 3622* (D); Baboquivari Mts., April 23, 1932, *Harrison & Kearney 8612* (P); between Sonoita and Vail, May 4, 1931, *McKelvey 2104* (G); stony hills, e. of Arivaca, April 11, 1935, *Nelson & Nelson 1468* (M, NY); Arivaca, 1095 m. alt., May 4, 1935, *Peebles & Fulton 11414* (F); mesas near Tucson, April 26, 1884, *Pringle* (F, PA); Santa Rita Mts., May 15, 1884, *Pringle* (F, G, M, NY, PA). SANTA CRUZ CO.: dry, grassy hills, east slope of Tumacacori Mts., April 6, 1932, *Fosberg 7935* (M, P, UC, UCLA); rocky hillsides, between Ruby and the Tucson-Nogales Highway, April 13, 1935, *Nelson & Nelson 1503* (M, NY); Sonoita to Elgin, 1455 m. alt., May 5, 1935, *Peebles & Fulton 11479* (F). YAVAPAI CO.: dry elevations in moist valleys, Skull Valley, May 3, 1865, *Coues & Palmer 186* (M); Skull Valley, 1290 m. alt., April 28, 1903, *Jones* (P); Hillside, 1110 m. alt., May 1, 1903, *Jones* (D, P); Congress Junction, 900 m. alt., May 2, 1903, *Jones* (M, P); Congress, April 30, 1897, *Kunze* (NY); between Prescott and Ashfork, May 12, 1931, *McKelvey 2189* (G); Bloody Basin, midway between Fort Verde and Fort McDowell, April 21, 1888, *Mearns 203, in part* (NY); Fort Verde, 1884, *Mearns 258* (NY); near Prescott, May 14, 1927, *Peebles & Harrison 3984* (UCLA). MARICOPA CO.: Bush Highway, 1050 m. alt., May 12, 1935, *Collom 157, 377* (M); Wickenberg, 630 m. alt., May 5, 1903, *Jones* (P); stony slopes along the Apache Trail, May 1, 1935, *Nelson & Nelson 1701* (M, NY). MOHAVE CO.: n. of White Cliffs, vicinity of Kingman, April 9, 1927, *Braem* (D); hills e. of Kingman, May, 1933, *Braem* (D); Kingman, April 15, 1931, *Eastwood 18041* (CA); Hackberry, May 24, 1884, *Jones* (P); Chemehuevis, 1140 m. alt., April 23, 1903, *Jones* (D, NY, P); Hackberry, 1140 m. alt., April 25, 1903, *Jones* (P); Peach Springs, June, 1884, *Lemmon 4175* (G, UC); between Hackberry and Peach Springs, May 17, 1931, *McKelvey 2262* (G); Huapai Indian Reservation, Peach Springs to New Water Point on Colorado River, 1500 m. alt., April 29, 1934, *Stone 104* (NY); Peach Springs, May, 1893, *Wilson 109* (UC). YUMA CO.: Harcuvar Mts., April 21, 1932, *Peebles 8521* (F, UC).

NEVADA. ESMERALDA CO.: below Tule Canyon, Death Valley, June 4, 1891, *Bailey 2006* (D); Lida, June 4, 1924, *Jones* (P).

CALIFORNIA. INYO CO.: 15 mi. n. of Little Lake, May, 1927, *Fleisher* (CA); open hillside, between Deep Springs Valley and Oasis, 1911 m. alt., June 11, 1937, *Grinnell & Grinnell 1047a* (UC); gravelly hillside, near Dantes View, April 17, 1932, *Hitchcock 12345* (M, P, UC, UM); Wild Rose Canyon, Panamint Mts., 1950 m. alt., May 15, 1931, *Hoffmann 273* (P); Argus Mts., 1500 m. alt., May 11, 1897, *Jones* (P); among shrubs on dry flats, Wild Rose Canyon, Panamint Mts., 1800 m. alt., May 8, 1932, *Munz 12518* (P); dry bench, North Fork of Hanaupah Canyon, Panamint Mts., 1800 m. alt., May 7, 1932, *Munz 12542* (M, P); Mesa Mal Pais, Argus Mt., 1200–1500 m. alt., June, 1897, *Purpus 5013* (G, M, UC). SAN BERNARDINO CO.: south end of Providence Mts., April 12, 1930, *Barnes* (UCLA); Cottonwood Canyon, Providence Mts., May 8, 1931, *Barnes* (UCLA); Barnwell, May 16, 1911, *Brandegee* (UC); brushy hilltop, Mojave River at junction with Deep Creek, 900 m. alt., May 15, 1935, *Clokey & Anderson 6541* (M); same locality, May 19, 1935, *Clokey & Clokey 6993* (Clokey, F, M, NY, WS); near Hesperia, May 11, 1936, *Epling & Stewart* (UCLA); quartzite slopes, Johnston Grade, below Baldwin Lake, 2100 m. alt., June 19, 1932, *Fosberg 3502* (P); Victorville, 900 m. alt., May, 1905, *Hall 6193* (UC); Cajon Pass, May 10, 1926, *Hart 11* (CA); Cactus Flats, June 1, 1930, *Hilend 457* (UCLA); Mojave Desert, 12 mi. s. e. of Victorville, 900 m. alt., June 11, 1927, *Howell 2499* (CA); east slope of Clark Mt., June 10, 1933, *Jaeger* (P); open desert, w. of Deadman Point, May 16, 1920, *Johnston* (P); 9 mi. n. w. of Hesperia, May 17, 1920, *Johnston* (P); hillside, Mojave Desert, 3 mi. n. of Granite Well, May 14, 1922, *Johnston*

6487 (Clokey, P, UC); Victor, 780 m. alt., May 17, 1903, *Jones* (P); bridge on the Mojave, near Hesperia, May 7, 1926, *Jones* (CA, D); n. of and near Victorville, May 11, 1926, *Jones* (D, NY); Stoddards Well, Mojave Desert, May 7, 1927, *Jones* (P); sandy soil, benches along Mojave River at Deep Creek, 885 m. alt., May 15, 1935, *Keck & Stockwell 3288* (D); dry, rocky wash, Cactus Flats, San Bernardino Mts., 1800 m. alt., June 13, 1922, *Munz 5744* (P); dry flats, mouth of Deep Creek, north base of San Bernardino Mts., 900 m. alt., May 21, 1930, *Munz 11913* (P); open field, 10 mi. e. of Victorville, 870 m. alt., April 21, 1932, *Munz 12441* (M, P, UC); dry slopes above Vontrigger Spring, eastern Mojave Desert, 1050 m. alt., May 3, 1935, *Munz 13671* (D, F, P, UC); lower slope, vicinity of Bonanza King Mine, east slope of Providence Mts., Mojave Desert, 1200 m. alt., May 21–24, 1920, *Munz, Johnston & Harwood 4259* (D, P, UC), type collection of *C. Kennedyi* var. *Munzii* Jepson; among low shrubs, vicinity of Bonanza King Mine, east slope of Providence Mts., Mojave Desert, 1200 m. alt., May 21–24, 1920, *Munz, Johnston & Harwood 4275* (D, P, RM, UC); Rock Spring, May, 1876, *Palmer 526* (F, G, M); Cushenbury Canyon, San Bernardino Mts., 1680 m. alt., June 1, 1892, *Parish 2467* (NY); borders of Mojave Desert, Cushenbury, June 1, 1892, *Parish 2497* (F); Barstow, Mojave Desert, May 30, 1914, *Parish 9296* (D); in desert sand, Hesperia, May 4, 1917, *Spencer 413* (G, NY, P). RIVERSIDE CO.: dry soil, Coyote Holes, Little San Bernardino Mts., 1050 m. alt., May 6, 1922, *Munz & Johnston 5204* (P, UC). KERN CO.: rocky soil, south slope, Tehachapi Pass, Piute Range, 1200 m. alt., May 7, 1932, *Benson 3491* (UC); between Mojave and Cameron, May 16, 1905, *Brandegee* (UC); Randsburg, 1914, *Chittenden* (CA); valley below Cuddy's, Mt. Pinos Region, June 15, 1896, *Dudley & Lamb 4518* (D, UC); Inyokern, Mojave Desert, May, 1922, *Fitch* (P); Cuddy Canyon, 1350 m. alt., June, 1905, *Hall 6314* (UC); near Frazer Mt. Park, Santa Barbara National Forest, May 27, 1928, *Hilend* (UCLA); n. of Randsburg, Mojave Desert, May 12, 1927, *Jones* (P); Fort Tejon, Spring, 1876, *Kennedy* (F, G, PA TYPE); Red Rock Canyon, April 29, 1935, *McCracken* (CA); among shrubs of *Artemisia tridentata*, Cuddy Canyon, Mt. Pinos, 1350 m. alt., June 9, 1923, *Munz 6933* (P); dry soil, pine-sagebrush association, at head of Cuddy Valley, T. 9 N., R. 21 W., July 3, 1938, *Ownbey & Ownbey 1688* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS). LOS ANGELES CO.: Acton, May 9, 1926, *Atsatt* (UCLA); sloping hillsides, Manzana, Antelope Valley, May 9–24, 1896, *Davy 2480* (UC); 3½ mi. e. of Manzana, S. 21, T. 8 N., R. 16 W., 960 m. alt., May 14, 1935, *Gifford 715* (UC); Acton, 810 m. alt., May 25, 1893, *Hasse 1047* (NY); rocky ground, Mt. Soledad, s. of Mohave Station, May 5, 1920, *Johnston* (P); Ridge Route, June 7, 1926, *Jones* (D); gravel wash, Big Rock Creek, San Gabriel Mts., 1290 m. alt., May 26, 1923, *Munz 6818* (P). VENTURA CO.: near the Frazier Borax Mine, Mt. Pinos, 1560–1800 m. alt., June 12–14, 1908, *Abrams & McGregor 203* (D, G, NY); open, gravelly slope, w. of Lockwood Valley, 1500 m. alt., May 22, 1935, *Clokey & Anderson 6542* (Clokey); Griffins, Mt. Pinos, July, 1902, *Elmer 4175* (D); Cuddy Valley, Mt. Pinos, June 28, 1931, *Epling & Dunn* (UCLA); east slope, Mt. Pinos, 2100 m. alt., July, 1905, *Hall 6488* (UC); s. of Lebec, June 7, 1926, *Jones* (P).

SONORA. Rocky soil, Imuris, 825 m. alt., April 9, 1932, *Abrams 13183* (D); dry, rocky hills, 15 mi. n. of Magdalena, April 5, 1932, *Fosberg 7936* (D, P, UCLA).

40. Calochortus clavatus Watson in Proc. Am. Acad. **14**: 265. 1879.

Calochortus clavatus var. *avius* Jepson, Man. Fl. Pl. Calif. p. 235. 1923.

Bulb ovoid, with membranaceous coats; stem leafy, usually stout, zigzag, frequently branched, rarely bulbiferous; leaves broadly linear, attenuate, reduced upward; inflorescence 1–6-flowered, subumbellate, the outer bracts often exceeding the flowering pedicels; flowers large, erect, cup-shaped, lemon-yellow, sometimes with reddish brown markings on the sepals and a thin, transverse, zigzag line on each petal above the gland; sepals ordinarily much shorter than the petals, lanceolate, acute, glabrous; petals broadly obovate, cuneate, usually rounded and obtuse above, invested above the gland with a transverse band of distally enlarged, subclavate hairs; gland circular, deeply depressed, surrounded with a broad, deeply fringed membrane, densely covered with short, distally much-branched processes; anthers large, oblong, obtuse or acute, reddish or purplish brown, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit large, linear-lanceolate, acuminate, strongly 3-angled; immature seeds strongly flattened.

Well-developed plants of this species are the largest of the *Calochorti*. It is easily recognized by its yellow flowers and clavate hairs, but is otherwise quite variable. The variety *avius* is insufficiently known, but the single specimen examined is exactly matched by specimens from the Coast Ranges.

DISTRIBUTION. California: dry hills, southern Sierra Nevada, from Eldorado County to Mariposa County (according to Purdy), and in the South Coast Ranges from Stanislaus County southward to Los Angeles County.

CALIFORNIA. ELDORADO CO.: Pleasant Valley, *Purdy* (UC), type collection of *C. clavatus* var. *avius* Jepson. STANISLAUS CO.: lower part of Del Puerto Canyon, May 13, 1938, *Hoover 3415* (O). SAN BENITO CO.: Griswold Creek, April 29–May 1, 1921, *Abrams & Borthwick 7947* (D, NY, P, RM); loose soil in sandstone, *Pinus Sabiniana* belt, 2 mi. n. of Idria, San Carlos Range, 600 m. alt., May 25, 1938, *Constance & Morrison 2266* (O); near Idria, May 31, 1899, *Dudley* (D). SAN LUIS OBISPO CO.: summit, Cuesta, June 20, 1908, *Condit* (UC); California Polytechnic School Canyon, San Luis Obispo, June 7, 1910, *Condit* (UC); Cuesta, May 30, 1908, *Condit & Edwards* (UC); hills between Carisa and Cuyama, near the boundary between Santa Barbara and San Luis Obispo counties, June 13, 1902, *Eastwood* (G, NY); Arroyo Grande, June, 1895, *King* (UC); near San Luis Obispo, June, 1878, *Lemmon 1522* (F, G TYPE, M, UC); hills near San Luis Obispo, June, 1887, *Lemmon 4578* (G); exposed mountains, near San Luis Obispo, June, 1886, *Miles* (NY); Paso Robles, May 30, June, 1932, *Renner* (CA); summit, San Luis Mt., June 17, 1883, *Summers 841* (UC); Tunnel, San Luis Obispo, May 24, 1906, *Unangst* (UC). SANTA BARBARA CO.: Suey Creek, near Santa Maria, June 15, 1906, *Eastwood 394* (CA); on hills, Zaca Lake Forest Reserve, June 19-30, 1906, *Eastwood 521* (CA); Gaviota Canyon, near Santa Barbara, April 28, 1926, *Jones* (CA, P). SANTA CRUZ ISLAND: without exact locality, *Brandegee* (D). VENTURA CO.: South Mt., Santa Paula, May 31, 1908, *Abrams & McGregor 1* (D); Sulphur Mt. Spring, Sulphur Mts., 300–600 m. alt., June 1, 2, 1908, *Abrams & McGregor 3* (D); steep east slope in brush, Piru Creek, 3 mi. above Piru, April 7, 1932, *Fosberg 8169* (P, UCLA); Mt. Pinos, May 16, 1923, *Hart* (CA); Schuyler, Ridge Route, April 29, 1926, *Jones* (P); near Bardsdale, 180 m. alt., April 20, 1931, *McNab* (D); semi-shade, loam, near Bardsdale School, Bardsdale, Santa Clara Valley, 150 m. alt., May 14, 1931, *Wolf 2047* (D, P, UC, UCLA). LOS ANGELES CO.: Laurel Canyon, June 7, 1901, *Braunton 6* (D); openings in woods, north slope, Mandeville Canyon, Santa Monica Mts., 500 m. alt., May, 1929, *Clokey & Templeton 4552* (Clokey, F, M, NY, P, UC); Topanga Canyon, May 8, 18, 1926, *Epling* (UCLA); Topanga Canyon, May, 1927, *Epling* (UCLA); Los Alisos Canyon, Santa Monica Mts., May 9, 1931, *Epling* (CA, D, F, M, PA, UC, UCLA); open, sunny chaparral slope, near Summit, Ridge Route, 1500 m. alt., June 4, 1933, *Epling & Wheeler 1854* (D, M, UC, UCLA); Laurel Canyon, June 7, 1901, *Grant* (D); dry, heavy soil, south end of Ridge Road, May 15, 1922, *Pierce* (P); Castac Canyon, 9 mi. n. w. of Saugus, April 25, 1926, *Stanford* (P).

40a. Calochortus clavatus var. **gracilis** Ownbey, n. var.[40]

Smaller than the species in every way; stem slender; petals very sparsely bearded, usually with a narrow, zigzag, reddish brown line above the gland; gland small, scarcely depressed; anthers 4–7 mm. long, shorter than the filaments.

DISTRIBUTION. California: canyons, San Gabriel Mts., Los Angeles County.

CALIFORNIA. LOS ANGELES CO.: on dry slope, Bichota Canyon, North Fork of San Gabriel Canyon, June 28, 1930, *Crow* (P TYPE); San Antonio Canyon, May 15, 1910, *Davis 53* (M); San Gabriel Canyon, May 29, 1919, *Eastwood 9002* (CA); grassy slope, under oaks, mouth of Pico Canyon, near Newhall, 360 m. alt., May 17, 1930, *Ewan 5519* (RM); San Gabriel Canyon, June 25, 1904, *Grant* (D); canyons, Claremont, June, 1898, *Illingsworth 108* (P); San Francisquito Canyon, near Power Plant No. 1, June 12, 1922, *Moxley 1113* (RM); dry slope, Mint Canyon, n. of San Gabriel Mts., May 25, 1923, *Munz 6798* (NY, P); West Fork of San Gabriel Canyon, 675 m. alt., June 21, 1921, *Peirson 2468* (P).

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[40] **Calochortus clavatus** var. **gracilis** var. nov., minor omnino quam species; caule gracili; petalis parcissime barbatis plerumque supra glandulam linea angusta flexuosa rubro-fusca; glandula parva vix depressa; antheris 4–7 mm. longis filamentis brevioribus.

Subsection 8. GUNNISONIANI.[41]

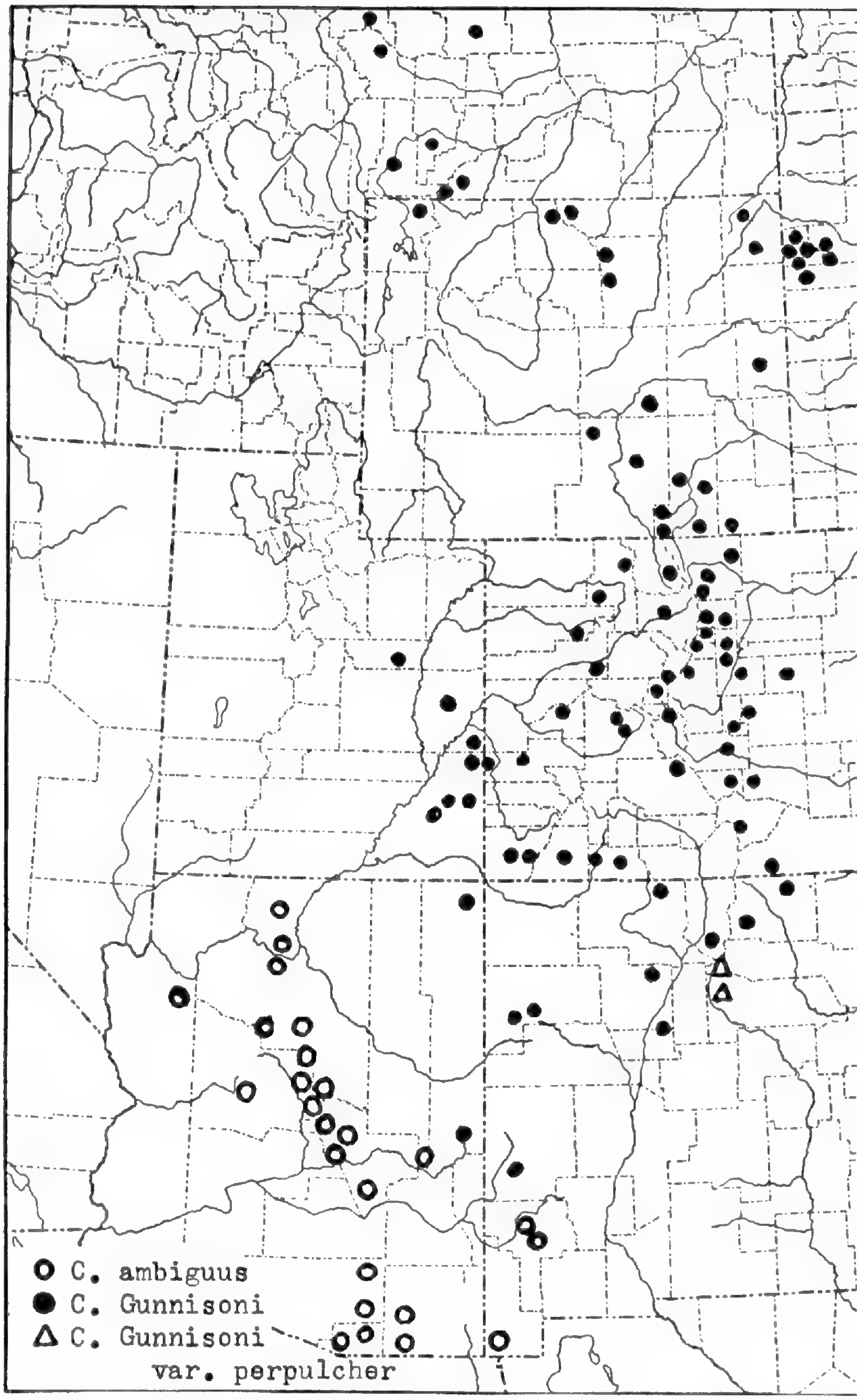
Inflorescences subumbellate; sepals usually shorter than the petals, lanceolate, acute to acuminate; petals obovate, cuneate, rounded and obtuse to abruptly short-acuminate, invested near the gland with distally branched, gland-tipped hairs; glands depressed, transversely more or less oblong, and densely covered with distally branched processes, the outermost of which are united at the base into a narrow, discontinuous membrane; anthers narrowly oblong to lanceolate, obtuse to apiculate; fruits linear-oblong, acute, 3-angled; seeds strongly flattened, with conspicuously inflated, hexagonally reticulate coats.

The GUNNISONIANI may be recognized by their transversely more or less oblong glands, narrow gland-membrane, and the distally branched, gland-tipped hairs on the face of the petals. The two species referred here are closely related. One has a Rocky Mountain distribution (Map 8), from western South Dakota to central Montana, and southward to New Mexico, westward to Utah and Arizona. The other is confined to the semi-desert regions of southwestern New Mexico and Arizona. Of these, *C. Gunnisoni,* the only one investigated, has a chromosome base number of nine.

41. Calochortus ambiguus (Jones) Ownbey, n. comb. and n. sp.[42]

[41] GUNNISONIANI subsect. nov., inflorescentiis subumbellatis; sepalis petalis plerumque brevioribus lanceolatis acutis vel acuminatis; petalis obovatis cuneatis rotundo-obtusis vel abrupte brevi-acuminatis, prope glandulam pilis apice ramosis glandulosisque; glandulis depressis transverse plus minusve oblongis, processis apice ramosis dense vestitis, processis extremis in membranam angustam interruptam basilariter coalitis; antheris anguste oblongis vel lanceolatis obtusis vel acutis vel apiculatis; capsulis lineari-oblongis acutis triangulatis; seminibus valde complanatis, testis insigniter inflatis hexagono-reticulatis.

[42] **Calochortus ambiguus** sp. nov., bulbo ovoideo membranaceo-tunicato; caule erecto plerumque simplici saepe bulbifero; foliis linearibus attenuatis superioribus reductis; inflorescentia 1–4-flora subumbellata; floribus erectis campanulatis roseolis aut caesiis, interdum prope basem sepalorum petalorumque obscure purpureis; sepalis petalis brevioribus lanceolatis acuminatis glabris; petalis obovatis cuneatis abrupte acuminatis, prope glandulam pilis fulvis apice ampliatis aut ramosis glandulosis praeditis; glandula depressa circulari vel transverse lunata, membrana angusta late fimbriata circumdata, processis brevibus apice ramosis dense vestitis; antheris oblongo-lanceolatis obtusis aut acutis roseolis filamentis basilariter dilatatis longioribus; ovario lineari non alato, stigmate persistente trifido; capsula lineari-oblonga acuta triangulata erecta; seminibus complanatis, testis insigniter inflatis hexagono-reticulatis.



Map 8. Distribution of the species and variety of the subsection GUNNISONIANI.

Calochortus Watsoni var. *ambiguus* Jones, Contrib. West. Bot. No. 14, p. 27. 1912.

Bulb ovoid, with membranaceous coats; stem erect, usually unbranched, often bulbiferous; leaves linear, attenuate, reduced upward; inflorescence 1–4-flowered, subumbellate; flowers erect, campanulate, pinkish or bluish gray, sometimes marked with dull purple near the base of the sepals and petals; sepals shorter than the petals, lanceolate, acuminate, glabrous; petals obovate, cuneate, abruptly acuminate, invested near the gland with yellowish, distally enlarged or branched, gland-tipped hairs; gland depressed, circular to transversely lunate, surrounded with a narrow, deeply fringed membrane, and densely covered with short, distally branched processes; anthers oblong-lanceolate, obtuse or acute, pinkish, longer than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-oblong, acute, 3-angled, erect; seeds flattened, with conspicuously inflated, hexagonally netted coats.

This species is most closely allied to *C. Gunnisoni,* from which it differs in its shorter gland and usually obtuse anthers. It is more likely to be confused with certain phases of *C. Nuttallii,* but the gland-tipped hairs on the petals and the fungoid gland-processes readily distinguish it.

Distribution. In dry soil, southwestern New Mexico, northwestward across Arizona to the region of the Grand Canyon.

New Mexico. grant co.: Silver City, 1911, *Beard* (M); Silver City, May 4, 1919, *Eastwood 8416* (CA, G); Gila River, near Silver City, May 4, 1930, *Jones 25930* (M, P); Mangas Springs, 18 mi. n. w. of Silver City, 1455 m. alt., May 9, 1903, *Metcalfe 55* (D, G, M, NY, P, RM, UC). hidalgo co.: dry, rocky places, San Luis Mts., Canyon of Guadaloupe, April 25, *Smith* (NY).

Arizona. cochise co.: Dragoon Mts., June, 1899, *Eby* (M); high mountains, Lowell, May 14, 1884, *Parish 252* (G). navajo co.: Fort Apache, May, 1893, *Hoyt* (NY); Fort Apache, 1903, *Mayerhoff 112* (F). gila co.: 2 mi. n. w. of Pine, May 19, 1937, *Cutler 1108* (M); on road to Amethyst Mine, Mazatzal Mts., Apache Trail Region, May 11, 1929, *Eastwood 17087* (CA, F, NY); Sierra Ancha, Apache Trail Region, May 17, 1929, *Eastwood 17304* (CA); same locality, May 27, 1929, *Eastwood 17549* (CA); Pinal, May 26, 1890, *Jones* (P); Apache Trail, near Roosevelt, May 5, 1929, *McKelvey* (CA); near Pine, where road turns off to Natural Bridge, May 11, 1931, *McKelvey 2150* (G). pima co.: between Sonoita and Vail, May 4, 1931, *McKelvey 2107* (G, P); foothills, Santa Catalina Mts., April 26, 1930, *Peebles 6864* (NY); Tucson to Redington, 1140 m. alt., April 27, 1935, *Peebles 11323* (P); Santa Catalina Mts., May 11, 1883, *Pringle* (F, G, NY, PA); Santa Rita Mts., 1500 m. alt., May 17, 1884, *Pringle* (F, PA). SANTA CRUZ CO.: Ruby, 1260 m. alt., May 4, 1935, *Peebles & Fulton 11436* (F); near Sonoita, May 6, 1930, *Peebles & Harrison 7073A* (CA). COCONINO CO.: Grand View, Grand Canyon of the Colorado River, June 17, 1916, *Eastwood 5791* (CA); on plateau above Oak Creek Canyon, 17 mi. s. of Flagstaff, 2100 m. alt., June 14, 1927, *Goddard 559* (UC); Cape Royal, Kaibab Forest, near rim of Grand Canyon, 2400 m. alt., July 17, 1930, *Goodman & Hitchcock 1650* (CA, D, M, NY, PA, UC, UM); rocky hillside, Flagstaff, 2100 m. alt., June 29, 1922, *Hanson A22A* (F, M, NY); Jacobs Pool, Kaibab Forest, July, 1926, *Jaeger* (P); Flagstaff, Aug. 5, 1884, *Jones* (D, NY, P TYPE); Flagstaff, Aug. 7, 1884, *Jones 48* (G); San Francisco Mts., June 4, 1890, *Jones* (P); Bright Angel, Grand Canyon, July 22, 1920, *Jones* (P); Grand Canyon, July 9, 1925, *Jones* (P); Williams, June 14, 1929, *Jones* (P); Williams, June 15, 1930, *Jones 25183* (D, M, P, UM); Toll Road, San Francisco Mts., 2400–2700 m. alt., July 28, 1935, *Kearney & Peebles 12182* (NY); Grand Canyon of the Colorado, 2100 m. alt., June 26, 1898, *MacDougal 164* (F, G, NY, PA, RM, UC); woods, Kaibab Plateau, n. of Jacob Lake, July 14, 1929, *Mathias 662* (M); Baker Butte, Mogollon Mts., July 31, 1887, *Mearns 108* (NY); plains, near Flagstaff, May–Oct., 1900, *Purpus 8017* (UC). YAVAPAI CO.: Fort Whipple, 1865, *Coues & Palmer* (M); Prescott, May 22, 1919, *Eastwood 8837* (CA); Fort Verde, Aug., 1887, *Mearns* (NY); Ashfork, May, 1883, *Rusby* (F, NY, PA); 2 mi. n. w. of Prescott, 1500 m. alt., April 25, 1934, *Stone 91* (NY); Prescott, via Juniper, to Seligman, 15 mi. n. w. of Prescott, 1650 m. alt., April 26, 1934, *Stone 93* (NY). MARICOPA CO.: near Ashdale, 1230 m. alt., May 18, 1935, *Peebles 11638* (NY). MOHAVE CO.: Peach Springs, July, 1884, *Lemmon & Lemmon* (UC).

42. Calochortus Gunnisoni Watson, Bot. U. S. Geol. Expl. 40th Par. [Bot. King's Exped.] p. 348. 1871.

Calochortus venustus var. ? Torrey & Gray in Rept. U. S. Pac. R. R. Surv. **2** [Bot. Beckwith's Rept. p. 130]. 1855.

Calochortus Gunnisoni var. *Kreglagi* Regel in Gartenflora **23**: 129, *t. 793*. 1874.

Calochortus Gunnisoni var. *maculatus* Cockerell in West. Am. Sci. **5**: 17. 1888 (misprinted *imaculatus*); **6**: 135. 1889.

Calochortus Gunnisoni var. *immaculatus* Cockerell, *l. c.* **5**: 17. 1888.

Calochortus Gunnisoni var. *purus* Cockerell, *l. c.*

Bulb ovoid, with membranaceous coats; stem erect, unbranched, rarely bulbiferous; leaves linear, reduced upward; inflorescence 1–3-flowered, subumbellate; flowers erect, campanulate, white to purple, greenish within, often with a narrow, transverse, purple band on each petal above the gland and a purple spot on the claw, sepals similarly marked; sepals usually much shorter than the petals, lanceolate, acute, glabrous; petals obovate, cuneate, usually obtuse and rounded above, densely bearded about the gland with distally branched, gland-tipped hairs; gland depressed, transversely oblong, more or less arched, densely covered with distally branched processes, the outermost of which are somewhat united at the base to form a discontinuous membrane; anthers lanceolate, acute to apiculate, longer than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-oblong, acute, 3-angled, erect; seeds flattened, with conspicuously inflated, hexagonally netted coats.

The longer gland and acute anthers separate this species from *C. ambiguus,* the only species to which it is closely allied.

DISTRIBUTION. Hills and mountains, western South Dakota to central Montana, southward through Wyoming, Colorado, eastern Utah and northeastern Arizona to central New Mexico.

SOUTH DAKOTA. MEADE CO.: open limestone slopes, Tilford, July 9, 1924, *McIntosh 464* (RM); Piedmont, July, 1895, *Pratt* (P, WS). LAWRENCE CO.: Black Hills, near Spearfish, 1200 m. alt., July 23, 1924, *Ballow* (D); meadow and open woods, yellow pine association, Limestone District, Crooks Tower, Black Hills, Aug. 5, 1927, *Hayward 2745* (F, RM); old open burn, limestone, rim of Spearfish Canyon, near Savoy, 1680 m. alt., June 29, 1910, *Murdoch 4182* (D, F, G); Whitewood, 1350 m. alt., July 7, 1892, *Rydberg 1046* (G, NY). PENNINGTON CO.: open grassland, Reynolds Prairie, 3 mi. n. e. of Deerfield, July 23, 1927, *Hayward 2341* (F, RM).

MONTANA. FERGUS CO.: near Judith Mts., Aug., 1860, *Hayden* (M). SWEET GRASS CO.: Greycliff, 1200 m. alt., June, 1913, *Marsh 9870* (G, NY). CARBON CO.: Red Lodge, July 10, 1905, *Draper* (UC); Rock Creek Canyon, Beartooth Mts., Custer National Forest, 1800 m. alt., July 27, 1937, *Williams & Williams 3726* (G, M, NY). CASCADE CO.: Belt Mts., July 22, 1886, *Anderson 404* (UM); 5 mi. from Barker, Little Belt Mts., 1800 m. alt., Aug. 17, 1896, *Flodman 348* (M, NY). MEAGHER CO.: rocky soil, in old burn, Nevada Creek, S. 13, T. 10 N., R. 11 E., Jefferson National Forest, 1560 m. alt., Aug. 25, 1927, *Park 57* (UM). PARK CO.: Livingston, 1901, *Scheuber 244* (NY).

WYOMING. CROOK CO.: foothills, Inyan Kara Creek, Black Hills, 1927, *Hayward 2112* (F); sandy soil under pines, 7 mi. n. w. of Hulett, July 13, 1938, *Ownbey 481* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS). NIOBRARA CO.: along creek, Hat Creek, June 30, 1938, *Cutler 2467* (O). LARAMIE CO.: Granite Canyon, July 31, 1930, *Fuller* (M). ALBANY CO.: Laramie Hills, July, 1892, *Buffum* (RM); hillside, Laramie-Fort Collins Highway, near State Line, July 17, 1937, *Detling 2310* (UO); Chimney Rock, Sand Creek, July 29, 1929, *Greenman & Greenman 6044* (M); University of Wyoming Summer Camp, Medicine Bow Mts., 2880 m. alt., Aug. 1, 1929, *Greenman & Greenman 6077* (M); moist, grassy gulch or slope, Rock River, 2100 m. alt., July 19, 1914, *Macbride 2836* (RM); Sybille Hills, July 8, 1894, *Nelson 319* (G, RM); Cummins, July 27, 1895, *Nelson 1451* (M, NY, RM); moist meadows, South Sybille, July 3, 1900, *Nelson 7389* (G, M, NY, P, RM, UO); among the underbrush, wet bottoms, Centennial, July 26, 1900, *Nelson 7685* (Clokey, D, RM); dry gulch, west slope of Sheep Mt., July 3, 1934, *Ownbey 217* (O); near the edges of moist thickets and meadows, Medicine Bow Range, 3300 m. alt., July, 1936, *Sella* (F). SHERIDAN CO.: open slope, near South Fork Inn, Big Horn National Forest, July 17, 1933, *Benner 5036* (PA); headwaters of Tongue River, Big Horn Mts., July, 1898, *Tweedy 61, 62, 63* (NY); Big Horn, 1800 m. alt., July, 1899, *Tweedy 2559* (NY). BIG HORN CO.: dry south slope of Medicine Mt., Big Horn Mts., 2550 m. alt., July 6, 1936, *Williams & Williams 3257* (G, M, NY, WS). JOHNSON CO.: creek bottoms, Cañon Creek, July 27, 1901, *Goodding 405* (G, M, NY, RM); eastern slope of the Big Horn Mts., headwaters of Clear Creek and Crazy Woman River, 2100–2700 m. alt., July 20–Aug. 15, 1900, *Tweedy 3515* (NY, RM). NATRONA CO.: Casper, July 13, 1893, *Evermann* (D). CARBON CO.: Freezeout Hills, July 10, 1898, *Nelson 4500* (P, RM); Indian Grove Mts., July 17, 1898, *Nelson 4897* (RM). YELLOWSTONE NATIONAL PARK: Soda Butte, Aug. 22, 1922, *Hawkins 937* (UCLA); open woods, Elk Fork, 2100 m. alt., Aug. 15, 1928, *Smith 158* (WS).

COLORADO. LARIMER CO.: Longs Peak Inn, Estes Park, 2850 m. alt., Aug. 11, 1933, *Allen 136* (M); arid plains, 10 mi. n. of Fort Collins, June 21, 1933, *Applegate 8626* (D); Estes Park, 2400 m. alt., Aug., 1933, *Burton* (M); at the "Forks," Thompson River, Estes Park, July 11, 1912, *Churchill* (G); Estes Park, 1904, *Cooper 279* (RM); hillsides, foothills, 1950 m. alt., June 17, 1895, *Cowen* (WS); Horsetooth Gulch, July 15, 1897, *Crandall 2474* (RM, UC); above the Brinwood, Rocky Mt. National Park, Aug. 2, 1933, *Nelson & Nelson 876* (D, M, RM); Horsetooth, July 16, 1895, *Osterhout 837* (RM); grassy slope, 3 mi. n. of Estes Park, Rocky Mt. National Park, 2550 m. alt., Aug. 4, 1937, *Rollins 1883* (O); slopes of Deer Mt., Aug. 13, 1927, *Woodson 1836* (M). BOULDER CO.: dry soil, Eldorado Springs, 1590 m. alt., June 24, 1917, *Clokey 2763* (Clokey, NY); mesa fronting Flagstaff Hill, Boulder, 1710 m. alt., June 18, 1906, *Daniels 53* (M); mesa slopes, Boulder, 1680 m. alt., June 23, 1921, *Hanson C323* (M); Sugar Loaf Mt., July 21, 1906, *Robbins 2210* (RM); Eldora, July 27, 1906, *Robbins 2322* (RM); Boulder, June 23, 1913, *Vestal* (D, M). JEFFERSON CO: vicinity of Conifer, 1950 m. alt., July, 1934, *Cletus 245* (F); mountain top, Lookout Mt., 2190 m. alt., July 25, 1917, *Clokey 2864* (CA, Clokey, F, RM, UC); near Mt. Morrison, 1830 m. alt., June 24, 1937, *Constance & Rollins 1919* (M, O, UC, WS); Morrison, *Eastwood* (UC); foothills, near Golden, June 20, 1878, *Jones 249* (P); Morrison, June 24, 1913, *Jones* (PA); South Table Mt., Golden, June 17, 1896, *Knowlton 81* (G); Morrison, June 19, 1881, *Smith* (PA); Morrison, June 18, 1891, *Smith* (M). GILPIN CO.: open aspen woods, Tolland, 2730 m. alt., Aug. 2, 1919, *Munz 2991* (P); Eldora to Baltimore, 2550–2850 m. alt., June 20–July 10, 1903, *Tweedy 5510* (NY, RM). CLEAR CREEK CO.: meadows, near Empire City, July 17, 1881, *Engelmann* (M); dry mountain sides, vicinity of Georgetown, June 28–Aug. 7, 1875, *Patterson* (F); vicinity of Georgetown, July 11–Aug. 11, 1876, *Patterson* (F). PARK CO.: Como, South Park, 2932 m. alt., Aug. 3, 1895, *Cowen* (NY); mountains, South Park, July 26, Aug. 7, 1892, *Hughes 64* (G). ELBERT CO.: grassy park, 12 mi. e. of Kiowa, June 22, 1937, *Ownbey 1294* (M, O). DOUGLAS CO.: 5 mi. w. of Sedalia, 1800 m. alt., June 23, 1937, *Snyder & Beetle 52* (RM).

EL PASO CO.: Colorado Springs, June 29, 1926, *Benke 4195* (CA, F); Ruxton Creek, region of Pikes Peak, 2850 m. alt., Aug. 3, 1912, *Brumback & Davies 22* (F); Dark Canyon, 2900 m. alt., July 25, 1901, *Clements & Clements 204* (D, G, NY, RM); Ruxton Dell, 2950 m. alt., July 27, 1901, *Clements & Clements 347* (D, G, M, NY, RM); grassy clearing in the brush, Manitou end of Ute Pass Trail, Pikes Peak Region, 2055 m. alt., July 27, 1920, *Johnston 2399* (UC); moist soil along creek, Pikes Peak Auto Highway, 2700 m. alt., Aug. 10, 1935, *Ownbey 939* (O, RM); Colorado Springs, July 16, 1872, *Porter* (PA); Pikes Peak, 1904–1906, *Schedin & Schedin 286* (RM); Ute Pass, Aug. 15, 1904, *Taylor* (PA); loam soil, Pikes Peak Road, 2700 m. alt., Aug. 11, 1935, *Williams 2475* (G, M, UC, WS); Colorado Springs, *Williamson* (PA). TELLER CO.: Cripple Creek, July, *Schedin & Schedin 264* (RM). FREMONT CO.: Cañon City, 1620 m. alt., June, 1877, *Brandegee* (UC). CUSTER CO.: Wet Mt. Valley, July 24, 1872, *Redfield* (M). PUEBLO CO.: Beulah, Aug., 1887, *Reed* (F). HUERFANO CO.: Veta Pass, 2400–2700 m. alt., July 3, 1900, *Rydberg & Vreeland 6434* (NY, RM); meadow, La Veta, July 14, 1896, *Shear 3560* (NY, RM); La Veta, July 14, 1896, *Shear 3641* (NY). LAS ANIMAS CO.: Trinidad, 1800–2100 m. alt., Aug., 1912, *Beckwith* (CA); steep slope among oak brush, 1 mi. s. of Morley, Trinidad to Raton, 2250 m. alt., July 4, 1937, *Rollins 1813* (G); dry hillside, north slope of Raton Mesa, near the head of San Francisco Canyon, 2400 m. alt., July 11, 1937, *Rollins 1853* (NY, O). JACKSON CO.: dry table-land, North Park, near Teller, 2400 m. alt., Aug. 4, 1884, *Sheldon 25* (F, NY, PA, UC). GRAND CO.: near Hot Sulphur Springs, Middle Park, 2280 m. alt., Aug. 3–8, 1907, *Ramaley & Robbins 3564* (RM, UC). LAKE CO.: Leadville, 1889, *Bailey* (UCLA); dry hillside near the Arkansas River, 1 mi. s. of Fremont Pass, Leadville to Dillon, 3300 m. alt., July 15, 1936, *Rollins 1393* (G, NY); near Leadville, Aug., *Schedin & Schedin 265* (RM); near Leadville, *Schedin & Schedin 285* (RM); Leadville, July 9, 1886, ex herb. *Trelease* (M). CHAFFEE CO.: Buena Vista, 2250 m. alt., July, 1886, ex herb. *Harper* (UC); Clear Creek, July 13, 1889, *Keller* (PA); gravelly slope, Buena Vista, 2460 m. alt., July 13, 1892, *Sheldon* (Clokey). GUNNISON CO.: Jacks Cabin, region of the Gunnison Watershed, 2484 m. alt., July 26, 1901, *Baker 609* (G, NY, P); Crested Butte, *Eastwood* (UC). SAGUACHE CO.: Steele Canyon, Villa Grove, July 23, 1896, *Shear 5107* (NY). ARCHULETA CO.: Piedra, July 9, 1899, *Baker 252* (F, G, M, NY, P, RM); Pagosa Springs, 2100 m. alt., July 18, 1893, *Smith* (PA). ROUTT CO.: Steamboat Springs, July, 1891, *Eastwood* (D, UC); mesa, Williams Fork, July 24, 1903, *Sturgis* (G). RIO BLANCO CO.: North Elk Canyon, July 28, 1902, *Sturgis* (CA, G, NY). GARFIELD CO.: Glenwood Springs, July 1, 1895, *Osterhout 838* (RM). DELTA CO.: hills, Surface Creek, Grand Mesa, 2520 m. alt., June, 1892, *Purpus 60* (F). MONTROSE CO.: open aspen grove, Tabeguache Basin, 2400 m. alt., July 29, 1914, *Payson 546* (F, G, M, RM); dry foothills, Paradox, 1950 m. alt., July 10, 1912, *Walker 213* (G, RM). LA PLATA CO.: Florida River, 7 mi. n. of Florida, July 29, 1933, *Alexander 151* (UC). MONTEZUMA CO.: sage plains, Mancos, June 22–July 8, 1898, *Baker, Earle & Tracy 1125, in part* (F, M, NY, P); entrance to Mesa Verde National Park, 2100 m. alt., June 29, 1930, *Goodman & Hitchcock 1355* (CA, D, M, NY, PA, UC, UM); Mesa Verde National Park, June 29, 1935, *Zobel* (M).

NEW MEXICO. COLFAX CO.: low uplands, vicinity of Raton, 1980 m. alt., July, 1895, *St. John 25* (G); Cimarron Canyon, July 8, 1937, *Schwarz & Talley* (M). TAOS CO.: more than a mile above the recreation area, La Junta Canyon, July 22, 1936, *Marcelline 2146* (F). RIO ARRIBA CO.: 3 mi. n. of Chama, 2355 m. alt., July 24, 1928, *Wolf 2966* (CA, D, G). SANDOVAL CO.: vicinity of Sulphur Springs, 2500 m. alt., Aug. 17, 1926, *Arsène & Benedict 16459* (F); among bushes, Balsam Park, Sandia Mts., 2460 m. alt., July, Aug., 1914, *Ellis 238* (M, NY). MCKINLEY CO.: Gallup to Zuñi, July 19, 1932, *Hawver* (CA); Fort Wingate, 2100 m. alt., July, 1874, *Rothrock 148* (F). CATRON CO.: Mogollon Mts., near the West Fork of the Gila River, 2550 m. alt., Aug. 14, 1903, *Metcalfe 494* (D, G, M, NY, P, RM, UC).

UTAH. CARBON CO.: Sunnyside, 2100 m. alt., 1905, *Jones* (P). GRAND CO.: ridge w. of head of Post Canyon, Book Cliffs, 2400 m. alt., July 27, 1935, *Graham 9832* (F, G, M); slopes, La Sal Mts., 3150 m. alt., July 31, 1924, *Payson & Payson 4085* (RM). SAN JUAN CO.: vicinity of La Sal Ranger Station, La Sal Mts., 2100 m. alt., July 2, 1932, *Maguire & Redd 1705* (M); western slope of La Sal Mts., 2200–3000 m. alt., July 6, 1911, *Rydberg & Garrett 8603* (NY); meadow, s. of Monticello, 2100 m. alt., July 24, 1911, *Rydberg & Garrett 9145* (NY); south side of Abajo Mts., 2000–2500 m. alt., July 28, 29, 1911, *Rydberg & Garrett 9239* (NY); Hammond Canyon, Elk Mts., 1800 m. alt., Aug. 10, 1911, *Rydberg & Garrett 9580* (NY). COUNTY NOT DETERMINED: without locality, Gunnison's Expedition (NY TYPE).

ARIZONA. APACHE CO.: Keet Seel Canyon, Navajo Reservation, 1950–2250 m. alt., June 17, 1933, *Darsie* (UCLA); 12 mi. e. of Big Lake, Apache National Forest, Aug. 2, 1938, *Hitchcock, Rethke & Van Raadshooven 4493* (O, WS).

42a. Calochortus Gunnisoni var. **perpulcher** Cockerell in Bot. Gaz. **29**: 281. 1900.

Petals pale yellow; otherwise as in the species.

Hardly more than a color form, but locally constant, and easily recognized.

DISTRIBUTION. New Mexico: in the mountains of western Mora and San Miguel counties.

NEW MEXICO. MORA CO.: Horsethief Meadow, Santa Fe Forest, 3000 m. alt., Aug. 15, 1923, *Eggleston 19032* (NY). SAN MIGUEL CO.: Hermits Peak, Aug., *Snow* (UC); Round Mt., Pecos River National Forest, 2700 m. alt., July 11 1908, *Standley 4268* (M, NY, RM). COUNTY NOT DETERMINED: Pecos River Forest Reserve, July 19, 1898, *Coghill 78* (M).

Section III. CYCLOBOTHRA

CYCLOBOTHRA [D. Don in] Sweet, Brit. Fl. Gard. **3**: *t. 273.* 1828, as genus; Baker in Journ. Linn. Soc. Lond. **14**: 307. 1874; Painter in Contrib. U. S. Nat. Herb. **13**: 343. 1911, as subgenus; Baker ex Watson in Proc. Am. Acad. **14**: 267. 1879, as section.

Bulbs ovoid, with fibrous-reticulate coats; stems usually branched, often bulbiferous in the axils of the upper leaves and bracts; basal leaves usually conspicuous, the cauline ones lanceolate to linear, successively reduced upward; inflorescences usually 2-flowered, the flowers narrowly to broadly campanulate, erect or nodding; sepals obovate to narrowly lanceolate, obtuse to attenuate, glabrous to sparsely hairy, sometimes with a gland like those on the petals; petals spatulate to broadly obovate, obtuse or acute, usually more or less conspicuously bearded on the inner face; glands oblong to circular, occasionally absent or represented by only a glandular blotch, surface naked or nearly so, rarely depressed; anthers oblong to lanceolate, obtuse to short-apiculate; ovaries linear, not winged, tapering to a persistent, trifid stigma; fruits lanceolate to linear, 3-angled, erect or nodding; seeds irregular or flattened, usually with minutely reticulate coats. (Spp. 43–57).

Type Species: **Calochortus barbatus** (HBK.) Painter.

The section Cyclobothra includes those species with fibrous-reticulate bulb-coats and elongate, 3-angled capsules. The glands are usually entirely naked, and are never as densely covered with processes as in the other two sections. The basal leaves are conspicuous, but usually not so much so as those of the section Eucalochortus. Nine is the haploid number of chromosomes in *C. Plummerae,* the only species which has been cytologically investigated.

The species of the section Cyclobothra are quite different in their morphology, and are easily separated into four, well-marked subsections. From both geographical and morphological evidence, these seem to represent four separate lines of development within the section. One of these, the weediani, closely resembles the section Mariposa in habit, particularly in its large, erect flowers. Another, the purpurei, shows a striking superficial resemblance to the genus *Fritillaria,* as do also the barbati, to a lesser degree.

In distribution, the section is entirely southern. Three of the species, comprising the subsection weediani, are confined to southern California and northern Lower California. The remainder are found from southern Chihuahua southward to Guatemala, entirely south of any other species of the genus. From this evidence, it would seem that there have been two centers of development and dispersal within the section Cyclo-

- Subsection 9. WEEDIANI
  - C. Plummerae
  - C. Weedii var. intermedius
  - C. Weedii var. peninsularis
  - C. Weedii
  - C. Weedii var. vestus
  - C. obispoensis
- Subsection 10. GHIESBREGHTIANI
  - C. venustulus
  - C. exilis
  - C. Hintoni
  - C. Ghiesbreghtii
- Subsection 11. BARBATI
  - C. barbatus
  - C. fuscus
  - C. Pringlei
  - C. nigrescens
- Subsection 12. PURPUREI
  - C. cernuus
  - C. purpureus
  - C. Hartwegi
  - C. foliosus

Fig. 3. Diagram showing morphological relationships of the subsections, species and varieties of the section CYCLOBOTHRA.

BOTHRA, the first in southern California, and the second on the Mexican Plateau. It is probable that the section originated in one of these areas and that the other represents an early migration, but there is little evidence on this point.

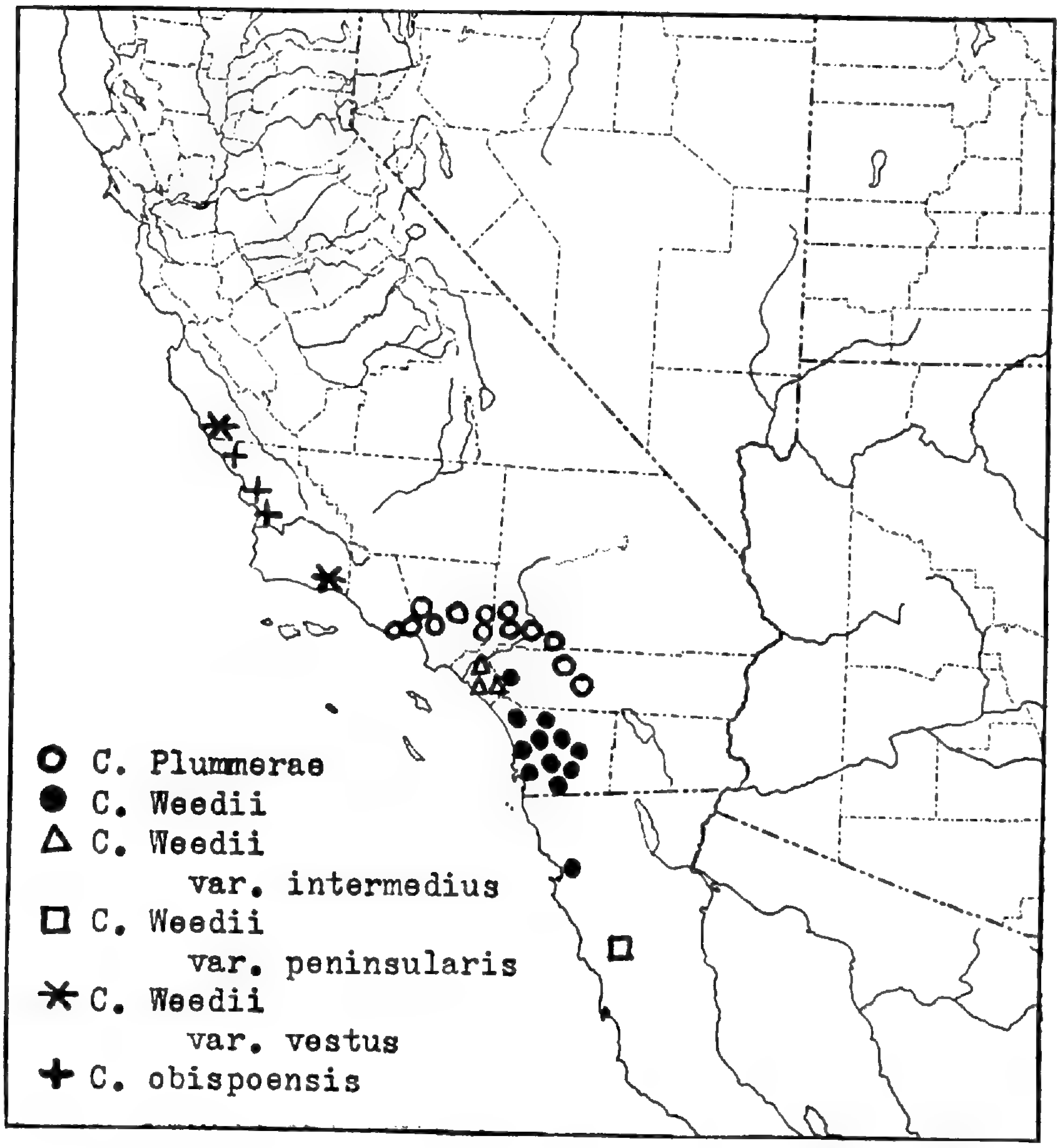
Subsection 9. WEEDIANI.[43]

Stems slender, tall, usually branched, not bulbiferous; flowers erect; petals conspicuously bearded; glands slightly depressed, surrounded by a dense ring of more or less united, hair-like processes; fruits linear, 3-angled, erect.

The WEEDIANI are distinguished by their erect flowers, densely bearded petals, characteristic glands and non bulbiferous stems. The three species referred here form an alliance somewhat apart from the remainder of the section CYCLOBOTHRA on both morphological and geographical grounds. Superficially, two of the species, *C. Weedii* and *C. Plummerae*, resemble the section MARIPOSA, with which they have been

[43] WEEDIANI subsect. nov., caulibus gracilibus altis plerumque ramosis non bulbiferis; floribus erectis; petalis insigniter barbatis; glandulis subdepressis, annulo denso processorum filiformium plus minusve coalitorum circumdatis; capsulis linearibus triangulatis erectis.

placed, but their natural affinities are entirely with the section CYCLOBOTHRA. The third species, *C. obispoensis,* although closely related, is quite unlike any other species of the genus. This subsection is limited in its distribution to southern California and northern Lower California (Map 9).



Map 9. Distribution of the species and varieties of the subsection WEEDIANI.

43. Calochortus Plummerae Greene, Pittonia **2**: 70. 1890.

Calochortus Weedii var. *purpurascens* Watson in Proc. Am. Acad. **14**: 265. 1879, in part.

Calochortus Weedii var. *albus* Hort. acc. Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 133. 1901, as synonym.

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender, tall, usually branched, not bulbiferous; basal leaf broad and long, usually withering before anthesis; cauline leaves linear, attenuate, becoming involute, reduced upward; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers broadly campanulate, erect, the petals pale pink to deep rose-colored, drying purplish; sepals equalling or exceeding the petals, narrowly lanceolate, acuminate, glabrous or with a few hairs near the base; petals broadly obovate, cuneate, usually rounded and erose-dentate above, very rarely at all fimbriate, conspicuously bearded with long, yellow hairs in a broad band across the middle, glabrous distally or nearly so; gland circular, slightly depressed, nearly naked, bordered with a dense ring of long, hair-like processes which are usually more or less united at the base into fascicles; anthers very large, narrowly lanceolate, acute to short-apiculate, as long as or longer than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, acute, 3-angled, erect; seeds strongly flattened, with minutely reticulate coats.

Calochortus Plummerae is closely allied to *C. Weedii*, but is easily recognized by its pinkish or rose-colored petals, which are not bearded to the apex and are only very rarely fimbriate.

DISTRIBUTION. California: on dry, rocky slopes, mountains of Los Angeles, San Bernardino and Riverside counties.

CALIFORNIA. LOS ANGELES CO.: Lone Pine Canyon, desert slopes of the San Gabriel Mts., 1050 m. alt., July 5, 1908, *Abrams & McGregor 681* (D, NY); mountains, near Newhall, June 25, 1897, *Barber 176* (UC); hills, near Sherman, June 5, 1901, *Braunton 131* (D); brushy ridge, Mandeville Canyon, Santa Monica Mts., 350 m. alt., June, 1929, *Clokey & Templeton 4579* (Clokey, F, G, M, NY, P, RM, UC, UM); Garvanza, May 27–June 10, 1906, *Eastwood 58* (CA); Claremont, June 15, 1928, *Eastwood 15408* (CA, UC); Pasadena, June 17, 1904, *Grant 126* (F, PA, RM); head of Long Canyon, San Gabriel Mts., 1275 m. alt., June 20, 1910, *Grinnell* (D); Live Oak Canyon, Claremont, 360 m. alt., June 10, 1897, *Hill 10342* (P); Claremont, June 2, 1926, *Jones* (CA, D, NY); dry hillside, in chaparral, Verdugo Canyon, near Los Angeles, June 22, 1915, *Macbride & Payson 762* (G, RM); Base Line Road, Claremont, June 10, 1919, *Munz 3274* (P); rocky hillside, mouth of Los Alisos Canyon, Santa Monica Mts., June 27, 1938, *Ownbey & Ownbey 1666* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); trail between Camp Coldbrook and Pine Flats, San Gabriel Mts., July 11, 1930, *West, Sweet & Crow* (P). SAN BERNARDINO CO.: Yucaipa Valley, June 18, 1902, *Berry* (D); Cajon Pass, 1860–1861, *Cooper* (G, type of *C. Weedii* var. *purpurascens* Watson); Cajon Pass, San Gabriel Mts., May 16, 1931, *Epling, Dunn & Goen* (CA, D, F, M, NY, UCLA); Lower Mill Creek Canyon, San Bernardino Mts., June 10, 1897, *Hall 631* (UC); Cajon Pass, San Antonio Mts., 1050 m. alt., June 1–3, 1900, *Hall 1417* (UC), *1480* (D); in chaparral, City Creek Road, below "Inspiration Point," San Bernardino Mts., 1500 m. alt., July 10, 1927, *Howell 2770* (CA); Cajon Canyon, June, 1928, *Jones* (G, P, WS); dry, rocky soil, among shrubs, Cajon Canyon, San Bernardino Mts., June 30, 1938, *Ownbey & Ownbey 1681* (G, Kew, M, O, UC); vicinity of San Bernardino, 300–450 m. alt., May, 1895, *Parish* (NY); dry mesas, San Bernardino Valley, near San Bernardino, 300 m. alt., June 8, 1917, *Parish 11333* (UC); Forest Home, San Bernardino Mts., 1590 m. alt., July, 1928, *Van Dyke* (CA); Mill Creek, San Bernardino Mts., 900 m. alt., June, 1903, *Williamson* (PA). RIVERSIDE CO.: lower canyons and slopes, San Jacinto Mts., 600 m. alt., June 21, 1910, *Condit* (UC); canyon of the San Jacinto River, San Jacinto Mts., 750 m. alt., June, 1901, *Hall 2015* (UC); near Banning, June 20, 1926, *Jones* (CA, D, NY, P); head of Banning Canyon, July 16, 1915, *Seitz* (CA).

44. Calochortus Weedii Wood in Proc. Acad. Philad. [**20**]: 169. 1868.

Calochortus luteus var. *Weedii* Baker in Journ. Linn. Soc. Lond. Bot. **14**: 309. 1874.

Calochortus citrinus Baker in Bot. Mag. Ser. III. **31**: *t. 6200.* 1875.

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender, tall, usually branched, not bulbiferous; basal leaf broad and long, usually withering before anthesis; cauline leaves linear, attenuate, becoming involute, reduced upward; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers broadly campanulate, erect, the petals orange-yellow, minutely flecked and often margined with reddish brown; sepals equalling or exceeding the petals, narrowly lanceolate, attenuate, glabrous or with a few hairs near the base; petals broadly obovate, cuneate, usually rounded above, with the margin minutely dentate to conspicuously fimbriate, conspicuously bearded on the inner face nearly or quite to the apex with long, yellow hairs; gland circular, slightly depressed, nearly naked, bordered with a dense ring of long, hair-like processes which are often united at the base into a more or less continuous membrane; anthers very large, narrowly oblong-lanceolate, acute to short-acuminate, about as long as the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, acute, 3-angled, erect; seeds strongly flattened, with minutely reticulate coats.

Calochortus Weedii may be distinguished from *C. Plummerae,* its nearest ally, by its yellow flowers, usually fimbriate petals and different geographical range. It is very variable.

DISTRIBUTION. Dry, rocky hills, southern California, in western Riverside and San Diego counties, southward to northern Lower California.

CALIFORNIA. RIVERSIDE CO.: dry, sandy places, Temescal, June 9, 1895, *Hall* (UC); Santiago Peak Trail, Santa Ana Mts., May 30, 1931, *Howell 6586* (CA); dry slopes, trail from Glen Ivy to Santiago Peak, Santa Ana Mts., 900 m. alt., June 14, 1923, *Munz 7104* (P, UC). SAN DIEGO CO.: Mission Hills, San Diego, June 17, 1903, *Abrams 3752* (D, G, M, NY, PA); dry ridges, between Ramona and Ballena, June 19, 1903, *Abrams 3774* (D, G, M, NY, P, PA); Quince Street, between First and Front, San Diego, June 10–25, 1906, *Brandegee* (D, UC); Capitan School House, between Alpine and Lakeside, June 17, 1906, *Brandegee* (UC); hill, between Julian and Cuyamaca, July 17, 1906, *Brandegee & Stockton* (UC); Laguna Mts., June 20, 1904, *Brandegee* (UC); near Valley Center, 360 m. alt., July 5, 1904, *Chandler 5440* (NY, UC); dry soil, foothills, La Jolla, June 6, 1914, *Clements & Clements 282* (F, G, NY, PA); Descanso, June 24, 1919, *Eastwood 9071* (CA); Cuyamaca, June 25, 1919, *Eastwood 9140* (CA); Flinn Springs, June 19, 1932, *Epling, Darsie, Knox & Robison* (CA, D, F, P, RM, UC, UCLA); Torrey Pines Park, June 25, 1935, *Epling & Robison* (UCLA); sandstone outcrops, near the Torrey Pines, just s. of Del Mar, 30 m. alt., Aug. 6, 1927, *Howell 2950* (CA); Palomar, May 17–June 1, 1901, *Jepson & Hall* (UC); Rincon Grade, May 29, 1926, *Jones* (P); e. of Julian, May 30, 1926, *Jones* (CA, D); Santa Ysabel, June 11, 1932, *Jones* (P, UC); Escondido, June, 1927, *Meyer 221* (UC); in clearing in chaparral, on dry slope, Alpine, June 27, 1923, *Munz & Harwood 7147* (P); about rocks, 2 mi. s. e. of Santa Ysabel, June 29, 1923, *Munz & Harwood 7312* (NY, P); rocky soil, along Cottonwood Creek, 1 mi. n. w. of Buckman Springs, June 23, 1938, *Ownbey & Ownbey 1657* (CA, D, F, G, Kew, M, NY, O, P, PA, RM, UC); dry, brushy hills, 2 mi. s. w. of Rainbow, June 25, 1938, *Ownbey & Ownbey 1665* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); Cuyamaca Mts., July 12, 1875, *Palmer 378* (F, G, NY, PA, UC); Rainbow P. O., Coast Range, June 17, 1897, *Parish 4458* (G, M, NY); Moreno Grade, June 29, 1897, *Reed* (P); high hill, La Jolla, June 17, 1895, *Snyder* (F); edge of woods, Pine Hills, 1260 m. alt., June 25, 1920, *Spencer 1601, 1601A* (G, P); chaparral, 6 mi. w. of Henshaw Dam, Palomar Mts., June 14, 1928, *Wiggins 3113* (D, UC, UCLA); ¼ mi. n. of Old Spanish Lighthouse, Point Loma, 60 m. alt., May 26, 1931, *Wolf 2070* (D); ½ mi. above Cottonwood Creek, on the Potrero Grade, 360 m. alt., May 27, 1931, *Wolf 2137* (D, UC).

LOWER CALIFORNIA. Ensenada, June 4, 1893, *Brandegee* (UC).

44a. Calochortus Weedii var. **vestus** Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 133. 1901.

Calochortus Weedii var. *purpurascens* Watson in Proc. Am. Acad. **14**: 265. 1879, as to specimen from Santa Barbara.

Petals triangular-obovate, truncate, purplish, with a conspicuous, reddish brown fringe, densely bearded on the inner face with yellow or reddish brown hairs; anthers lanceolate, apiculate; otherwise quite similar to the species.

The original publication of *C. Weedii* var. *purpurascens* included two elements. The collection from Santa Barbara, which is mentioned first, is probably that of Torrey cited below, but since the description is entirely of the second element, the name cannot properly be applied to the present entity. This is a well-marked variant between *C. Weedii* and *C. obispoensis,* much nearer, however, to the former than to the latter.

DISTRIBUTION. California: on dry hillsides, Santa Lucia Mountains, Monterey County, and near Santa Barbara, Santa Barbara County.

CALIFORNIA. MONTEREY CO.: Santa Lucia Mts., Aug., 1885, ex herb. *Brandegee* (G). SANTA BARBARA CO.: Santa Barbara, Aug., 1902, *Elmer 3740* (D, M, P); near Santa Barbara, Aug., 1909, *Goodwin* (G); dry hillside, Franklin Canyon Trail, beyond Carpenteria, July 24, 1923, *Grant 1699* (G, P); 2 mi. w. of La Cumbre Peak, July, 1939, *James* (O); without exact locality, *Torrey 519* (G, M, NY).

44b. Calochortus Weedii var. **peninsularis** Ownbey, n. var.[44]

Petals pale yellow, not fringed, sparingly bearded below the middle; otherwise similar to the species.

This variety appears to be quite constant, and is probably more frequent than the two known collections would indicate.

DISTRIBUTION. Mexico: mountains of northern Lower California.

LOWER CALIFORNIA. Brushy, northwest slope, hills n. e. of Valle Redondo, May 30, 1932, *Fosberg 8387* (D, P); granitic soil on foothills of Sierra San Pedro Martin, in the vicinity of Rancho San Jose, 25 mi. e. of San Telmo, 780 m. alt., March 1, 1931, *Meling 10* (D, NY, P, US TYPE).

44c. Calochortus Weedii var. **intermedius** Ownbey, n. var.[45]

Dried petals lilac to purple, conspicuously fringed at the apex and bearded on the inner face with long, yellow hairs; otherwise as in the species.

Although clearly intermediate between *C. Plummerae* and

[44] **Calochortus Weedii** var. **peninsularis** var. nov., petalis pallide aureis non fimbriatis infra medium parce barbatis; aliter similis speciei.

[45] **Calochortus Weedii** var. **intermedius** var. nov., petalis siccatis lilaceis vel purpureis apice insigniter fimbriatis, facie interiore pilis longis flavis barbatis; aliter similis speciei.

C. Weedii, this variety does not seem to be of simple hybrid origin. In the first place, neither of the above species appears to occur in the immediate vicinity, and, in the second, it shows little tendency to segregate either yellow flowers or unfringed petals. The type collection is marked "variable," but the variation shown is hardly greater than that found in either *C. Plummerae* or *C. Weedii.*

DISTRIBUTION. California: hills and canyons, Orange County.

CALIFORNIA. ORANGE CO.: Trabuco Canyon, June, 1901, *Abrams 1802* (D, M, NY); hills back of Laguna Beach, June 29, 1938, *Copeland* (O); sandy soil on sandstone outcrop, hills on north side of Santa Ana Canyon, 240 m. alt., June 22, 1927, *Howell 2572* (CA TYPE, NY); dry, rocky slope, Claymine Canyon, Santa Ana Mts., 300 m. alt., July 3, 1927, *Howell 2636* (CA).

45. Calochortus obispoensis Lemmon in Bot. Gaz. **11**: 180. 1886.

Calochortus Weedii var. *obispoensis* Purdy in Proc. Calif. Acad. Ser. III. Bot. **2**: 133. 1901.

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender, erect, branched, not bulbiferous; basal leaf broad and long, usually withering before anthesis; cauline leaves linear, attenuate, becoming involute, reduced upward; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers small, erect, opening flat, with the sepals reflexed, petals orange, tipped with purplish brown; sepals greatly exceeding the petals, narrowly lanceolate, attenuate, glabrous; petals oblong, obtuse, fimbriate at the apex, conspicuously bearded with long, slender hairs; gland circular, slightly depressed, surrounded with a dense ring of slender, hair-like processes which are united at the base into a more or less continuous membrane; anthers oblong, obtuse or acute, about half as long as the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear, acute, 3-angled, erect; seeds flattened, with minutely reticulate coats.

Its greatly reduced, profusely bearded petals give *Calochortus obispoensis* a curious appearance quite unlike that of any other species of the genus. It is closely allied to *C. Weedii,* but this affinity is evident only after close examination.

DISTRIBUTION. California: dry hills and canyons, San Luis Obispo to Arroyo Grande, San Luis Obispo County.

CALIFORNIA. SAN LUIS OBISPO CO.: hills n. e. of San Luis Obispo, May 7, 1936, *Eastwood & Howell 2246* (CA); Serrano Canyon, June 14, 1938, *Eastwood & Howell 5942* (CA); dry, gravelly hillside, in chaparral, between San Luis Obispo and Pismo, 270 m. alt., June 3, 1928, *Hitchcock 5* (P); Steele's Ranch, 1885, *Lemmon* (UC); San Luis Obispo, June, 1886, *Lemmon* (G); Arroyo Grande, 1895, *Lowe* (UC); dry, rocky, clay soil, Reservoir Canyon, about 3 mi. n. e. of San Luis Obispo, July 4, 1938, *Ownbey & Ownbey 1692* (CA, Clokey, D, F, G, Kew, M, NY, O, P, PA, RM, UC, UCLA, UM, UO, US, WS); San Luis Obispo, 1915, *Reed* (G); Reservoir Canyon, June, 1930, *Rountree* (P); Reservoir Canyon, near San Luis Obispo, June 20, 1930, *Sinseheimer* (CA, F, G, M, P); Polytechnic Canyon, San Luis Obispo, May 28, 1934, *Sinseheimer* (NY); Santa Lucia Mts., June 8, 1882, *Summers 842* (UC); San Luis Obispo, 1886, *Summers* (G); Tunnel, San Luis Obispo, June 24, 1906, *Unangst* (UC).

Subsection 10. GHIESBREGHTIANI.[46]

Stems slender, simple or branched, flexuous, rarely bulbiferous in the axils of the upper leaves; flowers small, broadly campanulate, erect; petals obovate, cuneate, bearded near the base; glands present or absent; fruits linear, 3-angled, erect.

This subsection may be recognized by its small, erect flowers and inconspicuously bearded petals. Three of its four species, *C. venustulus, C. Hintoni* and *C. exilis,* are closely related; the fourth, *C. Ghiesbreghtii,* only remotely so. In the first three, the gland is obscure or lacking, while, in the last, there are glands on both petals and sepals. In this character and in the occasional presence of bulblets in the axils of the upper leaves, *C. Ghiesbreghtii* connects the subsection GHIESBREGHTIANI with the subsection BARBATI.

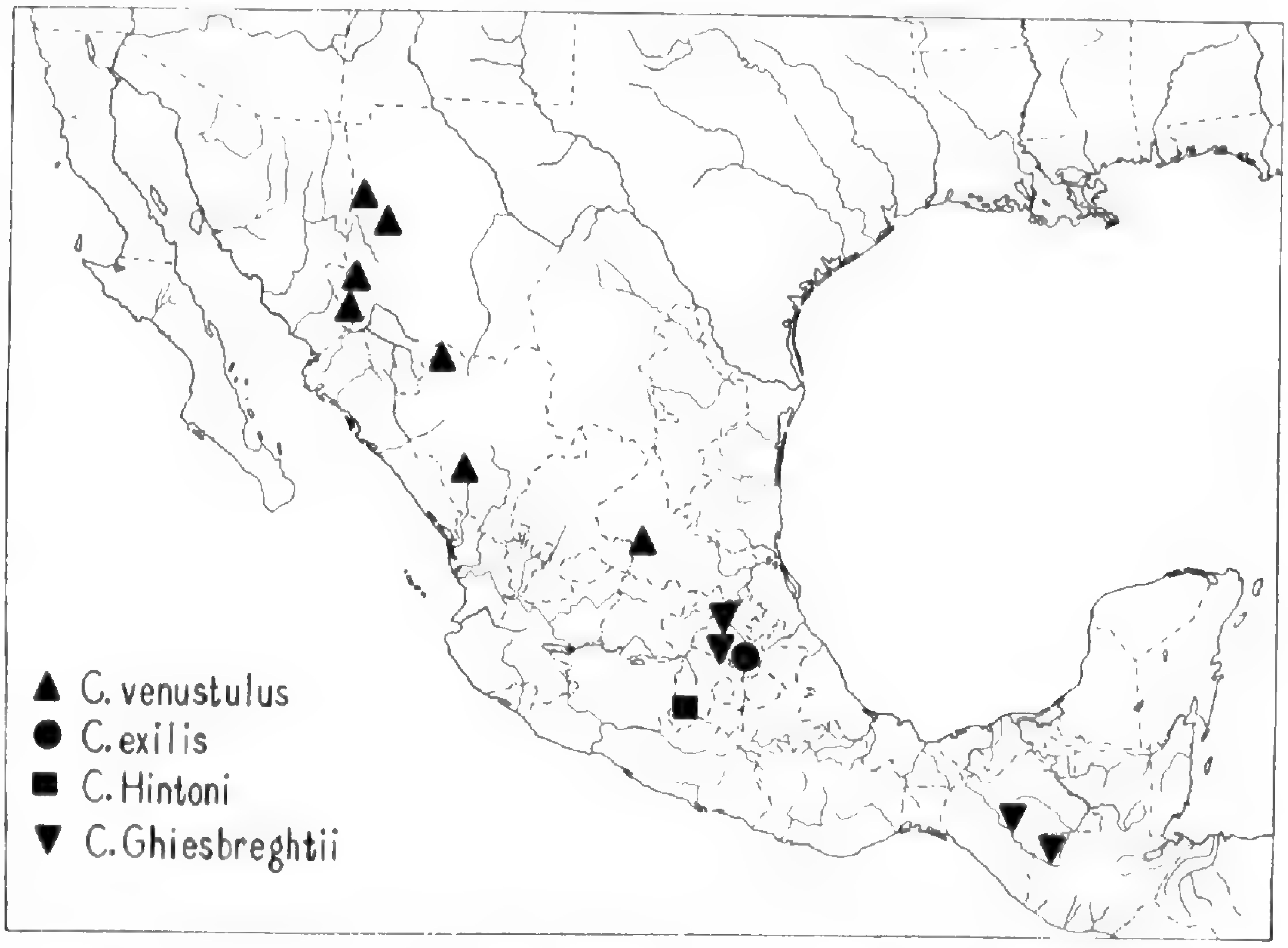
46. Calochortus venustulus Greene, Pittonia **1**: 158. Jan., 1888; *ibid.* 225.

Calochortus madrensis Watson in Proc. Am. Acad. **23**: 283. May, 1888.

Bulb ovoid, with fibrous-reticulate coats; stem slender, erect, flexuous, usually branched, not bulbiferous; basal leaf linear, acute to acuminate, about equalling the stem; cauline leaves

[46] GHIESBREGHTIANI subsect. nov., caulibus gracilibus simplicibus aut ramosis flexuosis raro in axillis foliorum superiorum bulbiferis; floribus parvis late campanulatis erectis; petalis obovatis cuneatis prope basem barbatis; glandulis aut praesentibus aut absentibus; capsulis linearibus triangulatis erectis.

linear, attenuate, reduced upward; inflorescences usually 2-flowered, the bracts similar to the uppermost leaf; flowers erect, broadly campanulate, clear yellow or with the sepals sometimes purplish; sepals equalling the petals, elliptic, acute or obtuse, glabrous except for a few short hairs near the base; petals obovate, cuneate, obtuse or acute, densely bearded near the base with short hairs; gland inconspicuous or absent; anthers linear-oblong, obtuse or acute, shorter than the basally dilated filaments; ovary linear, not winged, tapering to a per-



Map 10. Distribution of the species of the subsection GHIESBREGHTIANI.

sistent, trifid stigma; fruit linear-oblong, acute, 3-angled, erect; seeds irregular, with minutely reticulate coats.

Calochortus venustulus is closely allied to only *C. exilis* and *C. Hintoni.* From *C. exilis,* it is distinguished by its larger size, yellow flowers, longer capsules and proportionately shorter and broader basal leaf; from *C. Hintoni,* by its flower color and distribution.

DISTRIBUTION. Mexico: in the Sierra Madre of Chihuahua and Durango; also apparently in San Luis Potosi.

CHIHUAHUA. On dry rock ridge, Sierra Charuco, Rio Fuerte, Sept. 13, 1935, *Gentry 1819* (F, G, M, UC, US); rock shale, on the cold shoulder of the peak of

Cascaron, Los Cascarones, Rio Mayo, Sept. 11, 1936, *Gentry 2670* (F, G, UC, US); Soldier Canyon, Sierra Madre, 1800 m. alt., Sept. 16, 1903, *Jones* (D, M, P, US); Culebra Mts., Aug. 18, 1936, *LeSueur 577* (F); near Colonia Garcia, Sierra Madre, Aug., 1899, *Nelson 6108* (G, NY, US); pine plains, base of the Sierra Madre, Sept. 20, 1887, *Pringle 1382* (F, G, NY, PA, UO, US), type collection of *C. madrensis* Watson; Sierra Madre, 2100–2850 m. alt., Sept. 29, 1888, *Pringle 1679* (NY, UC); near Colonia Garcia, Sierra Madre, 2400 m. alt., July 20, 1899, *Townsend & Barber 155* (F, G, M, NY, P, PA, RM, UC, US).

DURANGO. Sierra Madre, w. of Durango, 2430 m. alt., Sept., Oct., 1881, *Forrer* (F, G, NY, PA, UC, US), TYPE COLLECTION; Sierra Madre, 15 mi. n. of Guanacevi, 2250–2400 m. alt., Aug. 17, 1898, *Nelson 4761* (US).

SAN LUIS POTOSI. Minas de San Rafael, Nov., 1910, *Purpus 5061* (UC). This collection has smaller flowers and shorter fruits than any other examined, and may possibly represent an undescribed variety intermediate between *C. venustulus* and *C. exilis.*

47. Calochortus exilis Painter in Contrib. U. S. Nat. Herb. **13**: 346. 1911.

Bulb ovoid, with fibrous-reticulate coats; stem very slender, erect, flexuous, often branched, not bulbiferous; basal leaf narrowly linear, attenuate, usually much longer than the stem; cauline leaf similar, but much shorter; inflorescences usually 2-flowered, the bracts linear-lanceolate, acute, unequal; flowers small, erect, broadly campanulate, white or yellowish, usually with the sepals purplish; sepals equalling the petals, oblong, acute or obtuse, glabrous except for a few short hairs near the base; petals obovate, cuneate, obtuse or acute, densely bearded near the base with short hairs; gland inconspicuous or absent; anthers oblong, short-apiculate, about equalling the basally dilated filaments in length; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit narrowly lanceolate, acute, 3-angled, erect; mature seeds unknown.

Calochortus exilis is the smallest species of the section CYCLOBOTHRA. It is closely allied to *C. venustulus,* but constantly differs in its more slender habit, proportionately longer and narrower basal leaf, smaller, paler flowers, and shorter, thicker capsules.

DISTRIBUTION. Mexico: in the mountains of Hidalgo.

HIDALGO. Cerro de los Navajos, Mineral del Monte, Nov., 1835, *Ehrenberg 501* (G); bare summits, Sierra de Pachuca, 3000 m. alt., Sept. 14, 1899, *Pringle 8247* (F, G, M, NY, P, PA, RM, UC, US TYPE); Sierra de Pachuca, 3000 m. alt., Aug. 28, 1906, *Pringle 13798* (G, US); Sierra de Pachuca, Sept. 24, 1906, *Rose & Rose 11492* (NY, US).

48. Calochortus Hintoni Bullock in herb., n. sp.[47]

Bulb ovoid; stem slender, erect, flexuous, branched, not bulbiferous; basal leaf linear, attenuate, about equalling the stem; cauline leaves linear, attenuate, reduced upward; inflorescence usually 2-flowered, the bracts similar to the uppermost leaf; flowers erect, broadly campanulate, apparently dark red, drying brown; sepals slightly shorter than the petals, elliptic-lanceolate, acute or obtuse, glabrous except for a few slender hairs near the base; petals obovate, cuneate, obtuse or acute, densely bearded near the base with slender hairs; gland inconspicuous or absent; anthers elliptic, obtuse or acute, shorter than the basally dilated filaments; ovary linear, not winged, tapering to a trifid stigma; fruit and seeds unknown.

Calochortus Hintoni is closely allied to *C. venustulus* and *C. exilis,* but differs from both in flower-color and distribution. The flowers in the dried condition are a rich chocolate-brown.

DISTRIBUTION. Mexico: known only from the District of Temascaltepec, State of Mexico.

MEXICO. Oak woods, Cerro Muñeca, District of Temascaltepec, 2300 m. alt., Aug. 18, 1932, *Hinton 1383* (M), TYPE COLLECTION; oak woods, Limones, District of Temascaltepec, 910 m. alt., Sept. 12, 1933, *Hinton 4739* (M).

49. Calochortus Ghiesbreghtii Watson in Proc. Am. Acad. **14**: 268. 1879.

Calochortus Ghiesbreghtianus Watson in Jackson, Index Kewensis **1**: 390. 1893, in error.

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender, erect, flexuous, often branched, rarely bulbiferous in the axils of the upper leaves and bracts; basal leaf linear, attenuate, nearly as long as the stem; cauline leaves linear, attenuate, successively shorter upward; inflorescences usually 2-

[47] **Calochortus Hintoni** Bullock in herb., sp. nov., bulbo ovoideo; caule gracili erecto flexuoso ramoso non bulbifero; folio basali lineari attenuato cauli subaequilongo; foliis caulinis linearibus attenuatis, sursum ex ordine brevioribus; inflorescentia plerumque 2-flora, bracteis folio summo similibus; floribus erectis late campanulatis obscure rubris ut videtur, in siccis fuscantibus; sepalis petalis leviter brevioribus elliptico-lanceolatis acutis vel obtusis, glabris praeter paucos pilos graciles prope basem; petalis obovatis cuneatis obtusis vel acutis, prope basem pilis gracilibus dense barbatis; glandula inconspicua vel absente; antheris ellipticis obtusis vel acutis filamentis basilariter dilatatis brevioribus; ovario lineari non alato, stigmate trifido; capsula seminibusque ignotis.

flowered, the bracts similar to the upper leaves; flowers erect on often greatly elongate pedicels, broadly campanulate, purplish; sepals about as long as the petals, elliptic, acute or obtuse, with a circular, glandular spot near the base, which is bordered above with a horseshoe-shaped, deeply laciniate membrane; petals obovate, cuneate, acute or obtuse, sparsely to densely bearded about the gland with short hairs which are distally more or less thickened and glandular; gland not depressed, naked, bordered above with a membrane like that on the sepals; anthers linear-lanceolate, apiculate, shorter than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-oblong, 3-angled, erect; mature seeds unknown.

Calochortus Ghiesbreghtii is readily distinguished by its erect, purplish flowers, with glands on both petals and sepals.

DISTRIBUTION. Mountains of Hidalgo and Chiapas, Mexico, southward to Guatemala.

HIDALGO. Jacala, Aug. 14, 1937, *Edwards 812* (F); Jacala, 1500 m. alt., Aug. 14, 1937, *Fisher* (M); Jacala, Nov. 17, 1937, *Kenoyer 462* (F); Ixmiquilpan, Aug., 1905, *Purpus* (UC).

CHIAPAS. Without exact locality, *Ghiesbreght 104* (G); on rocks, Aug., Sept., 1864–1870, *Ghiesbreght 661* (F, G TYPE, M); near San Cristobal, 2100–2640 m. alt., Sept. 18, 1895, *Nelson 3158* (G, US).

GUATEMALA. On lightly wooded calcareous mountains, Trinidad, Department of Huehuetenango, Aug. 13, 1896, *Seler & Seler 3200* (G).

Subsection 11. BARBATI.[48]

Stems erect, flexuous, usually branched, often bulbiferous in the axils of the upper leaves; flowers small, broadly campanulate, nodding; petals obovate to spatulate, conspicuously bearded; glands usually present; fruits linear or lanceolate, 3-angled, erect.

The BARBATI are characterized by their nodding flowers and conspicuously bearded petals. The four species here recognized are very distinct, and probably not closely related.

50. Calochortus barbatus (HBK.) Painter in Contrib. U. S. Nat. Herb. **13**: 348. 1911.

[48] BARBATI subsect. nov., caulibus erectis flexuosis plerumque ramosis, saepe in axillis foliorum superiorum bulbiferis; floribus parvis late campanulatis cernuis; petalis obovatis vel spathulatis insigniter barbatis; glandulis plerumque praesentibus; capsulis linearibus aut lanceolatis triangulatis erectis.

Fritillaria barbata Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. Pl. **1**: 288. 1816; **7**: *t. 677.* 1825.

Cyclobothra barbata [D. Don in] Sweet, Brit. Fl. Gard. **3**: *t. 273.* 1828.

Calochortus flavus Schultes f. in Van Hall, Vrolik & Mulder, Bijdr. Nat. Wet. **4**: 134. 1829; Schultes & Schultes, Syst. Veg. **7**: 1535. 1830.

Cyclobothra flava Lindley in Bot. Reg. **20**: under *t. 1662.* 1834.

Calochortus pallidus Schultes f. in Van Hall, Vrolik & Mulder, Bijdr. Nat. Wet. **4**: 129. 1829; Schultes & Schultes, Syst. Veg. **7**: 1533. 1830.

Cyclobothra pallida Lindley in Bot. Reg. **20**: under *t. 1662.* 1834.

Cyclobothra lutea Lindley in Bot. Reg. **20**: *t. 1663.* 1834.

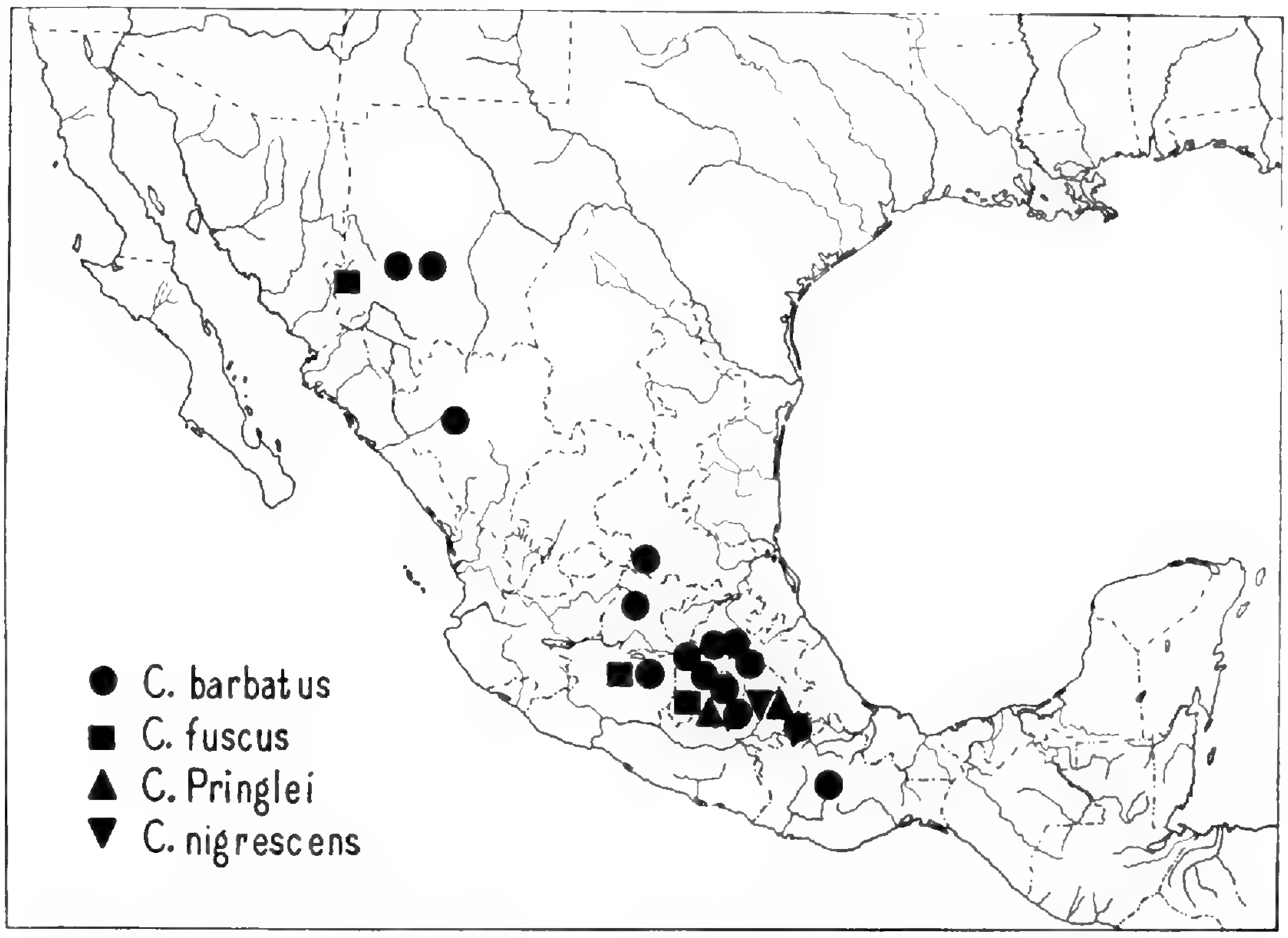
Cyclobothra propinqua Schauer apud Nees & Schauer in Linnaea **19**: 701. 1847.

Calochortus barbatus subsp. *chihuahuanus* Painter in Contrib. U. S. Nat. Herb. **13**: 349. 1911.

Calochortus barbatus var. *chihuahuanus* Macbride in Contrib. Gray Herb. N.S. No. 59, p. 28. 1919.

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender, erect, flexuous, usually branched, rarely bulbiferous in the axils of the upper leaves and bracts; basal leaf broadly linear, attenuate, shorter than the stem; cauline leaves successively shorter upward, linear to linear-lanceolate, attenuate; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers campanulate, nodding, yellow or with the petals sometimes and the sepals often purplish; sepals shorter than the petals, lanceolate, acute or obtuse, sparsely bearded within, often with a gland like those on the petals; petals obovate, cuneate, obtuse to acuminate, fringed laterally and densely bearded on the inner face to below the gland with slender hairs; gland sometimes depressed, more or less circular to indefinite in outline, naked; anthers oblong, short-apiculate, shorter than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-oblong, acute, 3-angled, erect; seeds irregular, with minutely roughened coats.

Calochortus barbatus is a widespread and variable species. The variety *chihuahuanus* differs only in its purplish petals, and this character does not hold throughout the type collection. The species, as a whole, is easily recognized by its broad, densely bearded petals, linear fruits and yellow flowers. Its closest ally is *C. fuscus.*



Map 11. Distribution of the species of the subsection BARBATI.

DISTRIBUTION. Throughout the plateau region of Mexico, from Chihuahua to Oaxaca.

CHIHUAHUA. Majalca, Aug. 18–20, 1935, *LeSueur 94* (F); Santa Eulalia Mts., Sept. 1885, *Pringle 328* (F, G, NY, PA, US, type of *C. barbatus* ssp. *chihuahuanus* Painter); mesas near Cusihuiriachic, Aug. 29, 1887, *Pringle 1580* (M, UC); Santa Eulalia Hills, Sept. 1, 1885, *Wilkinson* (US).

DURANGO. Papasquiaro, Aug. 7, 1898, *Nelson 4667* (G, US); Santiago Papasquiaro, Aug., 1896, *Palmer 415* (F, G, M, NY, UC, US).

SAN LUIS POTOSI. Region of San Luis Potosi, 1800–2400 m. alt., 1878, *Parry & Palmer 891* (G, M, PA, US); San Luis Potosi, 1879, *Schaffner 229* (F, NY, US); San Miguelito Mts., 1876, *Schaffner 542* (G, PA).

GUANAJUATO. Mountains, Guanajuato, Sept., 1903, *Dugès 3* (G).

MICHOACÁN. Punguato, vicinity of Morelia, 2100 m. alt., July 16, 1909, *Arsène 3039* (CA, F, G, M, NY, US); same locality, 1950–2000 m. alt., Aug. 18, 1910, *Arsène 5267* (CA, F, G, M, NY, UC, US); n. of Loma del Zapote, vicinity of Morelia, 1950 m. alt., Aug. 4, 1910, *Arsène 6606* (US); Cerro San Miguel, vicinity of Morelia, 2100 m. alt., Sept. 15, 1910, *Arsène 6909* (US); Punguato, Morelia, Aug. 8, 1911, *Arsène* (CA, F).

Hidalgo. El Chico, July, 1927, *Lyonnet 184* (US); mountains, El Chico, near Pachuca, Sept., 1906, *Purpus 1703* (F, G, M, NY, P, UC, US); between Pachuca and Real del Monte, Aug. 31, 1903, *Rose & Painter 6702* (G, NY, US); near El Salto, Sept. 16, 1903, *Rose & Painter 7084* (US); Sierra de Pachuca, July 20, 24, 1905, *Rose, Painter & Rose 8774* (US); between Somoriel and Las Lajas, Aug. 5, 1905, *Rose, Painter & Rose 9237* (NY, US).

Mexico. Along Mexico City-Toluca Road, Valley of Mexico, 2400 m. alt., Sept. 9, 1935, *MacDaniels 490* (F); Pedregal, Valley of Mexico, Sept. 1, 1936, *MacDaniels 749* (F); meadows and banks, Flor de Maria, Aug. 1, 1890, *Pringle 3185* (D, F, G, M, NY, PA, UC, US); near Salazar, Sept. 14, 1903, *Rose & Painter 7048* (NY, US).

Federal District. Mixcoac, Lomas de Cacapula, 2300 m. alt., Aug. 11, 1913, *Arsène* (US); Tlalpam, 2250 m. alt., Aug. 3, 1924, *Fisher* (F, M); Tlalpam Pedregal, Valley of Mexico, Aug. 20, 1896, *Harshberger 161* (G, PA); Lomas de Santa Fe, Sept., 1927, *Lyonnet 185* (G, M, NY, US); among rocks in rather dry situations, Pyramid of Cuicuilco, Tlalpam, Aug. 15, 1935, *MacDaniels 36* (F); earth pockets, lava flow, Pedregal near San Angel, Aug. 16, 1929, *Mexia 2729* (F, M, NY, PA, UC); hills above Santa Fe, 2550 m. alt., Sept. 4, 1901, *Pringle 9302* (G, NY, US); grassy slopes, near Eslaba, 2400 m. alt., Sept. 18, 1903, *Pringle 11714* (F, G, US); near Tlalpam, Valley of Mexico, Aug. 20, 1903, *Rose & Painter 6457* (NY, US); Pedregal e. of Ajusco, Valley of Mexico, Sept. 8, 1903, *Rose & Painter 6842* (NY, US); near Tlalpam, Valley of Mexico, Aug. 14, 1905, *Rose, Painter & Rose 9440* (NY, US); near San Angel, Valley of Mexico, Aug. 15, 1905, *Rose, Painter & Rose 9485* (G, NY, US); Tlalpam, 2280 m. alt., Aug. 22, 1930, *Russell & Souviron 33* (US).

Morelos. Toro, 2940 m. alt., Aug. 5, 1924, *Fisher 169* (US).

Puebla. Vicinity of San Luis Tultitlanapa, near Oaxaca, July, 1908, *Purpus 3466* (G, NY, UC, US); Cerro del Oro, 2400–2700 m. alt., Aug., 1909, *Purpus 3941* (UC).

Oaxaca. Cerro de San Felipe, 2250 m. alt., Sept. 23, 1895, *Conzatti 703* (G); Cerro San Felipe, Distrito del Centro, 2000 m. alt., Sept. 20, 1908, *Conzatti 2250* (F); Valley of Oaxaca, 1650–2150 m. alt., Sept. 20, 1894, *Nelson 1428* (G, US); Sierra de San Felipe, 2100–2400 m. alt., Oct. 2, 1894, *Smith 745* (M, NY, US); La Carbonera, 2100 m. alt., Sept. 20, 1895, *Smith 791* (G).

State Not Determined. "Mexico," *Aschenborn 374*, photograph of specimen at Berlin (M), type collection of *Cyclobothra propinqua* Schauer; "in Mexico," *De Karwinski*, photograph of specimen at Munich (M), type of *Calochortus pallidus* Schultes f.

51. Calochortus fuscus Schultes f. in Van Hall, Vrolik & Mulder, Bijdr. Nat. Wet. **4**: 131. 1829; Schultes & Schultes, Syst. Veg. **7**: 1534. 1830.

Cyclobothra fusca Lindley in Bot. Reg. **20**: under *t. 1662*. 1834.

Calochortus spatulatus Watson in Proc. Am. Acad. **14**: 267. 1879.

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender, erect, branched, bulbiferous in the axils of the upper leaves and bracts; basal leaf linear, attenuate, not exceeding the stem; cauline leaves successively shorter upward, the lower ones linear, the upper ones linear-lanceolate, amplexicaul; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers campanulate, nodding, brownish or purplish; sepals shorter than the petals, obtuse or acute, with a median, oblong, glandular spot which is bordered above with a horseshoe-shaped, deeply laciniate membrane; petals narrowly elliptic to oblanceolate-spatulate, acute or obtuse, ciliate distally and sparsely bearded above the gland with slender, crisped hairs; gland not depressed, oblong, naked, bordered above with a membrane like that on the sepals; anthers linear-oblong, apiculate, less than half as long as the slender, basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-oblong, acute at both ends, erect; mature seeds unknown.

Calochortus fuscus is related to *C. barbatus,* from which it differs in its narrower perianth segments, less densely bearded petals and the color of the flowers.

DISTRIBUTION. Mexico: mountains, Chihuahua to Oaxaca.

CHIHUAHUA. Tilted oak glens, Guasaremos, Rio Mayo, Aug. 15, 1936, *Gentry 2385* (F, G); pine-oak country, Sierra Canelo, Rio Mayo, Aug. 30, 1936, *Gentry 2532* (UC, US).

MICHOACÁN. Cerro Azul, vicinity of Morelia, 2200 m. alt., 1910, *Arsène 6753* (US).

MEXICO. "In Mexico ad Arismendi, September 1827," *De Karwinski,* photograph of the TYPE in the herbarium at Munich (M); Temascaltepec, District of Temascaltepec, 1750 m. alt., Aug. 30, 1932, *Hinton 1441* (US); same locality, Sept. 1, 1932, *Hinton 1512* (F, M); Chorrera, District of Temascaltepec, 1230 m. alt., Sept. 24, 1932, *Hinton 1824* (M, NY); San Lucas, District of Temascaltepec, Sept. 14, 1933, *Hinton 4752* (M, US).

OAXACA. Without exact locality, 1842, *Ghiesbreght* (G, type of *C. spatulatus* Watson).

52. Calochortus Pringlei Robinson in Proc. Am. Acad. **36:** 472. 1901.

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender, erect, branched, bulbiferous in the axils of the upper leaves and bracts; basal leaf broadly linear, attenuate, not exceeding the stem; cauline leaves successively shorter upward, linear to linear-lanceolate, attenuate; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers small, broadly campanulate, nodding, apparently dark reddish brown; sepals shorter than the petals, oblong, obtuse or acute, with a tuft of slender hairs in the middle, and a glandular depression below; petals obovate, cuneate, short-acuminate, more or less ciliate laterally and bearded above the gland with slender, crisped hairs; gland slightly depressed, rounded distally, but indefinite below, naked; anthers oblong, short-apiculate, shorter than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit elliptic-lanceolate, acute, 3-angled, erect; seeds irregular, with minutely roughened coats.

Calochortus Pringlei is allied to *C. barbatus,* but is readily distinguished by the color of its flowers and its much thicker, shorter capsules.

DISTRIBUTION. Mexico: mountains of Morelos and Puebla.

MORELOS. Thin soil of the top of the knobs of the Sierra de Tepoxtlan, 2250 m. alt., Sept. 12, 1900, *Pringle 8435* (F, G TYPE, M, NY, P, PA, RM, UC, US).

PUEBLA. Los Tepates, 2100–2400 m. alt., Aug., 1909, *Purpus 3930, in part* (G, M, NY, UC).

53. Calochortus nigrescens Ownbey, n. sp.[49]

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender, often very short, more or less flexuous, branched, not bulbiferous; basal leaf linear, attenuate, greatly exceeding the stem; lower cauline leaves linear, attenuate, upper ones successively shorter; inflorescences 1–2-flowered, the bracts similar to the

[49] **Calochortus nigrescens** sp. nov., bulbo ovoideo tunicis crassis fibroso-reticulatis; caule gracili saepe brevissimo subflexuoso ramoso non bulbifero; folio basali lineari attenuato caulem multo superante; foliis caulinis inferioribus linearibus attenuatis, superioribus ex ordine brevioribus; inflorescentiis 1–2-floris, bracteis foliis superioribus similibus; floribus campanulatis cernuis perobscure rubris ut videtur, in siccis paene nigrescentibus; sepalis petalis subaequilongis lanceolatis acutis infra medium fasciculo pilorum brevium; petalis oblanceolatis acuminatis pilis brevibus rectis dense barbatis non ciliatis; glandula circulari non depressa processis brevibus subclavatis circumdata; antheris oblongo-lanceolatis apiculatis filamentis basilariter dilatatis subduplo brevioribus; ovario lineari non alato, stigmate persistente trifido; capsula lineari-oblonga acuta triangulata erecta; seminibus maturis ignotis.

upper leaves; flowers campanulate, nodding, apparently very dark red, drying nearly black; sepals nearly equalling the petals, lanceolate, acute, with a tuft of short hairs below the middle; petals oblanceolate, acuminate, densely bearded with short, straight hairs, not ciliate; gland circular, not depressed, surrounded with short, subclavate processes; anthers oblong-lanceolate, apiculate, about half as long as the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-oblong, acute, 3-angled, erect; mature seeds unknown.

Calochortus nigrescens has no close allies. Its hairy petals and nearly black flowers distinguish it at once from any other known member of the section. The type collection is perhaps somewhat depauperate, and is badly mixed with *C. Pringlei,* but the two may be separated at a glance.

DISTRIBUTION. Mexico: known only from the type locality.

PUEBLA. Los Tepates, 2100–2400 m. alt., Aug., 1909, *Purpus 3930, in part* (F, G, NY, UC, US TYPE).

Subsection 12. PURPUREI.[50]

Stems erect, usually stout, leafy, often branched, usually bulbiferous in the axils of the upper leaves; flowers campanulate, nodding; petals glabrous or sparsely bearded on the inner face; glands naked, often absent; fruits linear, erect or nodding.

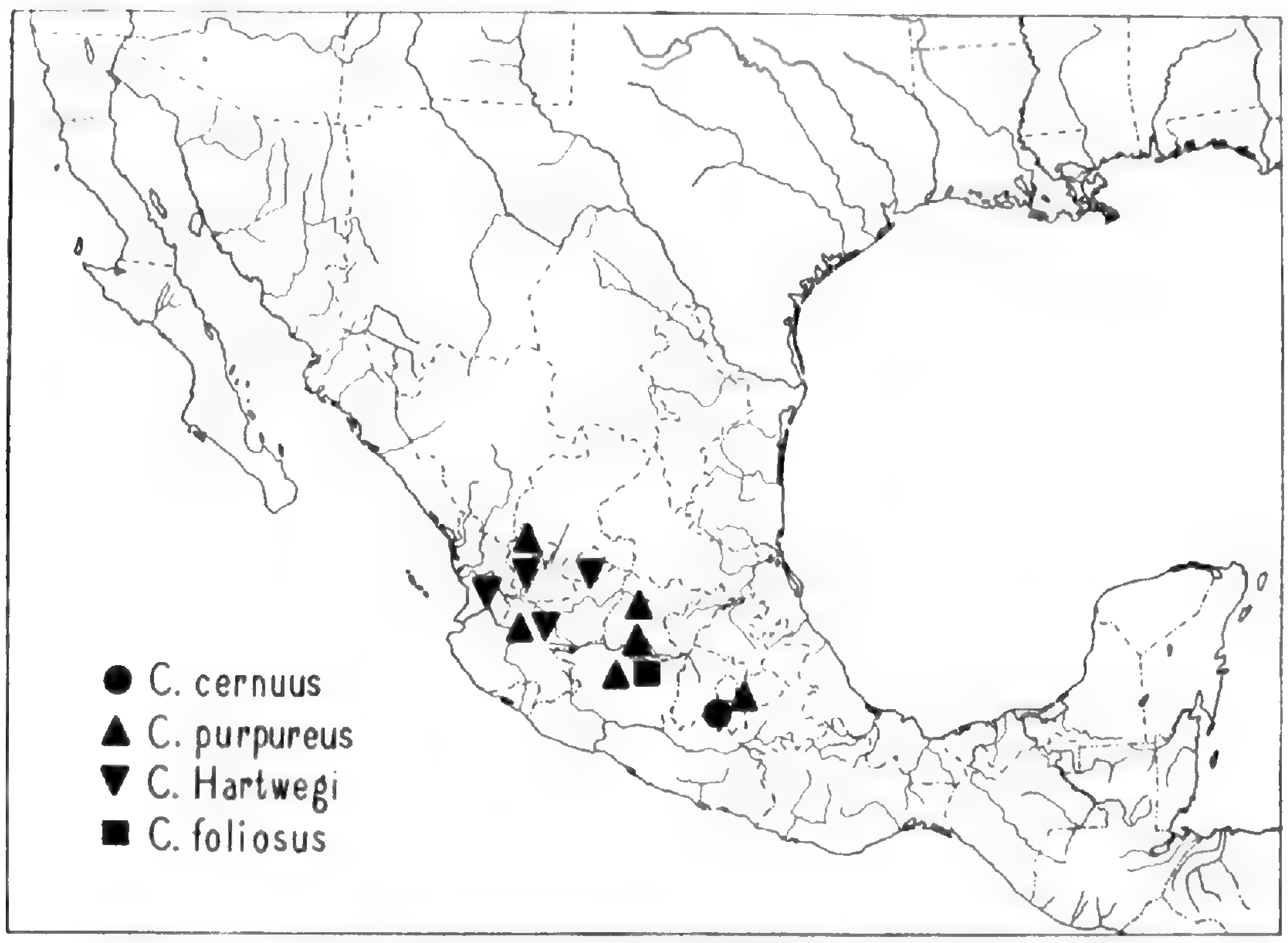
This subsection is distinguished by its leafy stems, nodding flowers, and sparsely bearded petals. Three of the species, *C. cernuus, C. purpureus* and *C. Hartwegi,* are closely allied, while the fourth, *C. foliosus,* is only remotely so. In superficial appearance, the species of the PURPUREI are strikingly similar to certain species of the genus *Fritillaria.*

54. Calochortus cernuus Painter in Contrib. U. S. Nat. Herb. **13**: 347. 1911.

Bulb ovoid, with thick, fibrous-reticulate coats; stem slender,

[50] PURPUREI subsect. nov., caulibus erectis plerumque robustis foliatis saepe ramosis plerumque in axillis foliorum superiorum bulbiferis; floribus campanulatis cernuis; petalis glabris aut facie interiore parce barbatis; glandulis nudis saepe absentibus; capsulis linearibus erectis aut cernuis.

erect, usually branched, bulbiferous in the axils of the upper leaves and bracts; basal leaf linear, attenuate, equalling the stem in length; lower cauline leaves linear, the upper ones successively shorter and broader, lanceolate, attenuate, amplexicaul; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers campanulate, nodding, purplish brown; sepals shorter than the petals, elliptic-lanceolate,



Map 12. Distribution of the species of the subsection PURPUREI.

acute, glabrous; petals narrowly elliptic, conspicuously ciliate above, invested with a few long hairs toward the tip; gland not depressed, blotch-like, naked; anthers oblong, short-apiculate, about half as long as the basally dilated filaments; ovary linear, not winged, tapering to a deeply trifid stigma; fruit and seeds unknown.

This species is very little known, and the two collections cited below are not absolutely identical. It is closely related to *C. purpureus,* differing only in the more slender stems, narrower leaves, smaller flowers, and more conspicuously fringed petals.

DISTRIBUTION. Mexico: known only from the State of Morelos.

MORELOS. El Parque, Aug. 31, 1910, *Orcutt 4088* (M, US); Sierra de Tepoxtlan, near Cuernavaca, 2250 m. alt., Sept. 12, 1900, *Pringle 9341* (G TYPE).

55. **Calochortus purpureus** (HBK.) Baker in Journ. Linn. Soc. Lond. Bot. **14**: 308. 1874.

Fritillaria purpurea Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. Pl. **1**: 288. 1816.

Cyclobothra purpurea [D. Don in] Sweet, Brit. Fl. Gard. Ser. II. **1**: *t. 20.* 1829.

Calochortus Bonplandianus Schultes f. in Van Hall, Vrolik & Mulder, Bijdr. Nat. Wet. **4**: 128. 1829; Schultes & Schultes, Syst. Veg. **7**: 1532. 1830.

Cyclobothra grandiflora Martens & Galeotti in Bull. Acad. Brux. **9**^{2}: 384. 1842.

Calochortus grandiflorus Painter in Contrib. U. S. Nat. Herb. **13**: 347. 1911, as to name-bringing synonym.

Bulb ovoid, with thick, fibrous-reticulate coats; stem stout, erect, leafy, often branched, bulbiferous in the axils of the upper leaves and bracts; basal leaf broadly linear, attenuate, about equalling the stem; lower cauline leaves linear, upper ones successively shorter, lanceolate, attenuate, amplexicaul; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers campanulate, nodding, purplish brown; sepals shorter than the petals, oblong to lanceolate, acute or obtuse, glabrous, often with a glandular spot near the base; petals oblong to spatulate, acute or obtuse, more or less ciliate and usually sparsely bearded toward the tip; gland not depressed, more or less circular, naked, sometimes lacking; anthers oblong, short-apiculate, shorter than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, deeply trifid stigma; fruit linear-oblong, acute, 3-angled, erect; mature seeds unknown.

Calochortus purpureus varies greatly in the size and shape of the perianth segments and in the amount of pubescence and ciliation of the petals. It is closely related to *C. Hartwegi,* but may be distinguished by its smaller flowers, broader leaves and bulbiferous habit. It is not so easily distinguished from its other near ally, *C. cernuus,* but in general has broader leaves, stouter stems, larger flowers, broader perianth segments, and less conspicuously ciliate petals.

DISTRIBUTION. Southern plateau region of Mexico, from Guanajuato and Jalisco to Oaxaca.

GUANAJUATO. Guanajuato, 1880, *Dugès* (G); Moroleón, 1895, *Dugès* (G).

JALISCO. Rio Blanco, Aug. 15, 1886, *Palmer 338* (G, M, NY, PA, US); slopes of canyons, near Guadalajara, Sept. 28, 1889, *Pringle 2329* (F, G, M, NY, PA, UC, US); bluffs of barranca, near Guadalajara, Sept. 10, 1890, *Pringle 3456* (F); road between Huejuquilla and Mesquitic, Aug. 25, 1897, *Rose 2589* (G, US); near Guadalajara, Sept. 28, 1903, *Rose & Painter 7381* (US).

MICHOACÁN. Punguato, vicinity of Morelia, 2100 m. alt., Aug. 9, 1909, *Arsène 2878* (CA, F, G, M, NY, US); Coronilla, vicinity of Morelia, Sept. 19, 1909, *Arsène* (US); Punguato, vicinity of Morelia, 1950 m. alt., Aug. 18, 1910, *Arsène* (G, M, US); same locality, 2000 m. alt., Aug. 25, 1910, *Arsène* (G, M, NY, US); La Huerta, vicinity of Morelia, 1950–2000 m. alt., Sept. 1, 1910, *Arsène 5581* (F, G, M, NY, UC, US); near Lake Patzcuaro, Aug., 1840, *Galeotti 5513* (Brussels, type of *Cyclobothra grandiflora* Mart. & Gal.; photograph, M).

MEXICO. Bluffs of barranca, below Ozumba, 2400 m. alt., Sept. 24, 1904, *Pringle 13223* (F, G, US); near Tlacotitlan, Aug. 28, 1903, *Rose & Painter 6621* (US).

MORELOS. In field, along the Mexico City-Cuernevaca Road, near Cuernevaca, 1650 m. alt., Aug. 28, 1935, *MacDaniels 285* (F).

OAXACA. Without exact locality, 1842, *Ghiesbreght* (G, US).

56. Calochortus Hartwegi Bentham, Pl. Hartw. p. 26. 1840.
Cyclobothra Hartwegi Kunth, Enum. Pl. **4**: 231. 1843.
Calochortus grandiflorus Painter in Contrib. U. S. Nat. Herb. **13**: 347. 1911, excl. syn.

Bulb ovoid, with thick, fibrous-reticulate coats; stem erect, sometimes branched, apparently not bulbiferous; basal leaf linear, elongate, about equalling the stem; cauline leaves linear to narrowly lanceolate, usually long-attenuate, amplexicaul, upper ones successively shorter and broader; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers campanulate, nodding, purplish brown; sepals shorter than the petals, elliptic-oblong, obtuse or acute, glabrous or with a few hairs below the middle, usually with a glandular spot near the base; petals elliptic-oblong, acute or obtuse, ciliate, usually with a median, longitudinal line of short hairs; gland not depressed, more or less triangular, naked; anthers oblong, acute, about one-third as long as the basally dilated filaments; ovary linear, not winged, tapering to a deeply trifid stigma; fruit and seeds unknown.

Calochortus Hartwegi is closely allied to *C. purpureus,* and may represent only a well-marked variety of that widespread and variable species. It is distinguished by its usually larger flowers, narrower leaves and perianth segments, nearly naked petals, and apparent lack of bulblets in the axils of the upper leaves. These characters are none too convincing, and further collections may unite the two entities.

DISTRIBUTION. Mexico: in pastures, Aguascalientes, Nayarit and Jalisco.

AGUASCALIENTES. In mountain pasture, near Aguascalientes, *Hartweg 230* (G), TYPE COLLECTION.

NAYARIT. In pasture, Tecolote, Tepic, Oct. 3, 1923, *Collins & Kempton 48* (US).

JALISCO. Rio Blanco, Sept. 20, 1886, *Palmer 580* (G, NY, US); Sierra Madre, w. of Bolaños, Sept. 15–17, 1897, *Rose 2949* (US); vicinity of Rio Blanco, near Guadalajara, Sept. 30, 1903, *Rose & Painter 7445* (G, US).

57. **Calochortus foliosus** Ownbey, n. sp.[51]

Bulb unknown; stem rather slender, erect, very leafy, branched, bulbiferous in the axils of the upper leaves and bracts; cauline leaves linear-lanceolate, long-attenuate, the lower ones exceeding the stem, the upper ones successively shorter and amplexicaul; inflorescences usually 2-flowered, the bracts similar to the upper leaves; flowers campanulate, nodding, apparently bluish; sepals shorter than the petals, lanceolate, acute, glabrous; petals narrowly elliptic-oblanceolate, obtuse, sparsely bearded; gland not depressed, more or less circular, naked; anthers oblong, short-apiculate, shorter than the basally dilated filaments; ovary linear, not winged, tapering to a persistent, trifid stigma; fruit linear-oblong, acute at both ends, nodding; mature seeds unknown.

Calochortus foliosus is one of the most unusual species of the genus. Although it is related to *C. purpureus,* its nodding

[51] **Calochortus foliosus** sp. nov., bulbo ignoto; caule subgracili erecto foliatissimo ramoso bulbifero in axillis foliorum superiorum et bractearum; foliis caulinis lineari-lanceolatis longe-attenuatis, inferioribus caulem superantibus, superioribus ex ordine brevioribus amplexicaulibus; inflorescentiis plerumque 2-floris, bracteis foliis superioribus similibus; floribus campanulatis cernuis subcaeruleis ut videtur; sepalis petalis brevioribus lanceolatis acutis glabris; petalis anguste elliptico-oblanceolatis obtusis parce barbatis; glandula non depressa plus minusve circulari nuda; antheris oblongis brevi-apiculatis filamentis basilariter dilatatis brevioribus; ovario lineari non alato, stigmate persistente trifido; capsula lineari-oblonga utroque extremo acuta cernua; seminibus maturis ignotis.

capsules distinguish it from that and all other species of the section CYCLOBOTHRA, and its very leafy stems are not found in any other known species of *Calochortus*.

DISTRIBUTION. Mexico: known only from the type locality.

MICHOACÁN. Campanario, vicinity of Morelia, 2200 m. alt., Sept. 14, 1911, *Arsène 5687* (G, M, US TYPE).

EXCLUDED NAMES

Calochortus Barnardi Douglas in Steudel, Nomencl. Bot. ed. 2, **1**: 260. 1840, nomen subnudum.

Calochortus Holtzei F. Mueller in Durand & Jackson, Index Kewensis, Suppl. I. p. 74. 1906 = **Calochilus Holtzei** F. Mueller.

Calochortus medius S. Wats. ex Hort. in Notizblatt Bot. Gart. Mus. Berlin **2**: 318. 1899, nomen subnudum.

Calochortus pusillus Douglas in Steudel, Nomencl. Bot. ed. 2, **1**: 260. 1840, nomen subnudum.

Calochortus vestitus Bentham in Steudel, Nomencl. Bot. ed. 2, **1**: 260. 1840, nomen subnudum.

INDEX TO EXSICCATAE

The collector's numbers are indicated in *italics*, unnumbered collections by a dash. The numbers in parentheses are those of the species, varieties and hybrids, in this treatment.

Abbott, E. K., ex herb. — (12); — (32).

Abrams, Mrs. J. D. — (26).

Abrams, Le Roy. *10823* (1); *1571, 2620, 3861, 7466* (2); *8053* (3); *5980, 12208, 12287, 12488, 12521* (4); *2473, 6924, 12291, 12418* (6); *605*, (8); *9386* (9); *8082* (11); *4389, 4941* (13); *816* (16); *251, 1266, 3143* (22); *3810* (24); *1798, 3275, 3401, 3666, 3817, 6501* (26); —, *7499, 8054, 11667* (29); *4645* (30); *5944, 8124* (31); *1656, 7067* (32); *12552* (32X); *4432, 7326* (33); *1848, 2719* (36); *3682* (38); *13183* (39); *3752, 3774* (44); *1802* (44c).

Abrams, Le Roy, & G. T. Benson. *10221, 10264, 10318, 10362, 10396, 10519, 10653, 10682* (6).

Abrams, Le Roy, & H. A. Borthwick. *7939, 7971* (29); *7947* (40).

Abrams, Le Roy, & E. A. McGregor. *44, 361*, (29); *602, 635, 730* (36); *203* (39); *1, 3* (40); *681* (43).

Aiton, George B. — (8a).

Alexander, Annie M. *151* (42).

Alexander, Annie M., & L. Kellogg. *269* (6); *249* (14).

Allen, Paul. *136* (42).

Ames, Mrs. M. E. P. — (33).

Anderson, Fred W. *404* (42).

Anderson, H. T. — (13).

Anderson, J. R. — (34).

Anderson, W. B. — (10).

Andrews, Roy C. *11673* (6); —, *436* (9); *740* (34).

Anthony, A. W. — (26).

Applegate, Elmer I. *727, 727a* (2);

Henderson, Louis F. *15438* (4); —, *54, 983, 5784, 5988, 5989, 10134, 12263, 12458, 12679, 12784, 12786, 13578, 15432, 15445, 15455, 16170, 16294* (6); *2483* (8); *12881* (8b); —, *810, 982, 17581* (9); —, *1378, 5988, 12785, 16224* (12); —, *984* (15); *2484* (16); *4804, 5627, 5628* (17); *12809* (18); *2485* (20); —, *806, 5393, 8829, 12880* (34); *2727* (34a); —, *8827, 8828* (35a).
Henderson, Louis F., & J. R. Patterson. *14226* (9).
Hendrix, T. M. *212* (26).
Henshaw, H. W. — (26).
Herley, R. — (22).
Hermann, F. J. *4564* (35).
Herrin, Wm. F. — (7a).
Hiatt, Otis. — (26).
Hichborn, Deborah. — (2); — (6).
Hichborn, P. R. *275* (29); *260* (32).
Hilend, Martha. —, *15* (22); *319* (29); *78, 571* (36); —, *457* (39).
Hilend, Martha, & M. Canby Reis. — (2).
Hill, Grace A. — (8).
Hill, L. E. *10342* (43).
Hillman, F. H. — (35a).
Hinman, H. B. — (9).
Hinton, George B. *1383, 4739* (48); *1441, 1512, 1824, 4752* (51).
Hitchcock, C. Leo. — (2); *14* (3); *1900* (10); *2981* (23); — (26); — (29); *12345* (39); *5* (45).
Hitchcock, C. Leo, Roland V. Rethke & R. van Raadshooven. *3812* (17); *4493* (42).
Hoffmann, Ralph. — (2); — (22); — (32); *477* (35b); *273* (39).
Hollis, Mrs. C. W. — (14); — (33).
Hollis, M., & E. Hollis. *5724* (10).
Holman, R. M. — (1); — (6); — (30).
Hoover, R. F. *3471* (1); *3339* (3); *3186* (4); *3552* (26); *2453, 3414, 3488* (29); *2369, 2454, 3520* (30); *1179, 3491* (32); *3415* (40).
Hopping, Ralph. *107* (1); *40* (13).
Hormay, A. *H-132* (1); *H-155* (29).
Horner, Robert M. *B-485* (8); *463* (34).
Howden, W. R. *33* (33).
Howell, John Thomas. *5121* (1); *12989* (2); *1730, 6076* (4); *1909, 2310* (6); *6880* (8b); *7271* (9); *905, 11261* (11); *1757* (12); *27, 1238* (13); *13366* (14); *4773, 6186* (22); *4857, 6533* (26); *156, 413, 5055, 6471, 13814* (29); *130, 5161, 6675, 13863* (30); *8, 4258, 6496* (32); *91, 435, 1264, 1347, 12101, 14113* (33); *3900* (35b); *2733* (36); *2499* (39); *2770* (43) *2950, 6586* (44); *2572, 2636* (44c).
Howell, Joseph. — (6); — (12); — (19).
Howell, Joseph, & Thomas J. Howell. — (9).
Howell, Thomas J. —, *572* (6); *296* (8b); — (9); —, *295, 1396* (12); —, *560, 12577* (15); —, *294, 727, 1282* (19); — (34).
Hoyt, J. W. *42* (6).
Hoyt, Mrs. R. W. — (41).
Hughes, E. L. *64* (42).
Hughes, J. A. — (10).
Hull, W. R. *811* (8); — (34a).
Hunt, Clara. — (12).
Hunt, E. — (6).
Hunter, B. — (16).
Huntting, Mrs. H. H. — (16).

Illingsworth. *108* (40a).
Ingram, D. C. *1914* (9).
Irwin, Hardin. *64* (12).

Jackson, Belle Richardson. — (4).
Jaeger, Edmund C. — (35); — (38); — (39); — (41).
James, W. M. — (44a).
Jenkins & Street. *1953* (26).
Jenks, Gracia. — (26).
Jepson, Willis Linn. — (5); — (6); — (11); —, *6254* (12); —, *7656* (32).
Jepson, Willis Linn, & Harvey M. Hall. — (44).
Johnson, S. O. *147* (10).

1370 (10); *5066* (14); — (16); *2236* (35a).
Leithold, C. F. — (2).
Lemmon, J. G. — (2); —, *267* (14); — (29); — (38); *4175* (39); *1522, 4578* (40); — (45).
Lemmon, J. G., & Mrs. J. G. Lemmon. — (23); — (41).
Lemmon, Paul. — (10).
Le Sueur, Harde. *577* (46); *94* (50).
Lillard, J. B. — (13).
Little, E. E., & E. M. Stanton. *166* (35).
Lloyd, E. — (22).
Lloyd, Francis E. — (6); — (9).
Lobb, W. *257* (6); *242* (7); *243* (13).
Lockhart, Bruce. — (34).
Lodge, Elizabeth. *379* (12).
Lowe, Flora. — (45).
Luedinghaus, E. — (6).
Lyall, David. — (10); — (34).
Lyles, C. S. — (35a).
Lyon, W. S. — (22).
Lyonnet, E. *184, 185* (50).

McAllister, Mrs. D. B. — (6).
Macbride, J. Francis. *268, 1286* (34); *2752* (35); *2836* (42).
Macbride, J. Francis, & Edwin B. Payson. *2858, 2928, 3031* (17); *2845* (34); *2957, 3004* (35a); *762* (43).
McCracken, Isabel. — (23); — (39).
MacDaniels, L. H. *36, 490, 749* (50); *285* (55).
McDonald, Julia. — (1); — (30).
MacDougal, D. T. *151, 303, 584, 839* (10); *765* (34); *116* (35); *164* (41).
MacFadden, Fay A. *14163* (29).
McGregor, E. A. — (2); *50* (12); *6, 163* (13); *996* (26); *990* (38).
McIntosh, A. C. *307* (35); *464* (42).
MacKay, Ernest. *21* (34).
McKelvey, Mrs. Charles W. — (39); — (41).
McKelvey, Susan Delano. *2190* (23); *4646* (35); *4586, 4592, 4595, 4600* (35c); *2104, 2189, 2262* (39); *2107, 2150* (41).
McKenzie, Mrs. E. R. — (2).
Maclay, Anne. — (10).
McMurphy, Jas. *170* (6).
McMillen, F. — (6).
McNab, Anne. — (40).
Macoun, J. M. *70212* (20); —, *70200, 70211* (34).
Macoun, John. *13813, 25049* (10); — (34).
Maguire, Bassett, & H. L. Blood. *1310* (23).
Maguire, Bassett, Ruth Maguire & C. B. Maguire. *4753* (23); *15076* (32).
Maguire, Bassett, & J. D. Redd. *1705* (42).
Mann, Mrs. M. L. *1* (20).
Manning, Mrs. M. H. *8* (7a).
Manor, Harold V. — (3).
Marcelline, Sister M. *2146* (42).
Marsh, C. W. *9870* (42).
Marston, B. W. *161X, in part* (17).
Mason, H. L. —, 124 (2); — (11); — (29).
Mathias, Mildred E. *857* (2); *662* (41).
Matthews, W. — (34); *23* (35c).
Mayerhoff, Paul S. *112* (41).
Meany, E. S. — (6).
Mearns, Edgar A. *203, in part* (23); *3377* (38); *203, in part, 258* (39); —, *108* (41).
Mearns, Edgar A., & L. Schoenefeldt. *3471* (38).
Meehan, T. — (13).
Meiere, Mrs. Ernest. — (23); — (26).
Meling, Ada. *10* (44b).
Meredith, H. B. *4535* (35).
Merrill, E. D. — (14).
Merrill, E. D., & E. N. Wilcox. *789* (35).
Merrill, W. C. — (11); — (32).
Metcalfe, O. B. *55* (41); *494* (42).
Metz, Chas. W. *53* (2).
Mexia, Ynes. *2393* (4); — (17); *2389* (32); *2729* (50).
Meyer, C. V. *110* (26); *546* (36); *399* (38); *221* (44).
Meyer, Fred G. *251* (8); *1496* (9); *1500* (34).
Michener, C. A., & F. T. Bioletti. — (4); *2121* (11); — (31); — (32).

Miles, M. M. — (29); — (40).
Miller, C. E. — (2).
Miller, Mrs. C. E. — (22); — (32).
Mitchell, Mrs. H. M. — (5).
Moore, J. Percy. — (35).
Morrison, Mrs. J. H. — (2); — (5); — (6); — (14); — (32); — (32X).
Morrison, Miss. — (34).
Moxley, George L. *557* (1); *306* (22); *1114* (29); *1113* (40a).
Moyer, Lycurgus R. *523* (35).
Muenscher, Walter C. — (16).
Muir, John. *813* (13).
Mulford, A. Isabel. — (17); — (34); *119* (35).
Mulliken, Earle. *102* (2).
Munson, Beauford. *1021* (35).
Munz, Philip A. *8055* (2); *14450* (9); *2098, 10337* (22); *12595* (23); *8033, 8218, 8321, 9807* (26); *5740* (27); *6791, 6927, 6927a, 13224* (29); *7337, 8319* (30); *14856* (35b); *4651, 5749, 5856, 6073, 6109, 8380, 10469* (36); *5811, 5917, 8313, 8355, 9724, 10875* (38); *5744, 6818, 6933, 11913, 12441, 12518, 12542, 13671* (39); *6798* (40a); *2991* (42); *3274* (43); *7104* (44).
Munz, Philip A., & E. Crow. *11495, 11615* (22).
Munz, Philip A., & R. D. Harwood. *3977, 7233* (2); *3991* (22); *7314* (24); *3855, 7170* (26); *7147, 7312* (44).
Munz, Philip A., & Ivan M. Johnston. *5411* (26); *2919, 8636, 8651, 8776* (36); *5204* (39).
Munz, Philip A., Ivan M. Johnston & R. D. Harwood. *4259, 4275* (39).
Munz, Philip A., & David D. Keck. *4838* (23); *7094* (26); *7093* (36).
Munz, Philip A., Street & Williams. *2486, 2624* (22); *2625* (26).
Murdoch, John, Jr. *2560* (33); *4182* (42).

Nelson, Aven. *10374* (23); *7304, 9345, 9346* (35); *319, 1451, 7389, 7685* (42).
Nelson, Aven, & J. Francis Macbride. *1197* (17); *2149* (34); *1425, 1881* (35a).
Nelson, Aven, & Elias Nelson. *6814* (17).
Nelson, Aven, & Ruth Ashton Nelson. *527* (2); *557* (4); *1792, 1984, 2039* (23); *2168* (35c); *1468, 1503, 1701, 1850* (39); *876* (42).
Nelson, Elias. *4926* (35); *4500, 4897* (42).
Nelson, E. W. *4761, 6108* (46); *3158* (49); *1428, 4667* (50).
Nelson, J. C. —, *75, 578, 1158, 3595* (6).
Newell, Gwendolan. — (2); — (32).
Newhall, Mrs. C. S. — (1).
Nuttall, L. W. *6* (22); *216, 598* (26).
Nuttall, Thomas. — (17).

Orcutt, C. R. *532, 839* (24); — (38); *4088* (54).
Orr, Robert T. — (17).
Osterhout, George E. *1967, 4257, 5097, 7215* (35); *837, 838* (42).
Otis, I. C. *673* (20); *1945* (34).
Owens, C. E. — (6).
Owens, J. G. — (35c).
Ownbey, Gerald Bruce. *404* (35); *481* (42).
Ownbey, Marion. *788* (35); *217, 939, 1294* (42).
Ownbey, Marion, & Ruth Peck Ownbey. *1743* (7); *1724* (7a); *1748* (8b); *1797, 1799* (9); *1740, 1744* (14); *1800* (15); *1829, 1832, 1834, 1851, 1867* (17); *1770* (19); — (21); *1667* (22); *1664* (24); *1675* (25); *1660, 1685* (26); *1677* (27); *1686, 1689* (29); *1801, 1850* (34); *1670, 1690* (36); *1688* (39); *1666, 1681* (43); *1657, 1665* (44); *1692* (45).

Packard, Jacqueline. *273* (8); *459* (17); *247* (34).
Palmer, Edward. *376* (2); *527* (25); *452* (35); *526* (39); *378* (44); *415* (50); *338* (55); *580* (56).
Palmer, Ernest J. *37846* (34); *37032, 37322* (35).

Palmer, Ethel. — (23).
Parish, Samuel B. *4422, 20038* (2); *11149, 19296* (22); *1857* (25); *2075, 11334* (26); *5000* (27); — (29); —, *3158, 3159* (36); *2524* (38); *2467, 2497, 9296* (39); —, *11333* (43); *4458* (44).
Parish, Samuel B., & W. F. Parish. *357* (2); *586, 1341* (25); *1342* (27).
Parish, W. F. *252* (41).
Park, Barry C. *57* (42).
Parker, Chas. S. *416* (8).
Parks, Harold E. — (11).
Parks, Harold E., & S. T. Parks. *605* (4); *0580* (32).
Parks, Harold E., & J. P. Tracy. *0790, 11380* (6).
Parry, C. C. *260* (5); — (12); *265* (17); *254* (23); *255* (35).
Parry, C. C., & Edward Palmer. *891* (50).
Patterson, Miss, & Miss Wiltz. — (2); — (32).
Patterson, Francis D. — (5).
Patterson, Harry N. — (42).
Patterson, R. — (29); — (32).
Paulson, Myrtle. — (6).
Payson, Edwin Blake. *289, 357* (23); *8* (35); *546* (42).
Payson, Edwin Blake, & George M. Armstrong. *3505, 3506* (17); *3435* (35).
Payson, Edwin Blake, & Lois B. Payson. *1805* (8); *1850* (17); *2093, 2521, 2623, 2736, 4342* (35); *4085* (42).
Pearson, G. A. *347* (9).
Pearson, D., & E. Pearson. *52* (35).
Pease, Mrs. T. C. — (26).
Peck, Morton E. *1377, 1378, 3203, 3204, 9055, 13719, 14530a, 14641a, 14767, 14996, 17002* (6); *17625, 18221* (8); *1379, 9251, 15019, 18543, 19273* (8b); *3200, 3201, 9807, 13219, 14641, 16228, 18780, 18837* (9); *17200* (15); *3582, 3583, 3584, 10325, 17665, 17711, 17730, 18219, 176621* (17); *16381* (18); *1376, 7848, 8413* (19); *1373, 1374, 1375, 3202, 10106, 16087, 17656, 18425, 18632, 18983* (34); *18963, 18982* (35a).
Peebles, R. H. *8521,* (39); *6864, 11323, 11638* (41).
Peebles, R. H., & H. J. Fulton. *11414, 11479* (39); *11436* (41).
Peebles, R. H., & G. J. Harrison. *3984* (39); *7073A* (41).
Peers, Susie. — (2).
Peirson, Frank W. *8876* (1); *6619* (4); *8093* (10); *10130* (14); *9942* (23); *4563* (27); *11588* (33); *2468* (40a).
Pendleton, R. L. *797* (2); *1480* (29); *915* (32).
Pendleton, R. L., & F. M. Reed. *1028, 1073* (13); *1003, 1250* (33).
Pennell, Francis W. *20646* (17); *21633* (35); *20614* (35a).
Pennell, Francis W., & R. L. Schaeffer, Jr. *23485* (17); *21748, 21977a, 22279, 23079, 23094* (35).
Peters, Don. *197* (9).
Phelps, Kate E. — (20).
Pickett, F. L. *1490* (8).
Pierce, W. M. — (22); — (27); — (29); — (36); — (40).
Piper, C. V. — (4); —, *5089* (6); *6398* (7a); — (8); *4104* (8a); —, *3777* (10); *6282* (12); —, *1680, in part* (16); —, *2460* (17); — (34); *1681* (34a); — (35a).
Plaskett, R. A. *139* (2); *148* (29).
Porter, Thomas C. — (35); — (42).
Pratt, Alice D. — (42).
Prescott, H. S. — (6); — (12).
Price, Gordon. — (8).
Price, John. — (30).
Price, W. W. — (7).
Pringle, C. G. *82* (14); — (39); — (41); *1382, 1679* (46); *8247, 13798* (47); *328, 1580, 3185, 9302, 11714* (50); *8435* (52); *9341* (54); *2329, 3456, 13223* (55).
Purdy, Carl. — (2); — (3); — (4); — (5); — (6); — (9); — (11); — (12); — (17); — (29); — (40).
Purer, Edith A. *6577, 7269* (2); *6558* (22); *6523, 6676, 7267* (26).
Purpus, C. A. *871* (4); *879* (6); *1786* (13); *59* (35); *5013* (39); *8017*

Stone, Witmer. — (13).
Streator, Gertrude Inez. — (34).
Sturgis, W. C. — (42).
Suksdorf, Wilhelm N. — (9); —, *8856* (15); *371* (29); *317* (32); — (34).
Summers, Mrs. Lucia. — (45).
Summers, R. W. — (2); *841* (40).
Summers, Mrs. R. W. *840* (6); *844, 844a* (29); — (32); *842* (45).
Surr, Gordon. — (36).
Sutliffe, Mrs. E. C. — (11); — (29); — (33).
Sweet, Helen E. — (2).
Sweetser, A. M. — (9).
Sweetser, A. R. — (6); — (12).
Syblon, Mary I. *973* (35).

Taylor, Martha. — (42).
Taylor, W. P. — (36).
Taylor, W. P., & H. C. Bryant. — (33).
Taylor, W. P., & C. H. Richardson, Jr. *69* (35a).
Thew, Susan P. — (1).
Thompson, Mrs. A. P. — (23); — (35c).
Thompson, C. H. — (2); — (12); — (32).
Thompson, J. H. *63, 103* (6).
Thompson, J. William. *590, 610a, 2070, 2284, 2594, 4429, 4525, 4549, 10159, 10310, 12788, 12853, 12973* (6); *4725* (8); *3312, 3397, 5011, 5063, 11134* (9); *11927, 13304, 13523, 13835, 14135* (17); *6424, 6449, 7057, 8558, 10435, 10916, 11476* (20); *2838, 4777, 4955, 5151, 6773, 6906, 8529, 11625, 13153, 13646* (34).
Thompson, W. Gilman. — (10).
Thurber, Mrs. C. E. — (22).
Tidestrom, Ivar. *9266, 9313* (23); *10180* (33).
Tolmie, W. F. — (6).
Tompkins. — (13).
Torrey, John. *519(a)* (33); *519* (44a).
Townsend, C. H., & C. M. Barber. *155* (46).
Tracy, Joseph P. *1480, 4422* (4); *5746* (5); *2612, 2624, 4263, 4813* (6); *5763* (13); *4147, 4713* (31); *449* (32).
Tracy, Joseph P., & Ernest B. Babcock. *3621* (6).
Trask, Blanche. — (26).
Trelease, William, ex herb. — (42).
Trowbridge, Mrs. G. S. — (29).
Tucker, Mrs. Susan. — (34).
Turesson, G. W. — (34).
Twedt, Warner. *29* (35).
Tweedy, Frank. *42* (17); —, *2560* (35); *61, 62, 63, 2559, 3515, 5510* (42).

Umbach, L. M. *76, 104* (10).
Unangst, E. P. — (40); — (45).

Van Dyke, Mrs. E. C. — (1); — (9); — (10); — (14); — (33); — (35a); — (36); — (38); — (43).
Van Eseltine, G. P. *1741* (2); *1739, 1740* (5); *1738* (6).
Vasey, G. R. *632* (2); — (34).
Vestal, A. G. — (42).
Voegelin, E. W. *221* (27); *211* (29).
Vortriede, Wm. — (2); — (5).
Vreeland, F. K. *1052* (10); *838* (35).

Wagner, W. W. *261* (7).
Walker, Ernest P. *214* (35); *213* (42).
Walker, Harriet A. *1242* (7); *1317* (14).
Walther, Eric. — (2); — (32).
Ward, L. F. — (35).
Waring, M. G. *37* (35).
Wash, Eva F. — (9).
Watson, Sereno. *418* (8); *420* (10); *419* (16); *1173, in part* (17); *1172, 1173, in part* (35a).
Went, F. W. *18* (34).
West, Sweet & Crow. — (36); — (43).
Westerman, P. B. — (6); — (12).
Weston, E. Roy. *134, 640* (1); *680* (7b); *151* (30).
Wheeler, Louis C. *2570* (26).
White, Jane. *3* (26).
White, O. E. — (35).
Whited, Kirk. *40* (20); *A86, 1269, 3080a* (34); *2661* (35).

GENERAL INDEX

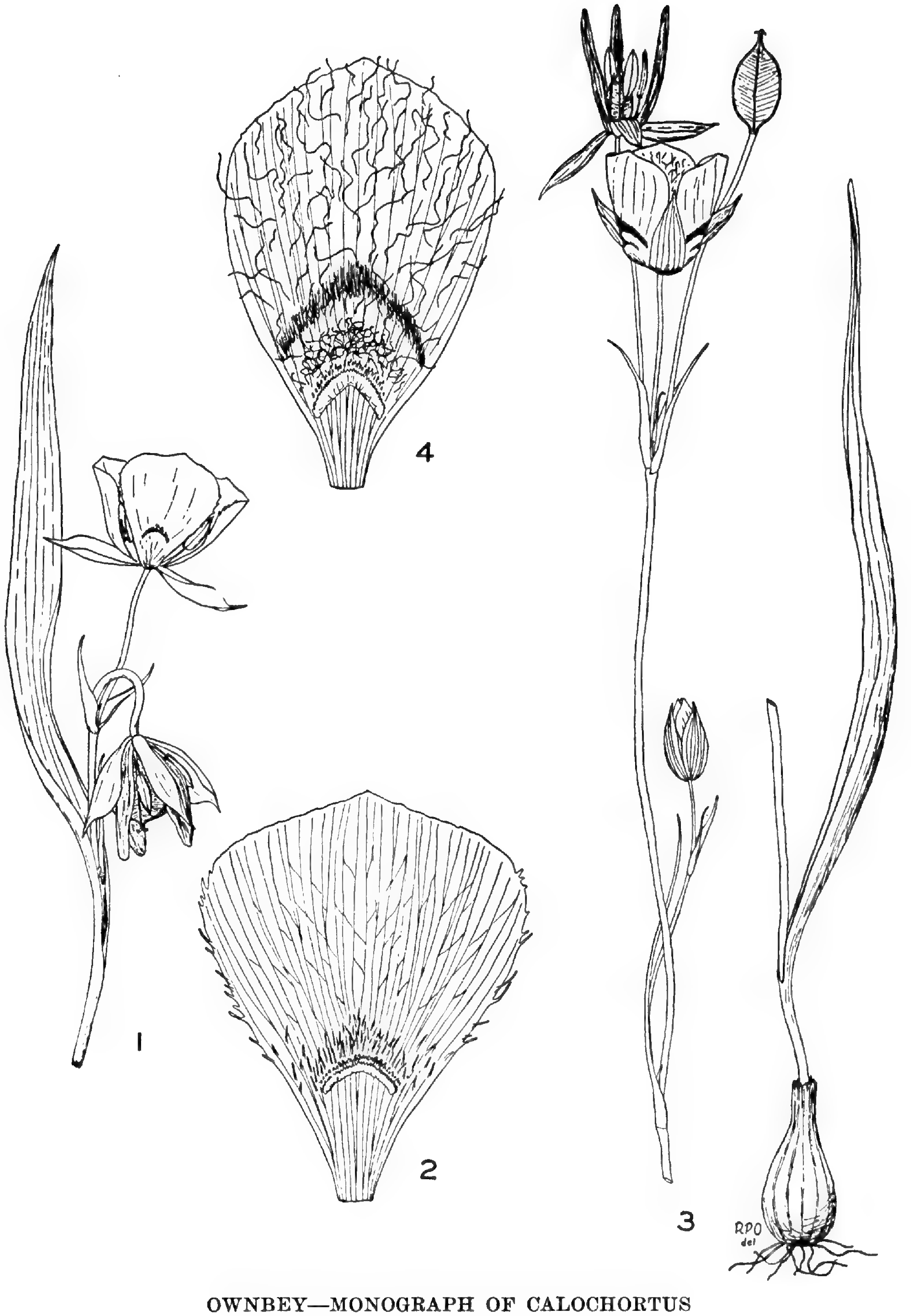
Accepted scientific names are in Roman type; synonyms, in *italics;* new names and new combinations, in **bold face** type.

Explanation of Plate

PLATE 38

Figs. 1–2. *Calochortus persistens* Ownbey. Drawn from the type collection.
Fig. 1. Habit, × ½.
Fig. 2. Petal, × 1½.

Figs. 3–4. *Calochortus Greenei* Watson
Fig. 3. Habit, × ½.
Fig. 4. Petal, × 1½.



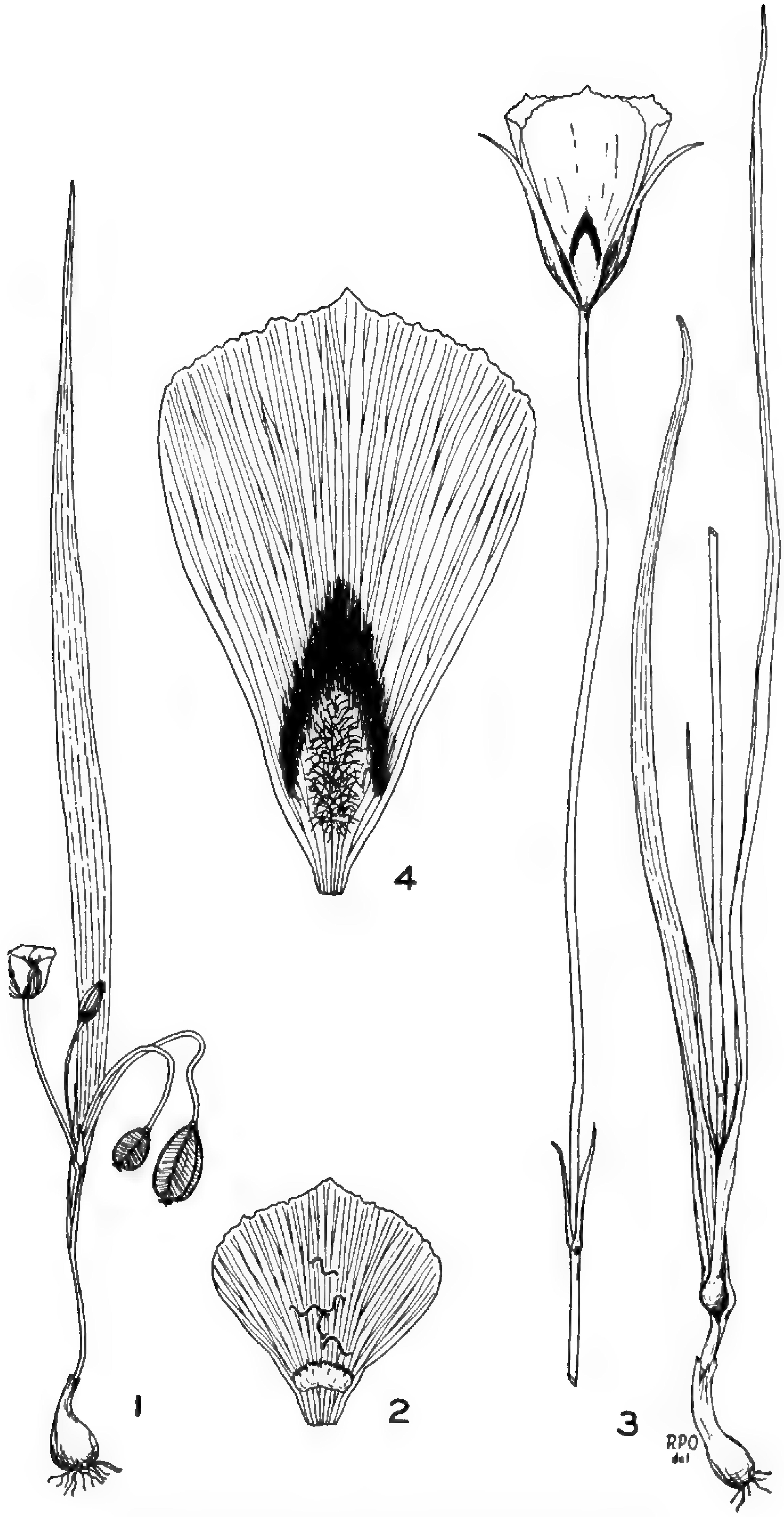
OWNBEY—MONOGRAPH OF CALOCHORTUS

Explanation of Plate

PLATE 39

Figs. 1–2. *Calochortus minimus* Ownbey
- Fig. 1. Habit, × ½.
- Fig. 2. Petal, × 2.

Figs. 3–4. *Calochortus monanthus* Ownbey. Drawn from the type collection.
- Fig. 3. Habit, × ½.
- Fig. 4. Petal, × 1½.



OWNBEY—MONOGRAPH OF CALOCHORTUS

Explanation of Plate

PLATE 40

Figs. 1–2. *Calochortus ambiguus* (Jones) Ownbey
- Fig. 1. Habit, × ½.
- Fig. 2. Base of petal, × 2½.

Figs. 3–6. *Calochortus nigrescens* Ownbey. Drawn from the type collection.
- Fig. 3. Habit, × ½.
- Fig. 4. Fruit, × ½.
- Fig. 5. Sepal, × 2.
- Fig. 6. Petal, × 2.

OWNBEY—MONOGRAPH OF CALOCHORTUS

Explanation of Plate

PLATE 41

Calochortus foliosus Ownbey
Habit, × ½.

Drawn from the type specimen.

OWNBEY—MONOGRAPH OF CALOCHORTUS

OBSERVATIONS ON THE CULTURAL AND PATHOGENIC HABITS OF THIELAVIOPSIS BASICOLA (BERK. & BR.) FERRARIS

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Introduction

It is now common knowledge that many species of pathogenic fungi possess physiologic races that differ in one or more of such factors as cultural characters, morphology, pathogenicity, physiologic and ecologic relations, and biochemical effects.

Stakman ('36) has suggested four principal explanations of the origin of races of fungi: (1) adaptation of an existing form, (2) hybridization of two existing forms, (3) mutations, and (4) heterocaryosis. Although new forms may arise through adaptation these changes are usually more satisfactorily explained by other means. Many investigators have shown conclusively that new forms do arise from hybridization—especially well demonstrated in the Uredinales and Ustilaginales. There seems to be some conflict of evidence regarding the origin of new forms by heterocaryosis, but it must be conceded that this phenomenon would satisfactorily explain some of the sectoring that has occurred in cultures. Results of many experiments, notably by Stakman and his students, seem to prove that mutations do occur in fungi.

Results of investigations indicate that many physiologic races exist undiscovered today. Furthermore, considering the modes of origin of these races, it becomes painfully apparent that new forms are continually arising. Their importance can hardly be over-estimated. Any attempt to combat the ravages of a disease caused by such a variable fungus, in order to be successful, must be based on a comprehensive knowledge of the specialization or variation exhibited by the causal organism in various regions.

Thielaviopsis basicola (Berk. & Br.) Ferraris, until recently considered the imperfect form of *Thielavia basicola* Zopf, is known to attack a large number of plants ranging through several families, and to exist in widely separated regions of the world. An investigation of the fungus should be not only of scientific interest but should have an economic value as well, since it causes a root-rot of tobacco resulting in the loss of millions of dollars annually, seriously threatens other commercially important crops such as cotton and peanuts, and inflicts severe losses on violets, *Primula, Cyclamen,* and many of the Leguminosae. Before effective means of control of these diseases can be devised a more thorough knowledge of the variation of the causal organism is essential.

The purpose of this research was to study the variation in pathogenicity, morphology, and cultural characters of a few selected isolants of *Thielaviopsis basicola* as a basis for a more comprehensive study of the pathogen.

Acknowledgments

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The History of Physiologic Specialization in Thielaviopsis basicola

The literature pertaining to the existence of physiologic races of *Thielaviopsis basicola* is somewhat brief and scattered but it is interesting, nevertheless, in showing the general trend of thought on the subject.

Among the first to report on the existence of physiologic races of *Thielaviopsis basicola* was Rosenbaum ('12), who compared cultures of the fungus isolated from cotton, ginseng, and tobacco, arriving at the conclusion that the forms isolated from the three different hosts were identical.

Taubenhaus ('14) secured pure cultures of *Thielaviopsis basicola* from cow-peas, violets, parsnips, and tobacco, and inoculated sweet-peas with them. At the same time he ran a parallel set of inoculations, using a culture obtained from sweet-peas. Since the fungus taken from hosts other than the sweet-pea would readily infect the latter, he regarded this as indicating the absence of physiologic races.

Johnson ('16) succeeded in infecting nearly one hundred species with *Thielaviopsis basicola* from tobacco and cites this as further evidence that no specialized races of the fungus appear to exist. Later, Johnson and Hartman ('19) state:

> It should be said that as far as evidence from literature, or as far as the observation of the writer is concerned, there is nothing to indicate that specialized races of *Thielaviopsis basicola* occur, or that the fungus varies in any way in virulence owing to differences in strains or age of culture. It may be said with considerable certainty, therefore, that we are dealing with a relatively constant organism as to pathogenicity.

Kletschetoff ('26) found that artificial inoculation of soil with *Thielaviopsis basicola* resulted in flax-sick soil. He did not consider the organism as a physiologic race because he was able to infect *Viola odorata, V. tricolor, Trifolium pratense,* and *Lupinus luteus* with it.

From the Kentucky Agriculture Experiment Station ('31) is sent the report that isolants of the black root-rot organism, *Thielaviopsis basicola,* from various sources and sometimes from the same source, varied markedly in morphological characters, including presence or absence of chlamydospores or endoconidia and in rate of growth. It has not been determined whether the differences observed represent permanent differences in the races.

Tiddens ('33) isolated two races of *Thielaviopsis basicola* from *Primula obconica,* one from tobacco, and one from poinsettia. Inoculations with these isolants showed that *Primula* was more seriously damaged by the races from *Primula* than by the race from tobacco, while that from poinsettia was less virulent to them than that from tobacco. Tobacco plants were most seriously damaged by the isolant from tobacco, while the races from *Primula* were less virulent to them than that from poinsettia. Bean plants were more seriously damaged by the race from poinsettia than by that from tobacco, while races from *Primula* were less virulent to them than that from poinsettia.

Johnson and Valleau ('35), working with eleven cultures of *Thielaviopsis basicola* isolated from White Burley tobacco, found that they differ from one another when grown on potato-dextrose agar. Numerous sectors were formed when these cultures were transferred to this medium in Petri dishes after having grown a few weeks in test-tubes. Single endoconidium cultures of the original cultures differed from one another and were unstable. Further single-spore isolants of the single-spore cultures proved to be equally unstable. An albino culture and cultures producing only chlamydospores were among the variants. Eight single-spore cultures differing in appearance showed little variation in pathogenicity.

The occurrence of physiologic specialization within *Thielaviopsis basicola* was demonstrated by Sattler ('36) in inoculation experiments on tobacco, beans, and lupines. Working with collections of the fungus from the United States and Germany, he found that tobacco reacted positively only to American races isolated from tobacco, while the other two (except *Lupinus albus)* were infected by the bean *(Phaseolus multiflorus)* and *Cyclamen* races from Germany and by that from *Primula obconica* of Holland but not by the tobacco collection.

Berkner ('37), while studying the use of certain legumes in crop rotation in Silesia, noticed a severe attack of *Thielaviopsis basicola* on *Lupinus luteus* and observed that *Lupinus angustifolius,* field peas, and *Vicia villosa* were also affected. He indicated the existence of a physiologic race adapted to legumes and especially to *Lupinus luteus.*

Allison ('38) reports as follows:

Seeds of various varieties of tobacco, including Burley and flue-cured types, were sown in flats containing soil artificially infected with single-spore cultures of *Thielaviopsis basicola.* Four definite physiologic races were determined on the basis of their pathogenicity on 4 tobacco varieties: Special 400, Kentucky No. 5, Kentucky No. 16, and Harrow's Velvet. Kentucky No. 5 was moderately susceptible to race 1, while the other varieties were resistant. Kentucky No. 5 and Special 400 were moderately susceptible to race number 2, and Kentucky No. 16 and Harrow's Velvet were resistant. Kentucky No. 5 and Special 400 were susceptible, Kentucky No. 16 moderately susceptible, and Harrow's Velvet was resistant to race 3. Harrow's Velvet was moderately susceptible to race 4, while the other three varieties were susceptible. Races 1 and 2 were isolated from specimens of black root-rot obtained from Tennessee and North Carolina. Race 3 was isolated from material obtained from Tennessee and Washington, D. C. Race 4 was isolated from specimens sent from Wisconsin and Canada.

It would be an endless task to present the numerous publications dealing with the host range of *Thielaviopsis basicola.* The work of Johnson ('16) is outstanding in the presentation of a comprehensive list of all the hosts on which this fungus had been reported to occur, and includes a large number from his own observations. Since his work only a few additional hosts have been reported.

In summarized form it may be stated that the fungus has been found on 120 species in 30 families, distributed as follows: Leguminosae—43; Solanaceae—25; Cucurbitaceae—8; Compositae—5; Umbelliferae, Begoniaceae, Hydrophyllaceae, and Scrophulariaceae—each represented by 3 species; Cruciferae, Primulaceae, Chenopodiaceae, Violaceae, and Orchidaceae—2 species each; and Portulacaceae, Bignoniaceae, Oxalidaceae, Malvaceae, Araliaceae, Linaceae, Convolvulaceae, Polemoniaceae, Papaveraceae, Gesneriaceae, Liliaceae, Ranunculaceae, Oleaceae, Aquifoliaceae, Euphorbiaceae, Orobanchaceae, and Rosaceae—represented by one species each.

Materials and Methods

From a total of ten cultures of *Thielaviopsis basicola* received from various sources and isolated from several hosts, three were selected for study. Of these three, one was isolated from tobacco in Tennessee, one from cotton in Texas, and one from *Primula obconica* in Holland. For the sake of convenience, the isolant from tobacco has been assigned the letter A, that from *Primula* the letter B, and that from cotton the letter C. Single-spore cultures were made from each, and stock cultures were prepared by mass transfers from the single-spore colonies. The single-spore colonies originated from endoconidia isolated according to the method suggested by Lambert ('39). All stock cultures were grown at room temperatures in test-tubes containing 10 cc. of Difco potato-dextrose agar with a pH of 5.6. Throughout the entire study of cultural behavior 20-cc. lots of media in 9-cm. Petri dishes were used.

In comparing the three races of *Thielaviopsis basicola* the author has used rather freely the patterns of frequency and growth curves as a basis. At first, this may seem like a rather obscure method of comparing racial characters but it reveals certain differences that could be noted in no other way. For example, in fig. 1 the various patterns of the growth curves represent clearly differences in behavior of races A, B, and C. Again, in fig. 9 the patterns of frequency curves of chlamydospore chain lengths reveal distinctive differences in behavior, as in race A, for instance, where a great majority of the spore chains fall in the class having a length of 31.35 μ and give the curve a high, narrow peak with very little spread. B, on the other hand, has the majority of its spore chains distributed through a range between 31.35 and 54.15 μ, creating an entirely different pattern with a much lower apex and a much wider spread. The fact that A produces chains largely of the same length while those formed by B vary greatly in length certainly forms the basis for a differential character between the two races which is well demonstrated by the patterns of the curves.

Variation in Culture

The three isolants of *Thielaviopsis basicola* were studied for variation in culture. Leonian's agar and onion agar were prepared after the recommendations of Riker and Riker ('36), and the acidity of each adjusted to a pH of 5.8. Difco potato-dextrose agar with a pH of 5.8 was also used. Each medium was made up in a single lot and all three were tubed, sterilized, and poured at the same time.

All Petri dishes were inoculated at the same time from stock cultures of the same age, each culture originating from a single endospore. Six or seven cultures of each race were started on each of the three media, and an attempt was made to equalize the amount of inoculum used. The cultures were incubated in a glass case at room temperatures ranging from 21° to 29° C., and observed for fifteen days. The positions of the cultures within the cases were frequently shifted in order to reduce the possibility of exposure to slightly different environmental conditions.

Room conditions were so variable over a period of five months that it was impossible to duplicate results exactly despite the fact that four different sets of cultures were observed. On each medium the individual colonies of each race were similar within a set but different between sets. In other words, in race C a group of cultures on potato-dextrose agar observed February 12 differed from a set observed November 15. This variation between sets was probably due, to a small extent, to variation of culture media, since the media were made up in separate lots for each set. Cultures kept in incubation chambers under constant conditions failed to show a marked variation from set to set. For this reason the variation exhibited between sets started at different dates was attributed largely to variable room conditions. The races were compared under room conditions, in preference to the constant conditions of an incubator, because the variable environmental factors brought out more striking differences.

Race C was found to vary more than the other two races between sets of cultures observed November 15, February 12, and March 8, exhibiting a wide range of color, zonation, sectoring, and type of mycelial growth. This would seem to indicate that race C is more reactive to environment than either of the other races, but it is probable that its inherent instability is in part responsible for the variation. Race A was very constant between sets, showing slight variation in any respect, while B was intermediate in variability.

Considering a single set of cultures, however, the variation among the colonies of a race on the same medium was surprisingly small, as shown by plates 42 and 43. Again race C showed the most variation in color, zonation, sectoring, and type of mycelial growth. In this case it seems that the slight variation must be due to the relative instability of the race. The colonies of A were practically alike while race B showed very slight variation.

In table I are summarized the cultural characteristics of races A, B, and C. The data were taken fifteen days after inoculation, with the exception of the diameters of the colonies. The latter were recorded at the end of twelve days because of difficulty in securing accurate measurements beyond this period—a difficulty due to uneven growth of the edges of the colonies.

Unfortunately, photographs of the cultures employed in securing data were faulty, except those on Leonian's agar. Photographs of cultures on onion and potato-dextrose agars at the age of nine days have been substituted, so there may be slight discrepancies between the photographs and the descriptions of table I.

The data included in table I, combined with the photographs, can leave little doubt that the three races are culturally distinct. One of the characters serving best to differentiate the three isolants is zonation. Regardless of the medium, race A shows only a very faint or no zonation. When this character is noticeable in cultures of A it is usually due to a single band of scanty, more or less appressed mycelium which may or may not differ slightly in shade of color. Race B shows definite zonation which varies from 5 to 10 bands generally ranging through several shades of gray. Race C produces the most striking zonation, 5 to 15 zones distinguished by various colors, usually some shade of gray, and by a difference in the compactness of the mycelium.

Race C is further distinguished by the production of white V-shaped sectors, usually more or less appressed and farinose, rarely felty. Their frequency varies with the medium employed. On potato-dextrose agar sectors appear occasionally; on Leonian's agar they are more frequent; and on onion agar there are several sectors in each colony, giving a somewhat star-shaped appearance (pl. 42). Sometimes these sectors are

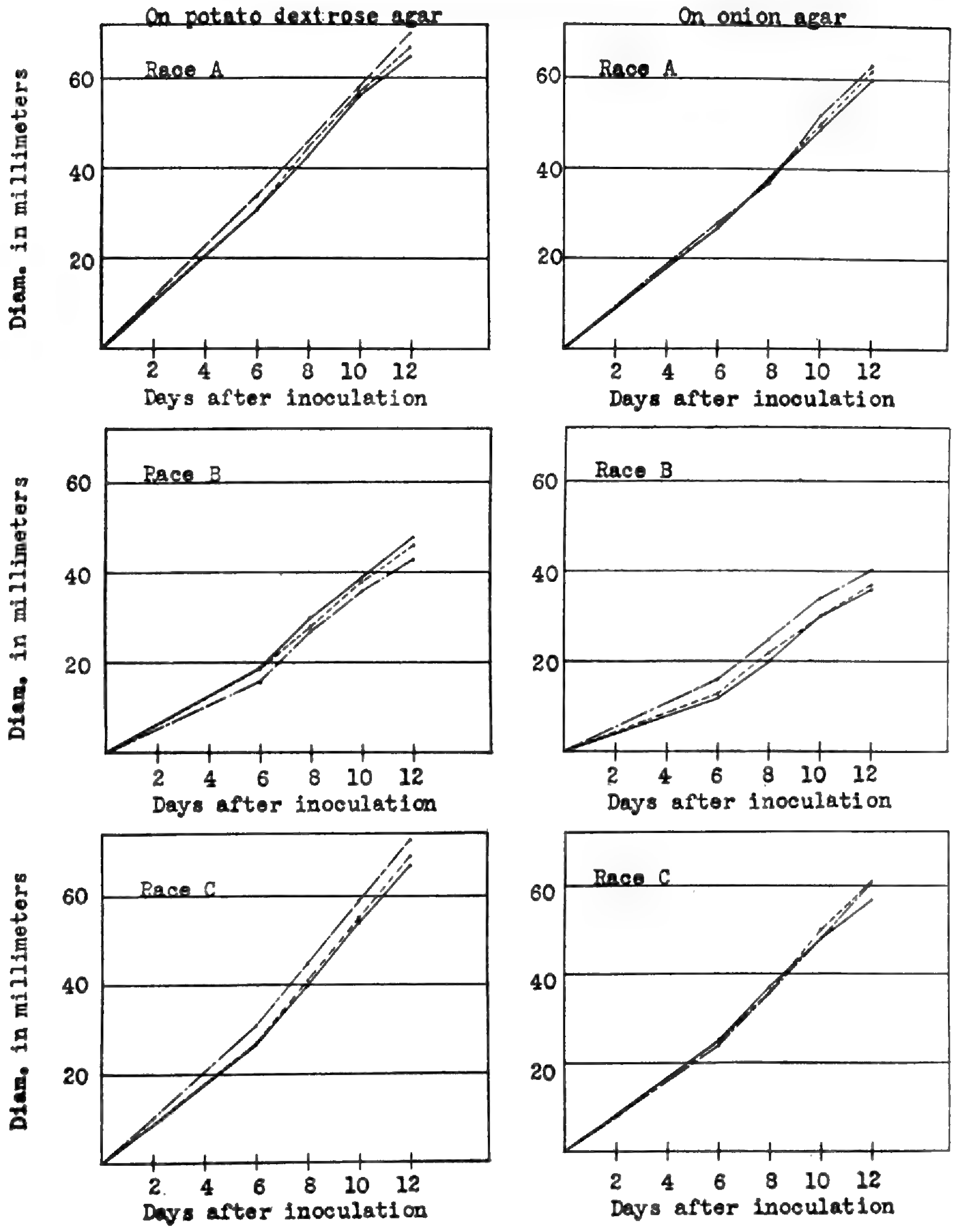

Fig. 1. Growth curves of races A, B, and C on potato-dextrose and onion agars. Growth of three colonies of each race plotted separately.

quite large, occupying as much as half the area of a colony. The stability of the sectors has not yet been established.

Most of the data used so far to differentiate the races have been purely of a qualitative nature. The average diameters of the three isolants on the various media form a quantitative basis for some interesting comparisons. Often throughout the following discussion reference will be made to the relative rates of growth of the isolants. It should be mentioned that the actual rates of growth have never been computed, but the average diameters have been used as an index of the growth rates since they are directly proportional to them. The average diameters 12 days after inoculation are recorded in table I. Reference to this table and to figs. 1 and 2 shows that A has a more rapid rate of growth on both Leonian's and onion agars than either B or C but is surpassed by C on potato-dextrose agar. On all media the growth rate of C is a great deal below that of either A or C. All three races grow fastest on potato-dextrose agar, slowest on Leonian's agar, and at an intermediate rate on onion agar. Statistically, the differences between diameters in A and B and B and C are in every case highly significant but those between A and C are much less so (table II).

Colonies of the same race were studied on various media in an effort to find a differential response of the races. Evidently there was a variation in their ability to grow on the different media. This is best shown in fig. 4, where the average growth of five colonies is considered. Since the greatest amount of growth was secured on potato-dextrose agar, this was chosen as a standard and represented by a 100 per cent. The growths of the races on the other media were plotted in percentages of the standard. It immediately becomes apparent that although the growth rate of A is greatly affected by the medium, that of both B and C is affected to a greater extent. This diagram also shows that B is capable of growing to better advantage than C on Leonian's agar while C grows better than B on onion agar.

A study of the growth curves in figs. 1 and 2 reveals certain differences in the behavior of the three races. In each case the diameters of three colonies are plotted separately to give an idea of the variation within the race. On potato-dextrose one immediately notices that not only do the colonies of the three races differ in size but that there are distinct differences in the

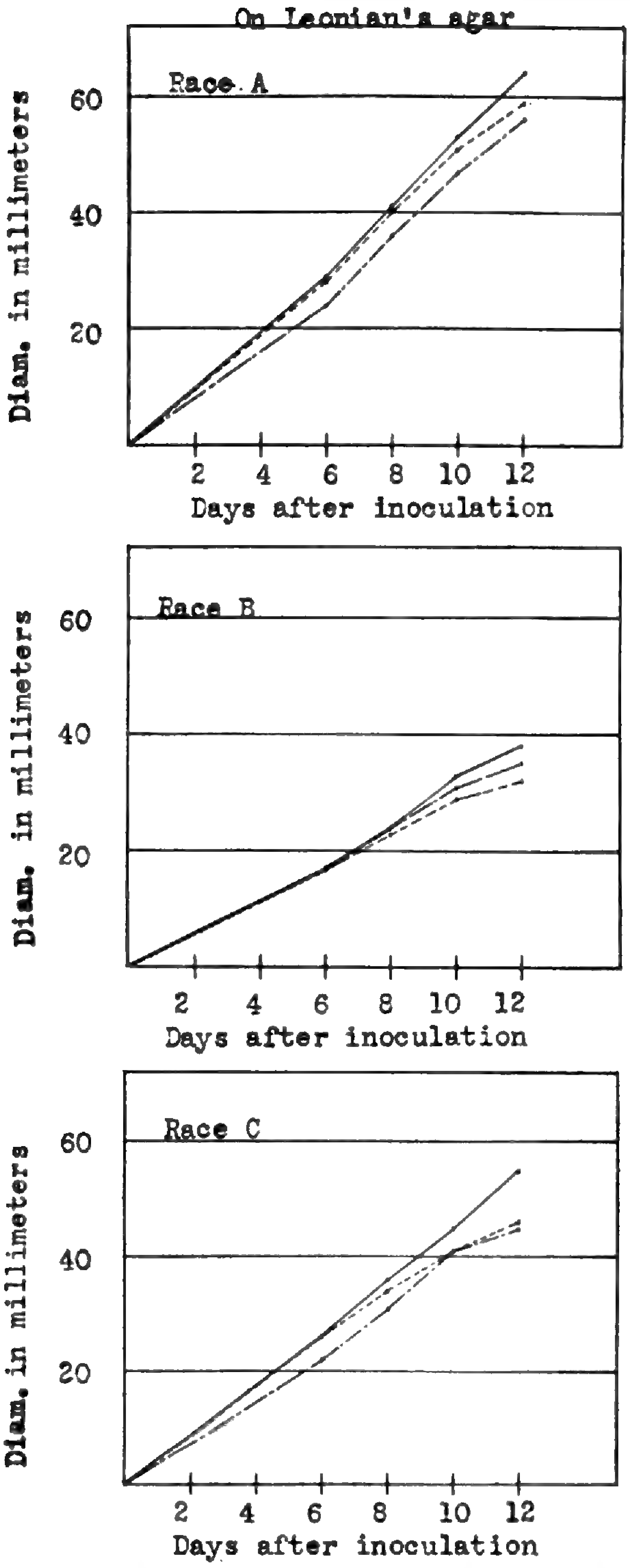

Fig. 2. Growth curves of races A, B, and C on Leonian's agar. Growth of three colonies of each race plotted separately.

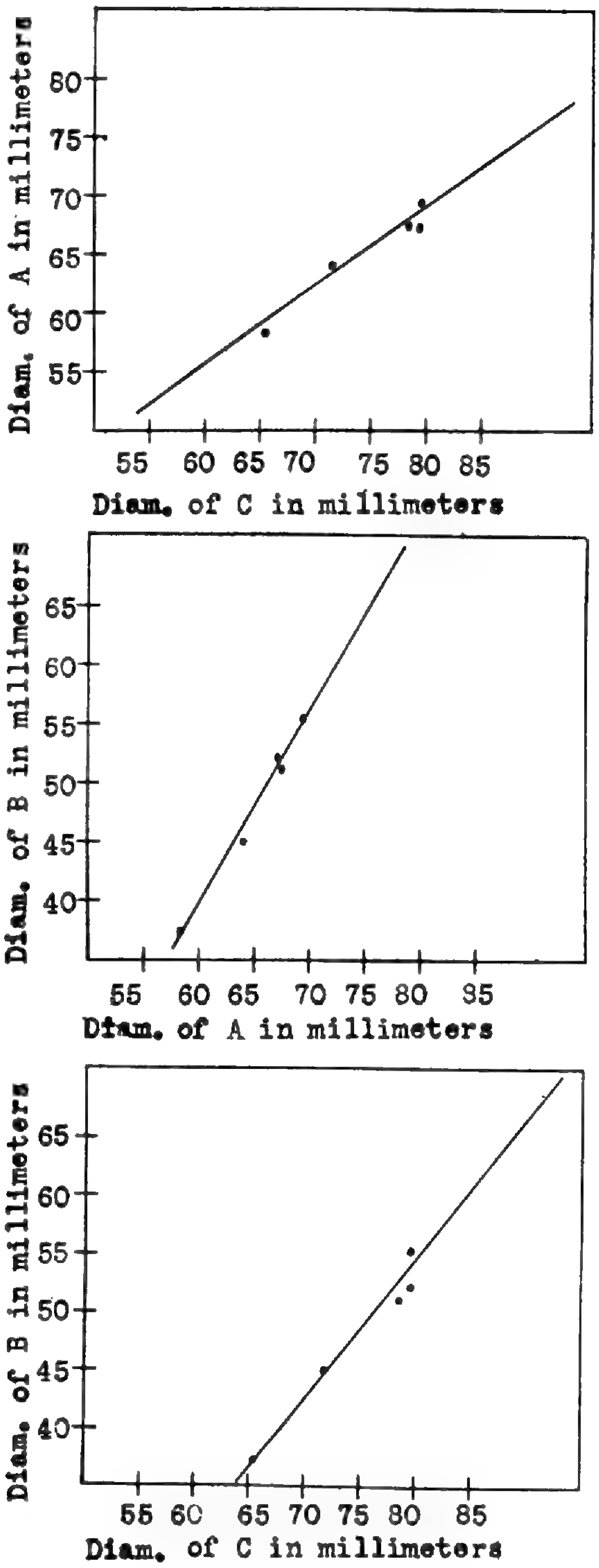

Fig. 3. Relative influence of hydrogen-ion concentration on growth of races A, B, and C. Explanation in text.

patterns of the growth curves. Eight to ten days after inoculation growth-inhibiting factors of some kind seem to be affecting the growth of B. In race C these factors have not made

TABLE I

CULTURAL CHARACTERISTICS OF THREE RACES OF *THIELAVIOPSIS BASICOLA* ON VARIOUS MEDIA FIFTEEN DAYS AFTER INOCULATION

Race and Medium	Diam. colonies in mm.*	Color †	Zonation	Type of mycelium and sectoring
A Potato-dextrose	67.33 ± 0.45	Light cinnamon-drab	Slight—1 band of scanty, appressed mycelium	Cottony, farinose; no sectoring
B Potato-dextrose	45.29 ± 0.48	Predominately gull-gray, some zones a light mouse-gray	5 to 7 faint zones of varying color	Cottony, outer part farinose; no sectoring
C Potato-dextrose	69.43 ± 0.49	From vinaceous-fawn in the center to pale mouse-gray and neutral gray in outer portions	5 to 7 pronounced zones	Felty, white V-shaped sectors
A Onion	62.17 ± 0.61	From dusky drab in center to blackish brown (3) and dark olive-gray on outer edge	Slight—1 band of scanty, appressed mycelium	Cottony, farinose; no sectoring
B Onion	37.16 ± 0.53	Mouse-gray in center to light olive-gray and white at outer edge	7 to 8 zones of varying color	Felty, farinose; no sectoring
C Onion	59.5 ± 0.65	From cinnamon-drab in center to deep neutral gray and mouse-gray in outer portions	8 to 10 zones of varying color	Part felty, part appressed and farinose; many sectors
A Leonian's	60.44 ± 0.7	Vinaceous-fawn	Slight—1 band of scanty, appressed mycelium	Cottony, farinose; no sectoring
B Leonian's	34.86 ± 0.5	From mouse-gray in center to deep neutral gray and pale gull-gray in outer portions	8 to 10 pronounced zones	Felty, outer part farinose; no sectoring
C Leonian's	48.0 ± 1.04	Mouse-gray in center, predominately olive-gray and gull-gray in outer portions	10 to 15 pronounced zones	Felty, portions appressed and farinose; several sectors

* Average diameters of five colonies 12 days after inoculation.
† Colors according to Ridgway's "Color Standards and Color Nomenclature." 1912.

their appearance by the end of twelve days but in race A they may be observed from ten to twelve days after inoculation. Apparently A is able to grow faster than C for a few days following inoculation but by the end of twelve days the diameters of colonies of C surpass those of A, due partially to

TABLE II

SUMMARY OF STATISTICAL DIFFERENCES IN DIAMETERS OF THREE RACES OF *THIELAVIOPSIS BASICOLA* ON VARIOUS MEDIA

Comparisons	Medium	Differences, in mm.	Difference divided by probable error
A and B	Potato-dextrose	22.04 ± 0.66	33.4
A and C	Potato-dextrose	2.1 ± 0.66	3.2
B and C	Potato-dextrose	24.14 ± 0.68	35.5
A and B	Onion	25.01 ± 0.82	30.5
A and C	Onion	2.67 ± 0.89	3.0
B and C	Onion	22.34 ± 0.84	26.6
A and B	Leonian's	25.58 ± 0.86	29.7
A and C	Leonian's	12.44 ± 1.25	9.9
B and C	Leonian's	13.14 ± 1.15	11.4
$A_{p.d.}$ and A_o*		5.16 ± 0.19	27.2
$B_{p.d.}$ and B_o		8.13 ± 0.18	45.2
$C_{p.d.}$ and C_o		9.93 ± 0.18	55.2
$A_{p.d.}$ and A_L		6.89 ± 0.84	8.2
$B_{p.d.}$ and B_L		10.43 ± 0.69	15.1
$C_{p.d.}$ and C_L		21.43 ± 1.14	18.8
A_o and A_L		1.73 ± 0.93	1.9
B_o and B_L		2.3 ± 0.73	3.2
C_o and C_L		11.5 ± 1.22	9.4

* $A_{p.d.}$, $B_{p.d.}$, $C_{p.d.}$—A, B, and C on potato-dextrose agar.
A_o, B_o, C_o—A, B, and C on onion agar.
A_L, B_L, C_L—A, B, and C on Leonian's agar.

an increase in C's rate of growth and partially to growth-inhibiting factors affecting A. A comparison of the growth curves of the isolants on Leonian's agar will show similar differences in pattern. Here, growth-inhibiting factors are definitely affecting both B and C from ten to twelve days after inoculation while A is influenced very slightly. Again, the colonies of A on onion agar grow much more rapidly than C immediately after inoculation but C later exceeds A in rate of growth. The term "growth-inhibiting factors" has been used rather loosely to designate any factors of the fungus, medium, or environment that tends to reduce the rate of growth. It should be remembered, however, that in each set of experiments the fungus is theoretically the only variable.

The fact that varying hydrogen-ion concentrations generally affect the virulence of *Thielaviopsis basicola* suggested that the three races studied might respond differently. Since the time and facilities for a study of the effect of hydrogen-ion concentration on the virulence of the fungus were lacking, observations were made of its effect on the races in culture. For this experiment Difco potato-dextrose agar was made up in a single lot and the acidity of portions adjusted to pH 4,5,6,7, and 8, respectively. Cultures of all three races were made at each of the pH values and incubated at 20° C. Observations were made for eleven days. There were very slight changes in appearance of the colonies at different acidities—so slight that no attempt was made to record them. The rates of growth showed a greater variation and were easily measured as expressed by the average diameters of the colonies at the end of eleven days. This data is recorded in table III.

In all cases the rates of growth were more influenced by the changes from pH 4 to 6 than from 6 to 8. Oddly enough, the growth rates continued to increase up to pH 8, or at least the diameters of all the colonies observed were greatest at this concentration. A pH of 8 had been considered above the optimum for growth but unfortunately the results fail to show the

TABLE III

RELATIVE EFFECT OF pH ON DIAMETERS OF COLONIES AND PRODUCTION OF CHLAMYDOSPORES OF RACES OF *THIELAVIOPSIS BASICOLA*

Race	pH	Average diameters in mm. of five colonies	Relative production of chlamydospores
A	4	58.3 ± 0.23	Medium
A	5	64.0 ± 0.24	Heavy
A	6	67.5 ± 0.15	Heavy–
A	7	67.2 ± 0.32	Light+
A	8	69.6 ± 0.20	Light
B	4	37.2 ± 0.68	Heavy
B	5	45.0 ± 0.43	Medium+
B	6	51.2 ± 0.53	Heavy
B	7	52.4 ± 0.63	Heavy
B	8	55.6 ± 0.27	Heavy
C	4	65.7 ± 0.23	Light–
C	5	71.7 ± 0.60	Light–
C	6	78.6 ± 0.66	Light
C	7	79.3 ± 0.50	Light
C	8	79.4 ± 0.40	Light

expected decrease in rate of growth on the basic end of the scale. As originally planned, this experiment would have shown the relative inhibiting action of less favorable hydrogen-ion concentration on each side of an optimum.

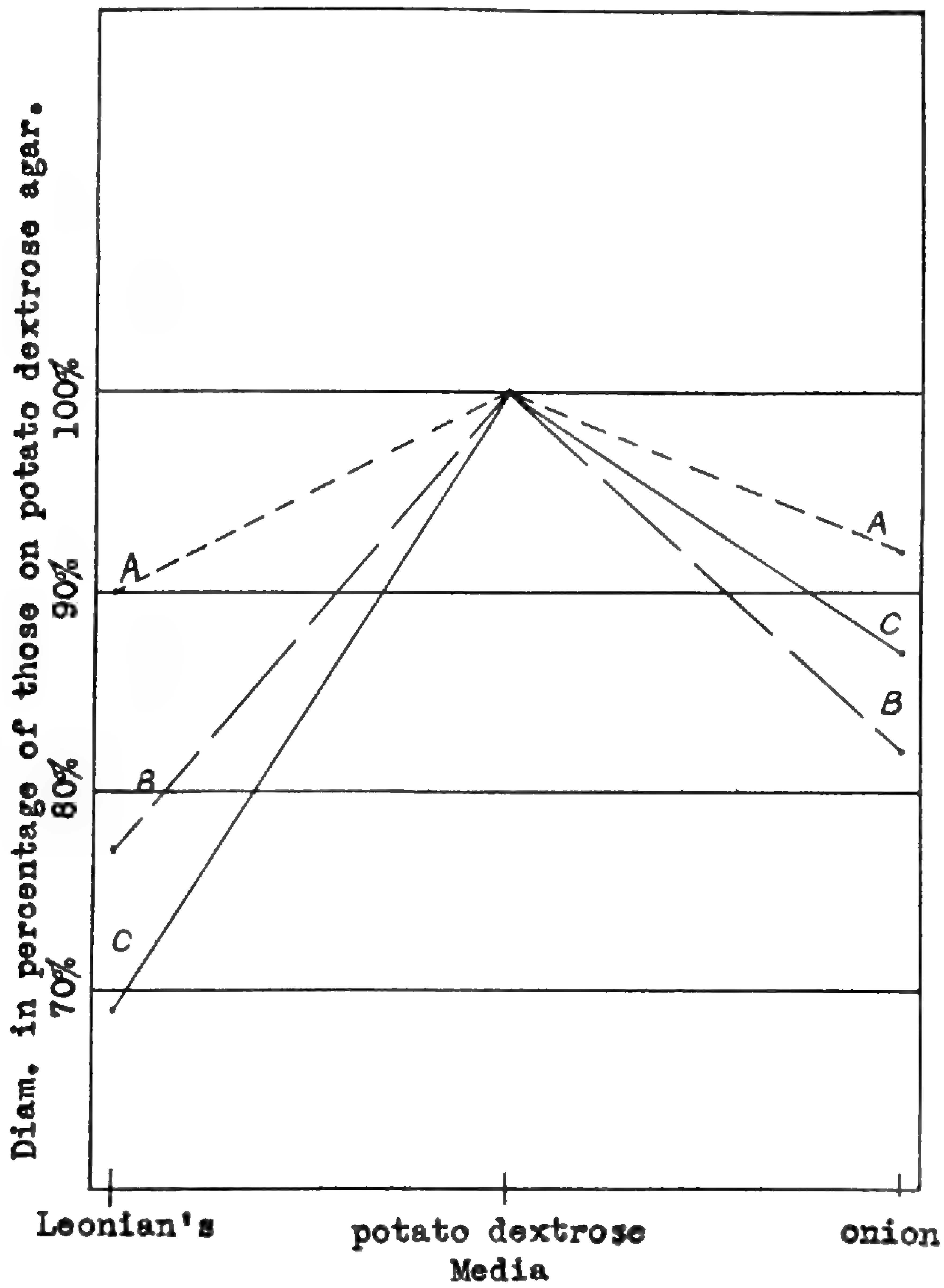

Fig. 4. Relative influence of media on the growth of races A, B, and C. Based on averages of five colonies of each race.

In order to get an idea of the relative effect of hydrogen-ion concentration on the three races the average diameters of one race were plotted against those of each of the other two as shown in fig. 3. For instance, in one graph the average diameter of five colonies of A at pH 4 were plotted against the average diameter of five colonies of race C at a pH of 4, and so on up the scale to a pH of 8. In another graph, A was plotted against B and in a third B was plotted against C. If the two races compared were equally affected the line formed by plotting their average diameters should form angles of 45° with the abscissa and ordinate. If, however, the two races

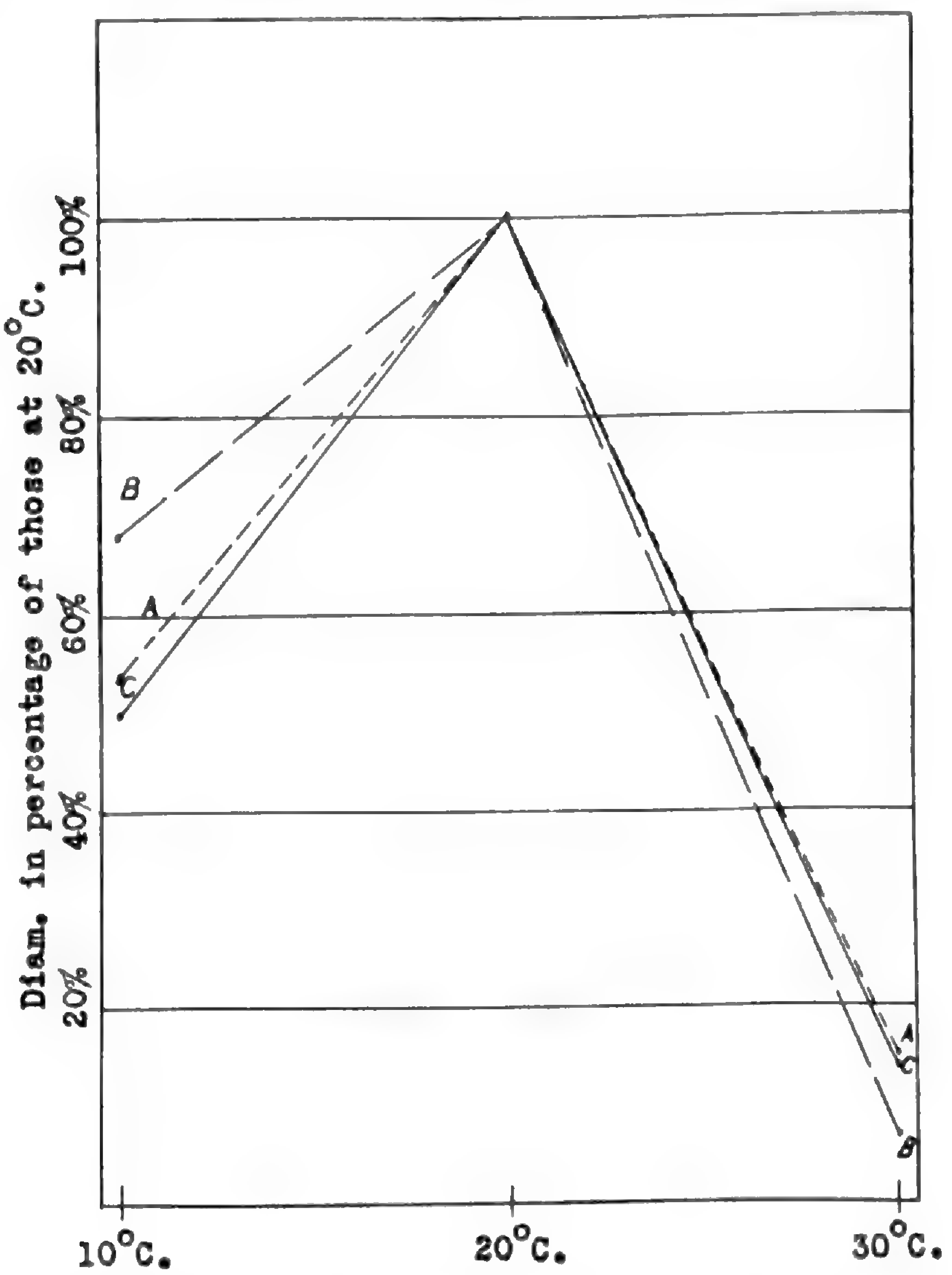

Fig. 5. Relative influence of temperature on the growth of races A, B, and C. Based on averages of five colonies of each race.

are unequally affected, as for example are A and B, the angles will differ. Since B is affected to a greater extent than A and since B is recorded on the axis of the ordinates the angles between the ordinate and the plotted line is less than 45°. In comparing the three races B was found to be most reactive to a variation in pH while race A was least affected.

A slight variation in the shade of color exhibited by race A on media of different pH suggested that perhaps the development of chlamydospores was influenced by these changes in hydrogen-ion concentration. An examination of the cultures showed a striking variation in chlamydospore formation (table III). Race A was greatly influenced by changes in hydrogen-ion concentration—spore production being greatly retarded by lower concentrations—while B and C were not noticeably affected.

In order to study the effect of temperature on the rate of growth, cultures of each race of *Thielaviopsis basicola* were incubated at 10° C., 20° C., and 30° C. The cultures were made following the usual procedure, on potato-dextrose agar with a pH of 5.6. The average diameters at the end of twelve days are recorded in table IV. Fig. 5 shows more plainly the variation in response to temperature. Since 20° C. is probably nearest the optimum for all three races, growth at that temperature was selected for a standard. As in fig. 4, this growth is considered a 100 per cent and the growth at the other temperatures plotted as percentages of the standard. From this diagram one can see that a change from 20° C. to 10° C. affects all races much less than a change from 20° C. to 30° C. Race B is least affected of the three by a change to 10° C. and most greatly influenced by a change to 30° C. while A is slightly less affected in both cases than C. The one outstanding variation shown here, and perhaps the only significant one, was the behavior of B at 10° C. It would seem to indicate that B is relatively better adapted to growth at lower temperatures than are A and C. Chlamydospore pro-

TABLE IV

AVERAGE DIAMETERS* OF RACES OF *THIELAVOPSIS BASICOLA* AT VARIOUS TEMPERATURES TWELVE DAYS AFTER INOCULATION

Race	10° C.	20° C.	30° C.
A	40.5 mm.	75.3 mm.	10.8 mm.
B	33.2 mm.	48.8 mm.	3.3 mm.
C	41.8 mm.	83.2 mm.	12.2 mm.

* Average diameters of five colonies.

duction was found to be about the same at 10° C. and 20° C., decreasing at 30° C. This tendency extended throughout all three races and failed to disclose any differential reactions.

Morphological Comparisons

Before entering into a comparison of the morphological characters of the three races of *Thielaviopsis basicola* perhaps it would be wise to give a brief description of the fungus.

Thielaviopsis basicola (Berk. & Br.) Ferraris, in the light of information furnished by McCormick ('25), is generally considered a member of the Fungi Imperfecti. More specifically, the fungus is classified under the Amerosporeae in the Dematiaceae. The mycelium of the fungus is made up of septate hyphae, variously branched, whose diameters range from 3 to 7 μ. The hyphae are hyaline when young but may become brown with age. The amount of protoplasm seems to decrease with age, and often the walls of the older hyphae are more or less collapsed.

Two very characteristic spore forms are produced by this fungus. The first to appear are the endoconidia which are formed by hyaline branches of the mycelium known as endoconidiophores. These endoconidiophores are phialides consisting of a bulbous base ranging from 5 to 10 μ in diameter, and an elongate barrel 50 to 90 μ in length, gradually tapering to a diameter of from 3 to 7 μ. They arise as small protrusions from near the center of a hyphal cell into which a nucleus migrates after a division of the single parent-cell nucleus (Brierley, '15). The endoconidiophore is soon cut off from the vegetative hyphae by a cross-wall. Within the barrel of the endoconidiophore are successively formed a number of hyaline endoconidia whose walls result from a tangential splitting of the walls of the barrel and from the laying down of a transverse wall at the lower end. The end of the sheath is ruptured with the production of the first conidium and a chain of spores is gradually extruded. The endoconidia vary greatly in size—from 3 to 6 μ in width and from 8 to 30 μ in length. The hyaline spores have a single nucleus and usually two vacuoles and are capable of germinating immediately to form a new mycelium. Although this spore form is exceedingly abundant in culture it was seldom noticed on the host plants.

The chlamydospores seem to grow from any part of the mycelium and may occur in clusters composed of many chains, whorls of two or three chains, or in single chains. They may be borne laterally or terminally on the hyphae. The chains are composed of three to nine spores, some of which are thick-walled and brown but one or more basal spores may be thin-walled and hyaline. Occasionally, these hyaline spores are not basally located. At maturity the spores tend to break apart and each is capable of germinating into a new mycelium. They are well adapted as resting spores and are thought to function in that capacity. They are abundant on the lesions produced on the various host plants. According to Brierley ('15), the chlamydospores are formed successively in the development of a hypha of limited growth.

The fact that the three races of *Thielaviopsis basicola* differed so distinctly in culture encouraged the belief that minor morphological differences might exist. Preliminary observations indicated that the endoconidia, endoconidiophores, and the chains of chlamydospores would lend themselves very well to measurement. Temporary slides were made from each race by mounting samples in lacto-phenol. Four samples of each

TABLE V

SUMMARY OF LENGTH AND WIDTH OF ENDOSPORES OF THREE RACES OF *THIELAVIOPSIS BASICOLA*

Race	Number spores measured	Length in microns		Width in microns	
		Mean	Range	Mean	Range
On potato-dextrose					
A	100	11.86 ± 0.19	7.6–22.8	4.15 ± 0.03	3.33–5.7
B	100	15.64 ± 0.23	7.6–28.5	4.72 ± 0.55	3.33–5.7
C	100	13.91 ± 0.25	7.6–28.5	4.32 ± 0.04	3.8 –5.7
On onion agar					
A	100	11.74 ± 0.11	7.6–17.1	4.09 ± 0.02	3.33–4.75
B	100	14.74 ± 0.18	7.6–24.7	4.45 ± 0.03	3.33–5.7
C	100	14.21 ± 0.22	7.6–24.7	4.41 ± 0.04	3.33–5.7

race from approximately the same position in different colonies were taken when the cultures were fifteen days old. Observations were made on cultures grown on potato-dextrose agar.

In table v are recorded the results of observations on the length and width of endospores. The endospores produced by race B are longer than those produced by C, and those of C are longer than those from A. The three races range within approximately the same limits with the exception of the upper limit of endospore length shown by race A. Race B produces the widest endospores and A the narrowest.

Table vi indicates that all of the differences in length and width of endospores are statistically significant with the exception of those between B and C on onion agar. It was thought that the kind of medium employed would have a great effect on the size of spores produced. However, a glance at table vi will show that the differences in spore size between colonies of the same race on different media are statistically insignificant, with the exception of race B on potato-dextrose and onion agars.

TABLE VI

SUMMARY OF STATISTICAL DIFFERENCES IN RELATIVE LENGTH AND WIDTH OF ENDOSPORES OF THREE RACES OF *THIELAVIOPSIS BASICOLA*

Races compared	Differences		Differences between means divided by probable error of differences	
	Length μ	Width μ	Length μ	Width μ
On potato-dextrose				
A & B	3.78 ± 0.29	0.57 ± 0.05	13.0	11.4
A & C	2.05 ± 0.32	0.17 ± 0.05	6.4	3.4
B & C	1.73 ± 0.34	0.4 ± 0.06	5.1	6.7
On onion agar				
A & B	3.0 ± 0.21	0.36 ± 0.04	14.3	9.0
A & C	2.47 ± 0.25	0.32 ± 0.04	9.9	8.0
B & C	0.53 ± 0.28	0.04 ± 0.05	1.9	0.8
A_{pd} & A_o*	0.12 ± 0.22	0.06 ± 0.04	0.55	1.5
B_{pd} & B_o	0.9 ± 0.29	0.27 ± 0.05	3.1	5.4
C_{pd} & C_o	0.3 ± 0.34	0.09 ± 0.06	0.88	1.5

* A_{pd}, B_{pd}, C_{pd}—A, B, and C on potato-dextrose agar.
A_o, B_o, C_o—A, B, and C on onion agar.

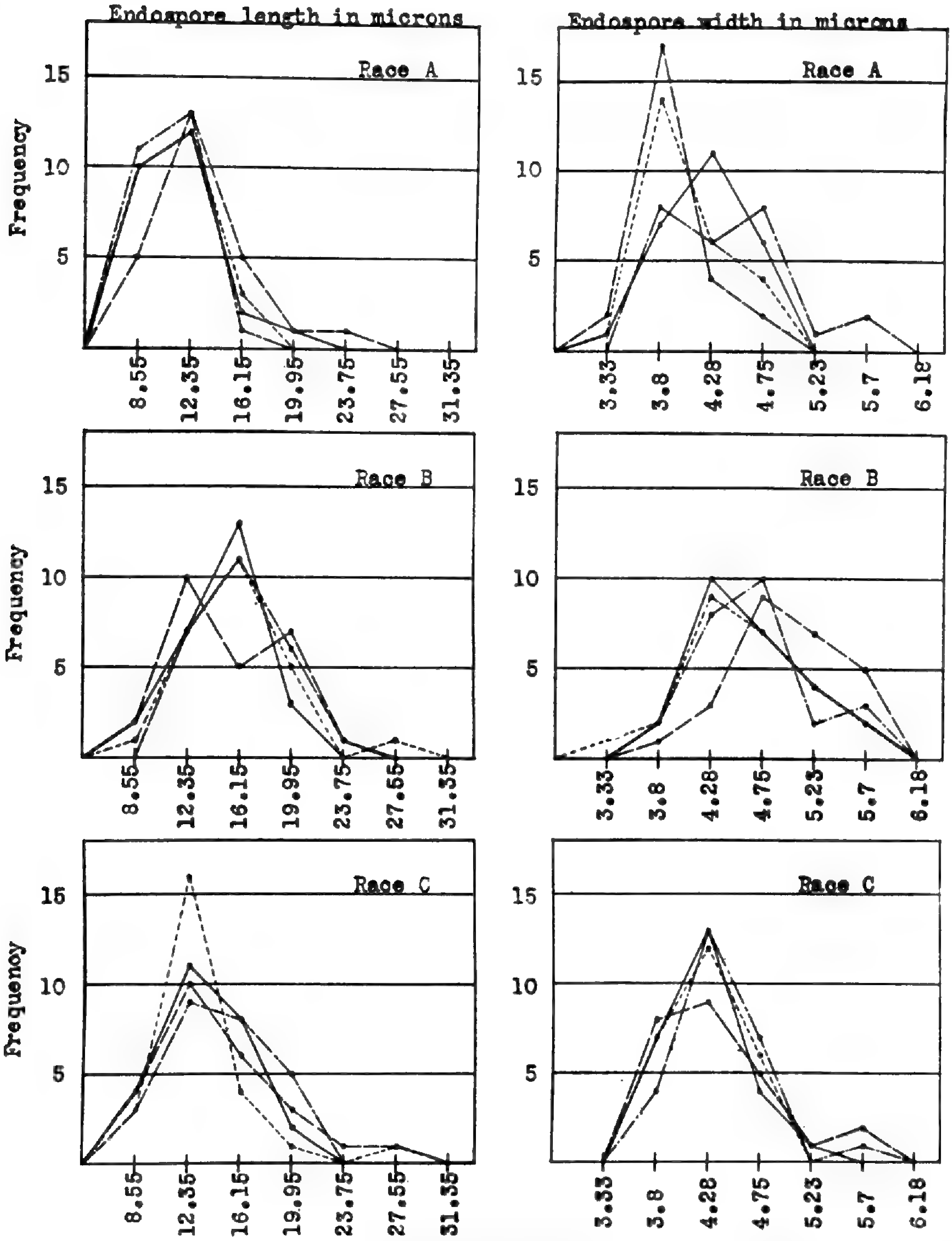

Fig. 6. Frequency curves of endospore lengths and widths of races A, B, and C on potato-dextrose agar. Samples from 4 colonies, each of 25 measurements, were plotted separately in each graph.

In fig. 6 are plotted frequency curves of the endospore length and width on potato-dextrose agar. Four samples of twenty-five measurements each are plotted separately for each race, each sample being taken from a separate colony. The most conspicuous features of these graphs are the distinct differences in pattern shown by the three races as well as the variability within the races. For instance, the samples of race A are surprisingly similar, all showing the same mode, 12.35 μ, and practically the same pattern. The samples of C have the same mode as those of A but show a much greater variation in pattern between the four samples. In addition, the general pattern exhibited by samples of C shows a much greater spread. Samples of B have a mode of 16.15 μ and the frequency curves have a pattern different from those of A and C.

In the light of information on spore lengths one would expect the spore widths to be most constant between samples of A, with B intermediate, and C most variable. Oddly enough, this order is reversed, with A most variable and C most constant. C has a mode of 4.28 μ; two samples of B have modes of 4.28 μ, and two of 4.75 μ; while three samples of A show modes of 3.8 μ, and one, 4.28 μ.

By plotting the widths of the endospores against their corresponding lengths (fig. 7) a slight difference in trend may be detected in race C. In race A an increase in length is usually accompanied by an increase in width. There is a slight difference in this respect between A and B, but race C is distinctly different. Although in race C a small increase in endospore width accompanied increases in length, it is proportionately much less than in A and B.

The same samples employed for a study of the endospores were used in the measurement of chlamydospores. A study of the chlamydospores revealed that the spore chains of A were shorter and broader than those of B and C, and those of B were longer and narrower than those of C. These measurements are summarized in table VII and the differences are statistically significant (table VIII).

The arrangement of the spore chains on the hyphae varied with the races but it was not a character lending itself easily to quantitative measurement. It may be stated, however, that in race A the chains were often in large conspicuous clusters. In race B the number of chains in a group usually ranged from one to three and in C seldom more than one chain arose from a point on the hypha (pl. 44).

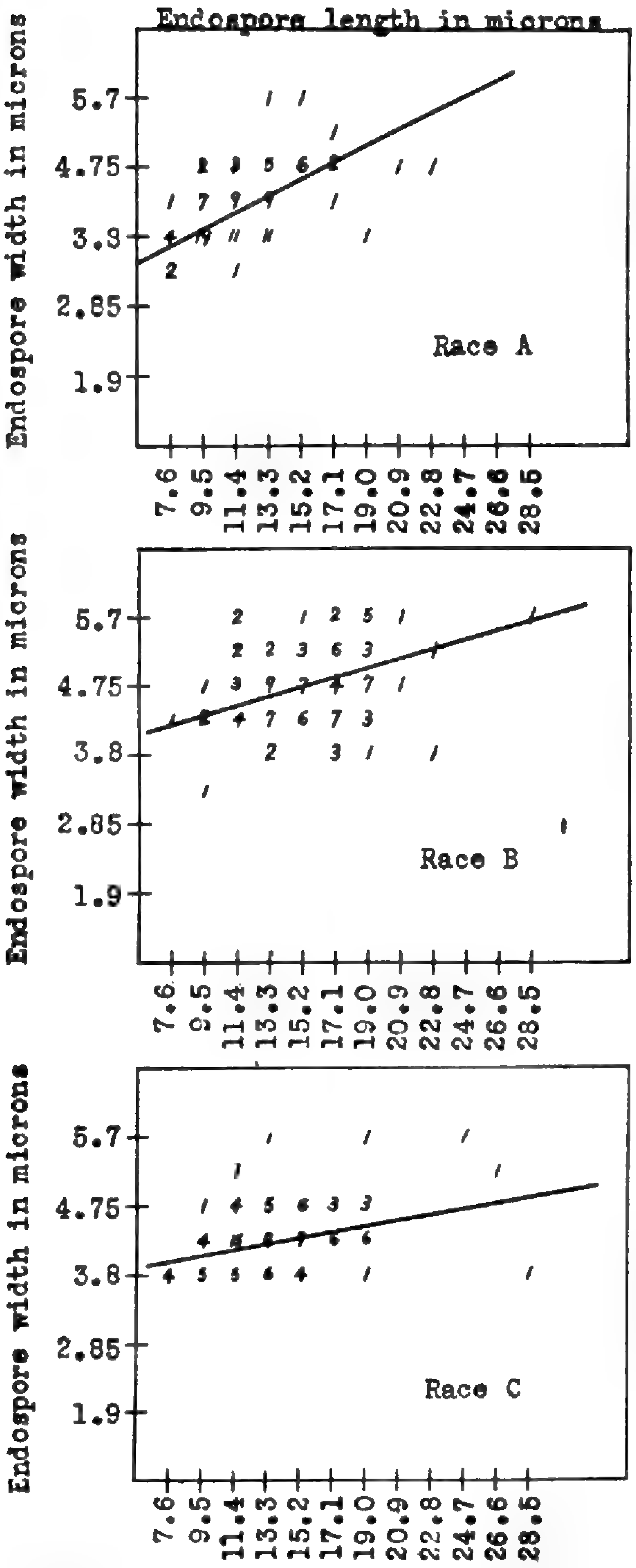

Fig. 7. Relation of endospore length and width of races A, B, and C. Based on 100 spore measurements.

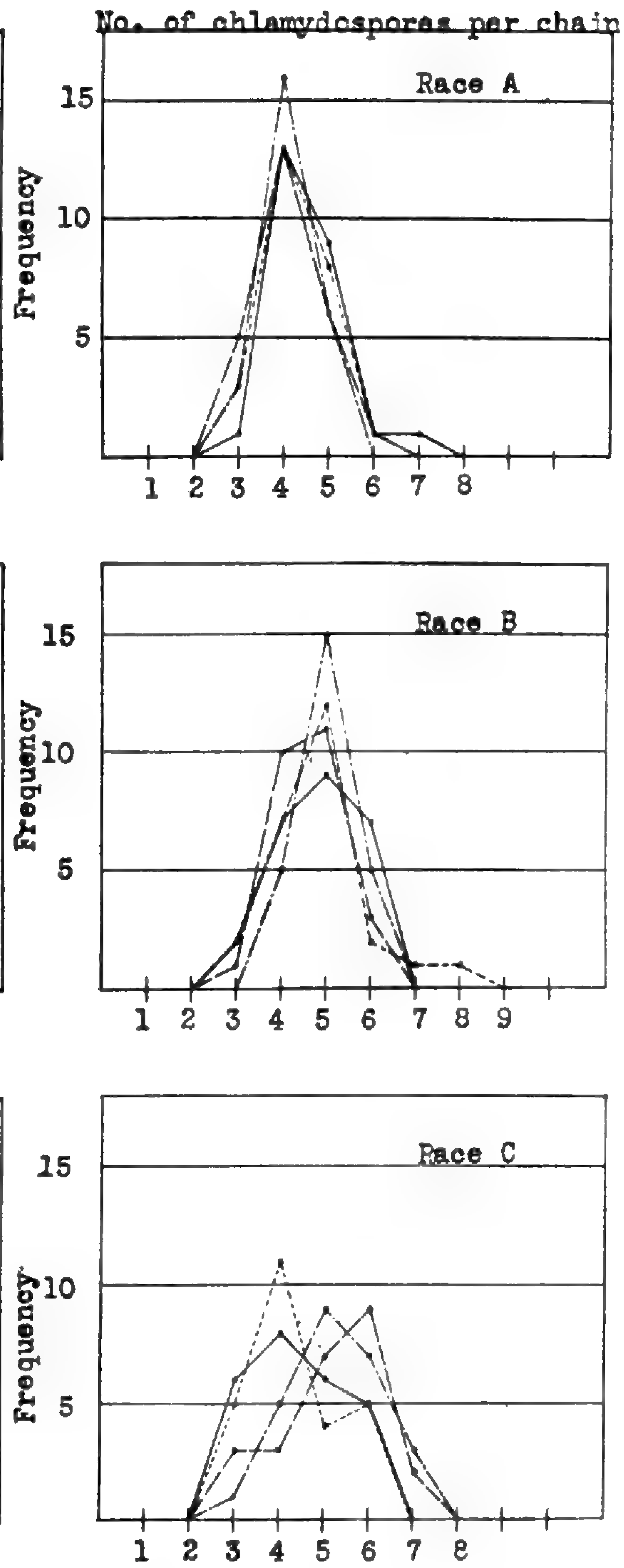

Fig. 8. Frequency curves of the number of chlamydospores per chain for races A, B, and C. Samples of 25 measurements from four different colors are plotted separately.

The frequency curves of chlamydospore chain lengths of race A are remarkably similar in pattern, all having a very narrow spread and a mode of 31.35 μ (fig. 9). The four samples of C are more varied than those of A as shown by the differences in pattern between the samples and the fact that two samples have modes of 31.35 μ and two of 38.95 μ. They all show a much greater spread than samples of A. The curves representing B are very distinctive due to the extremely wide spread near their tops.

The number of spores in each chain formed the basis for another differentiating character. The arithmetic mean fails to show the true differences in this case. A has a mean of 4.26 spores per chain, and B and C have 4.83. According to the arithmetic mean, B and C are identical in the number of chlamydospores in a chain but the frequency curves in fig. 8 show that there is a great difference between these races. There are differences in the patterns of the curves of all three races. A is very constant, all four samples exhibiting a narrow spread and a mode of 4. B is more variable than A, has a somewhat wider spread, and a mode of 5. C is extremely variable, and the four samples measured have three different modes. Two samples have modes of 4, one a mode of 5, and one a mode of 6. The curves show an even greater spread than those of B.

TABLE VII

LENGTH AND WIDTH OF CHLAMYDOSPORE CHAINS OF THREE RACES OF *THIELAVIOPSIS BASICOLA*

Race	No. chains measured	Length in microns		Width in microns	
		Mean	Range	Mean	Range
A	100	32.36 ± 0.31	20.9–55.1	11.86 ± 0.03	9.5–13.3
B	100	43.93 ± 0.23	24.7–74.1	10.1 ± 0.07	7.6–11.4
C	100	36.1 ± 0.56	22.8–60.8	11.04 ± 0.05	9.5–15.2

The actual lengths of individual chlamydospores were not measured but they were computed for each sample of the three races by dividing the lengths of the chains by the number of spores per chain. This is not a perfect measurement due to

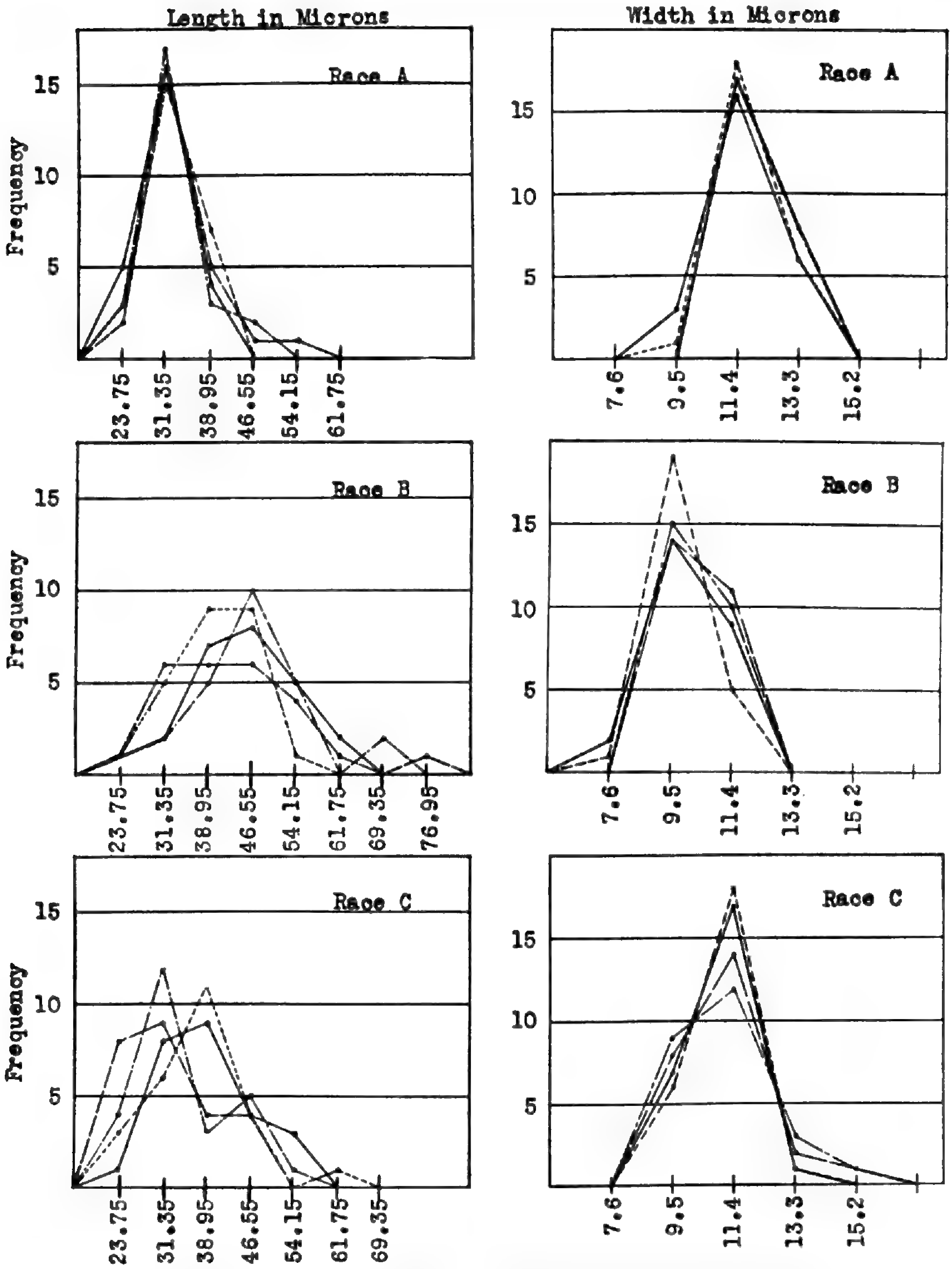

Fig. 9. Frequency curves of length and width of chlamydospore chains for three races of *Thielaviopsis basicola*. Samples of 25 measurements from 4 different colonies are plotted separately.

variation of spore length within a chain, but it will give the correct arithmetic mean (table IX).

Apparently the individual spores of B were longer than those of A or C, and those of A were slightly longer than those

TABLE VIII

SUMMARY OF STATISTICAL DIFFERENCES IN CHLAMYDOSPORE CHAIN LENGTH AND WIDTH

Races compared	Differences		Differences between means divided by probable error of differences	
	Length	Width	Length	Width
A & B	11.57 ± 0.46	1.76 ± 0.08	25.2	22.0
A & C	3.74 ± 0.64	0.82 ± 0.06	5.8	13.7
B & C	7.83 ± 0.61	0.94 ± 0.09	12.8	10.4

TABLE IX

LENGTH OF CHLAMYDOSPORES OF RACES A, B, AND C

Race	Sample * 1	Sample 2	Sample 3	Sample 4	Means of all four samples
A	7.41 μ	7.6 μ	7.41 μ	7.98 μ	7.6 μ
B	8.93 μ	9.12 μ	9.31 μ	8.74 μ	9.03 μ
C	7.98 μ	7.41 μ	7.6 μ	7.03 μ	7.51 μ

* 25 measurements in each sample.

of C. The longer chain length of B is primarily due to longer individual spores rather than to the number of spores in a chain since C and B have the same arithmetic mean for number of spores per chain. The chain length of C exceeds that of A, largely because C has more spores per chain than A though the individual spores of A are slightly longer.

Variation in Pathogenicity

In order to determine if there were any variations in pathogenicity of the three races of *Thielaviopsis basicola*, inoculation experiments were carried on in the greenhouse. Wooden flats, 8″ × 11″, were filled with soil composed of two parts garden loam and one part peat moss. The soil was sterilized and its acidity adjusted to approximately pH 7 by the addition of lime.

On October 24 seeds of cotton, tobacco (Kentucky White Burley), *Primula obconica*, peanuts, and watermelons were planted—four flats of each plant (Series I). On October 29, five days after planting, three flats of each plant were inoculated with races A, B, and C, respectively, and the fourth flat was reserved for a control. The flats were inoculated by watering with 200 cc. of a heavy fungal suspension which had been prepared by mixing thoroughly the contents of eight test-tubes of each race—all ten days old and on 10 cc. of potato-dextrose agar—with 1000 cc. of distilled water. The inoculum thus contained both endoconidia and chlamydospores, along with mycelium, and was probably greatly in excess of the amount necessary to insure infection.

A second set of inoculation experiments was set up on December 2 (Series II), differing from the first in the kind of soil and containers used. The soil was composed of a mixture of equal parts of garden loam, sand, and peat moss and was placed in 7″ pots. Lime was added to secure an approximate pH of 7. The plants were inoculated in the same manner as those in the flats.

It was impossible under the experimental conditions to regulate the soil temperature. During the latter part of October and the first part of November it ran somewhat higher than the accepted optimum for the development of *Thielaviopsis basicola*. Primarily for this reason the second set of host plants was installed early in December.

Periodical examinations indicated that the relative pathogenicity of the races could have been established four or five weeks after inoculation but a careful analysis of Series I was delayed until January 30—approximately twelve weeks after inoculation. Series II was examined February 10, about ten weeks after inoculation.

In determining the relative pathogenicity of each race on the various hosts, the extent of damage to the plant as a whole was stressed, along with the size and number of lesions. Microscopical examinations of the roots and stem bases were made. Specimens of each kind of plant were selected as standards for scoring the amount of injury. Heavy infection causing severe stunting and even death in some cases, along with large conspicuous lesions, was assigned a numerical value of 8; an intermediate degree of infection causing a slight stunting but with plainly visible lesions was given a value of 5; slight infection causing hardly discernible damage and very small lesions was represented by the number 2; and those plants which failed to show any lesions, even under microscopical examinations, were scored 0. Slight variations from these standards were scored with intermediate numbers.

The whole series of numbers was assigned as follows:

No infection	0	Medium	5
Slight–	1	Medium+	6
Slight	2	Heavy–	7
Slight+	3	Heavy	8
Medium–	4	Heavy+	9

The results of the examinations are summarized in table x and shown in graphical form in fig. 10.

These experiments indicate that there is a decided difference in the ability of the three races to parasitize various hosts. Throughout the whole series race C is a very weak parasite—so weak, in fact, that its damage can practically be ignored. This race damaged cotton more severely than any of the other host plants, showing a pathogenicity index of 2.3 in Series I. There was a great deal of variation in the virulence of C between Series I and II, but since the greenhouse conditions were not adequately controlled it was impossible to even guess at the factors entering into this variation.

Race A is, on the whole, more virulent than either B or C and was able to parasitize all of the host plants employed in the experiment. It was most virulent on watermelon but caused severe damage to both tobacco and peanuts. Race B was intermediate between A and C in virulence, considering the whole set of host plants. B exhibited its greatest virulence on watermelon in both Series I and II. In Series I, however, its damage to the other plants, with the exception of *Primula,* was very slight. In Series II, B increased amazingly in virulence, causing much heavier damage to cotton and peanuts. Unfortunately *Primula* seedlings were not available for this series. It is impossible under the experimental conditions employed to consider intelligently the cause of this great increase in viru-

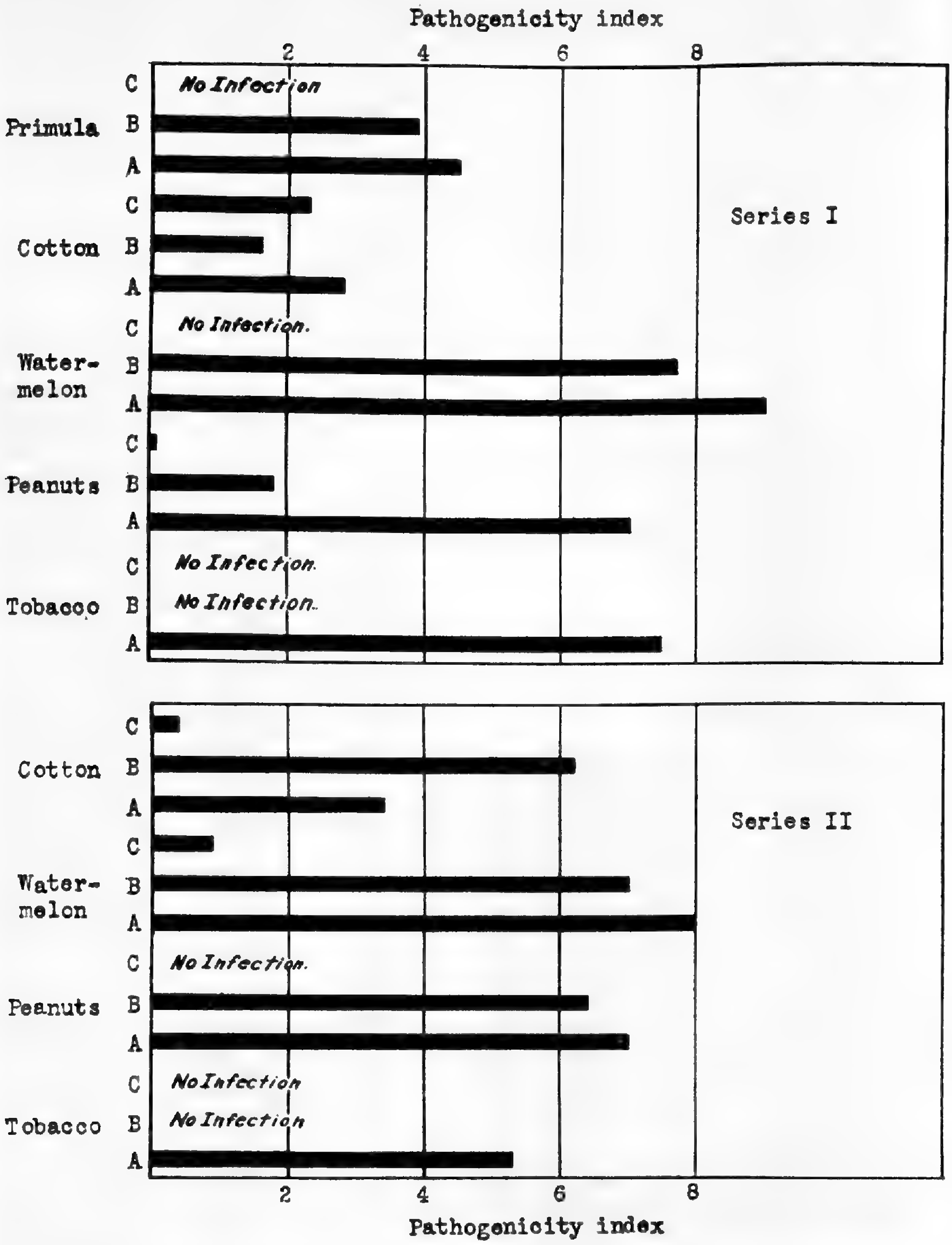

Fig. 10. Relative pathogenicity of races A, B, and C on various host plants.

lence. On the other hand, it does not seem out of place to mention one possible factor. Reference to table IV and fig. 5 indicates that lower temperatures are relatively more favorable to B than to either A or C and that high temperatures are rela-

TABLE X

SUMMARY OF INOCULATION EXPERIMENTS WITH THREE RACES OF *THIELAVIOPSIS BASICOLA* ON VARIOUS HOSTS

Race	Host	Number plants examined	Pathogenicity index	Percentage infection
		Series I		
A	Tobacco	100	7.5	91
B	Tobacco	100	0.0	0
C	Tobacco	100	0.0	0
A	Peanut	20	7.0	100
B	Peanut	20	1.8	90
C	Peanut	20	0.1	10
A	Watermelon	20	9.0	100
B	Watermelon	20	7.7	95
C	Watermelon	20	0.0	0
A	Cotton	20	2.8	90
B	Cotton	20	1.6	80
C	Cotton	20	2.3	60
A	*Primula*	5	4.5	60
B	*Primula*	9	3.9	56
C	*Primula*	7	0.0	0
		Series II		
A	Tobacco	98	5.3	94
B	Tobacco	125	0.0	0
C	Tobacco	130	0.0	0
A	Peanut	20	7.0	100
B	Peanut	20	6.4	100
C	Peanut	20	0.0	0
A	Watermelon	20	8.0	100
B	Watermelon	30	7.0	100
C	Watermelon	29	0.9	45
A	Cotton	20	3.4	95
B	Cotton	20	6.2	100
C	Cotton	20	0.4	20

tively more unfavorable to B. Recalling that Series I was exposed to rather high temperatures and Series II to cooler ones, there is a possible correlation in the soil temperatures and the variations in relative virulence exhibited by the races but it must be conceded that this is not substantiated by all of the data.

The outstanding feature of this set of experiments was the failure of race B to infect tobacco. Although approximately 225 plants were examined carefully not a single sign of infection was noted. It is true, of course, that C also failed to parasitize tobacco but this is not surprising since C has proven to be such a weak parasite. B, however, has exhibited a much higher index of pathogenicity and has infected every plant tested except tobacco. These data indicate that B possesses certain inherent factors, foreign to those exhibited by A and probably different from those of C, which prevent it from infecting tobacco.

Summary

1. Three isolants of *Thielaviopsis basicola* were selected for study—one from tobacco in Tennessee (A), one from *Primula obconica* in Holland (B), and one from cotton in Texas (C).

2. The three isolants were distinctly different in cultural habits as shown by general appearance (color, zonation, type of mycelial growth, and sectoring).

3. Race C proved to be extremely variable in culture, A quite constant, and B intermediate.

4. Race A grew more rapidly on both Leonian's and onion agars than either B or C but was surpassed by C on potato-dextrose agar. The growth rate of B was a great deal below that of either A or C on all media used.

5. The rates of growth of all three races were greatly affected by the media but A showed the least reaction, while B grew better than C on Leonian's agar and C grew better than B on onion agar.

6. The effect of hydrogen-ion concentration on growth rates was greatest on B and least on A.

7. Chlamydospore production by race A was materially reduced at pH 7 and 8. B and C were only slightly affected.

8. B seemed to be better adapted to growth at lower temperatures than A or C.

9. The endospores of the three isolants of *Thielaviopsis basicola* showed differences in length and width on potato-dextrose agar which were statistically significant. Race A—width 4.15 ± 0.03, length 11.86 ± 0.19 μ; B—width 4.72 ± 0.55, length 15.64 ± 0.23 μ; C—width 4.32 ± 0.04, length 13.91 ± 0.25 μ.

10. Differences in endospore measurements of the same race on potato-dextrose agar and onion agar were statistically insignificant, with the exception of race B which showed slightly significant differences.

11. The chlamydospore chains of A were shorter and broader than those of B and C, and those of B were longer and narrower than those of C. The differences were statistically significant in every case. A—width 11.86 ± 0.03, length 32.36 ± 0.31 μ; B—width 10.1 ± 0.07, length 43.93 ± 0.23 μ; C—width 11.04 ± 0.05, length 36.1 ± 0.56 μ.

12. The chlamydospore chains of A were often borne in large clusters, those of B in groups of from one to three, and those of C usually singly or in pairs.

13. The individual spores of B were longer than those of A or C, and those of A were slightly longer than those of C.

14. Race A severely damaged tobacco, peanuts, and watermelon; infecting cotton and *Primula obconica* less severely.

15. Race B infected watermelon severely, damaged cotton more seriously than did A, affected *Primula* and peanuts slightly less than A, but failed entirely to infect tobacco.

16. Race C was an extremely weak pathogen, showing a slight infection of cotton, peanuts, and watermelon and not infecting tobacco or *Primula* at all.

17. The three isolants proved to be distinct physiologic races.

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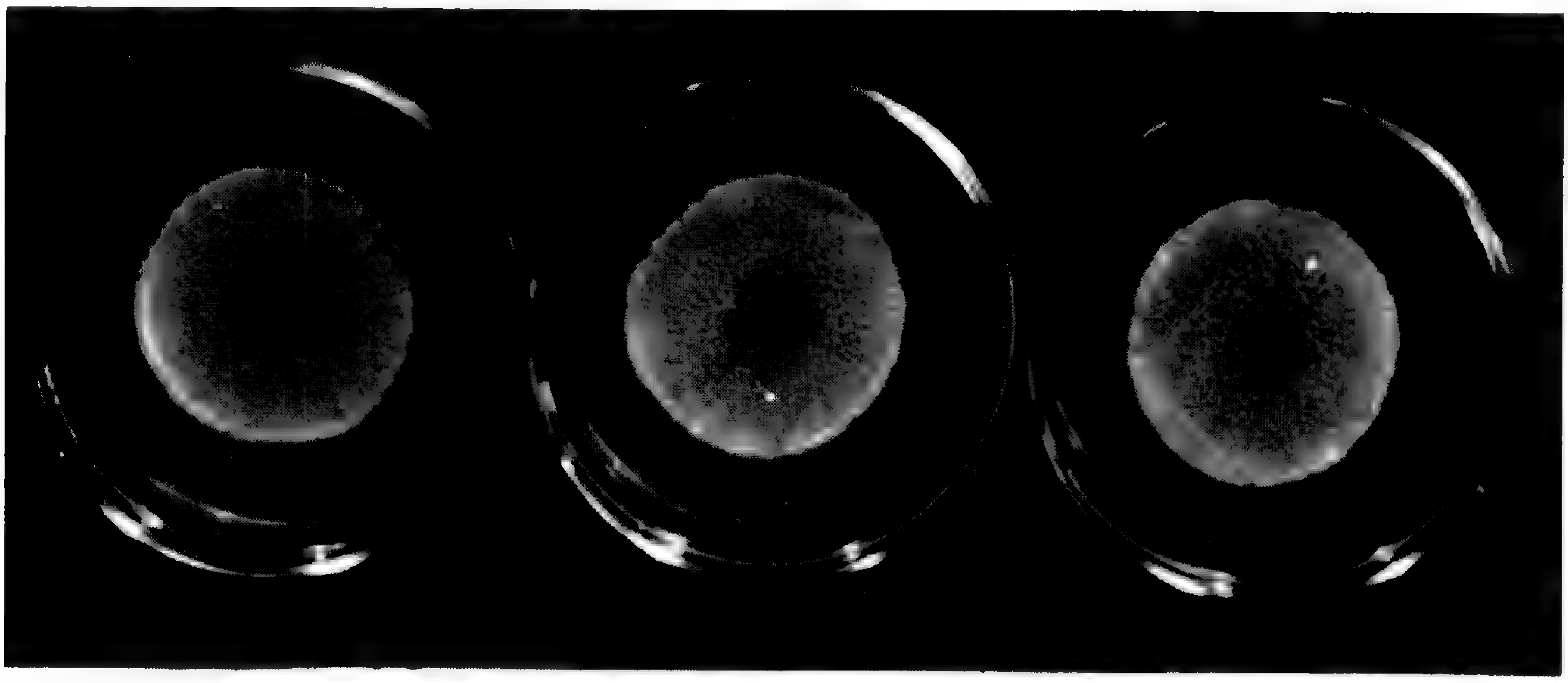
Explanation of Plate

PLATE 42

A. Colonies of race A on potato-dextrose agar nine days after inoculation.
B. Colonies of race B on potato-dextrose agar nine days after inoculation.
C. Colonies of race C on potato-dextrose agar nine days after inoculation.



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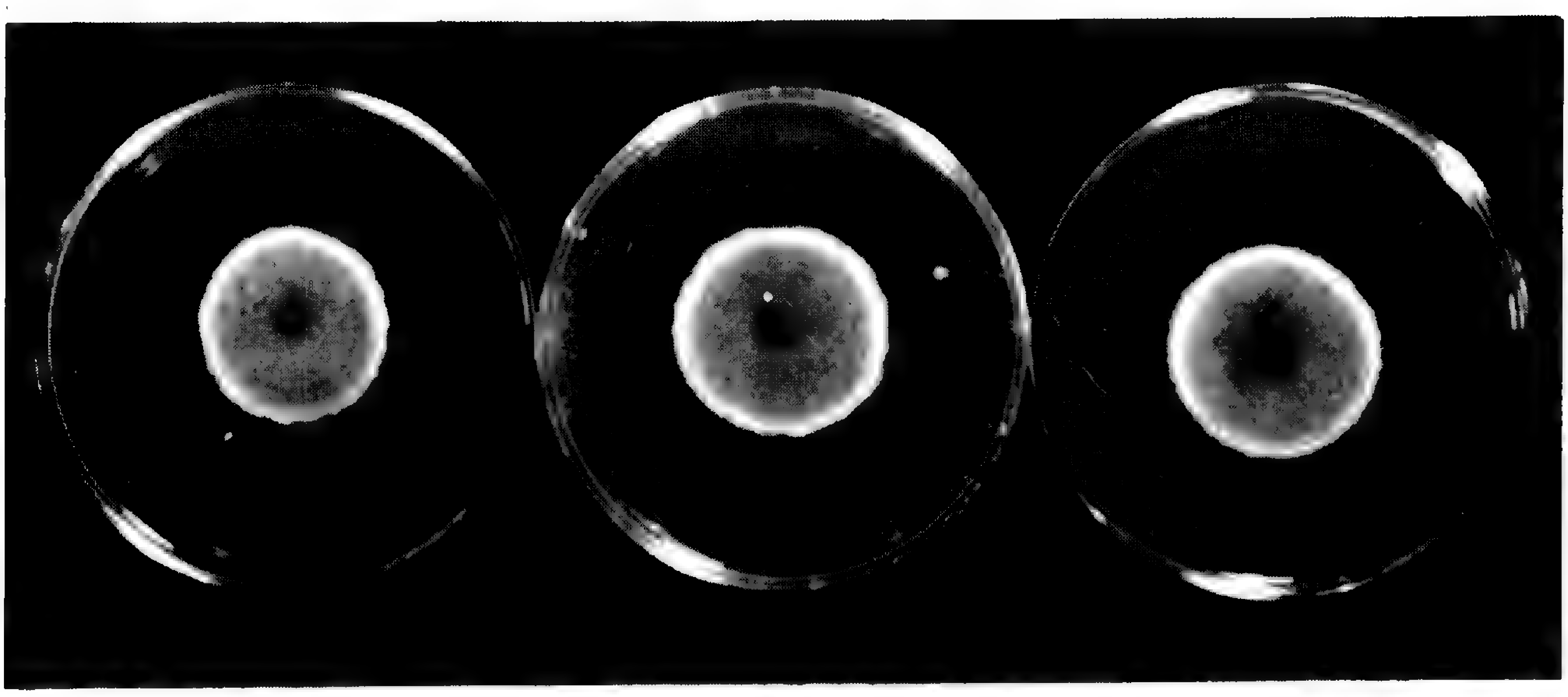

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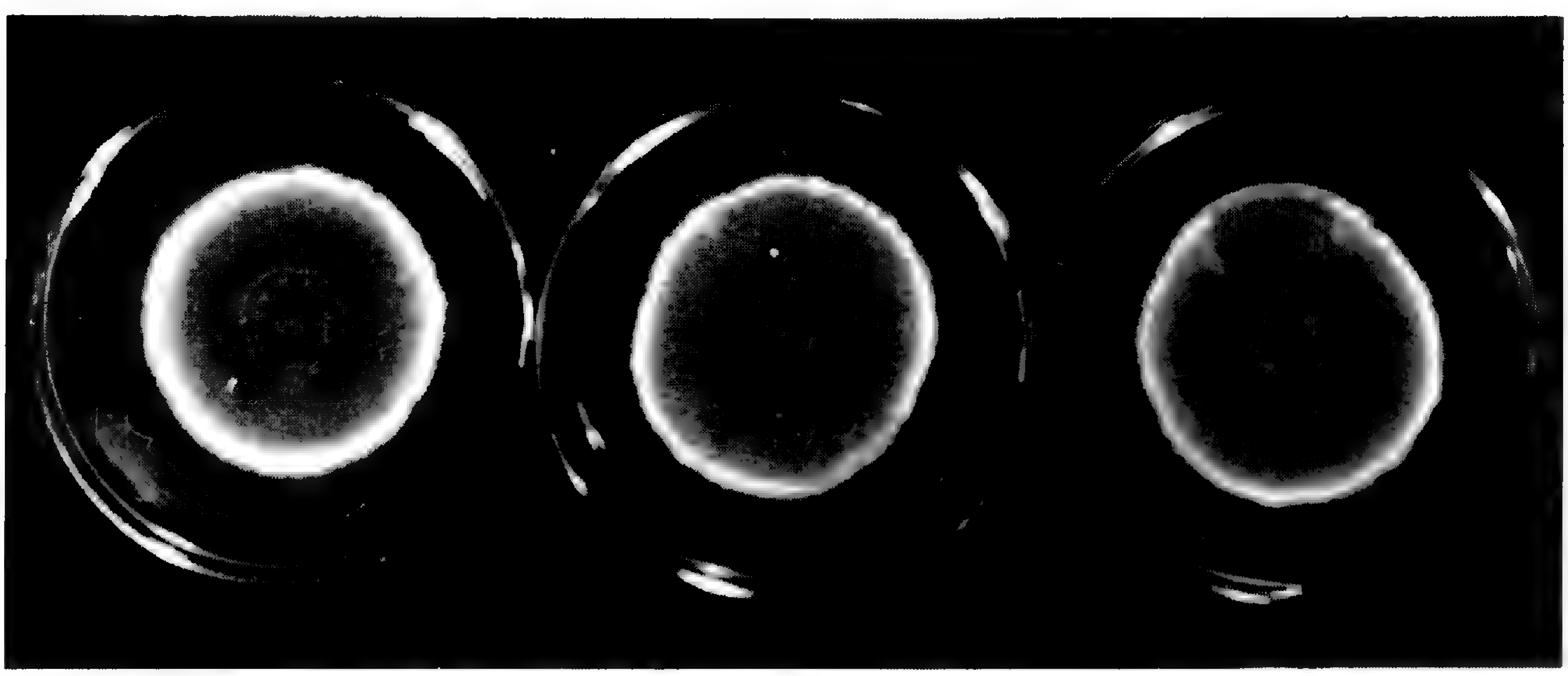


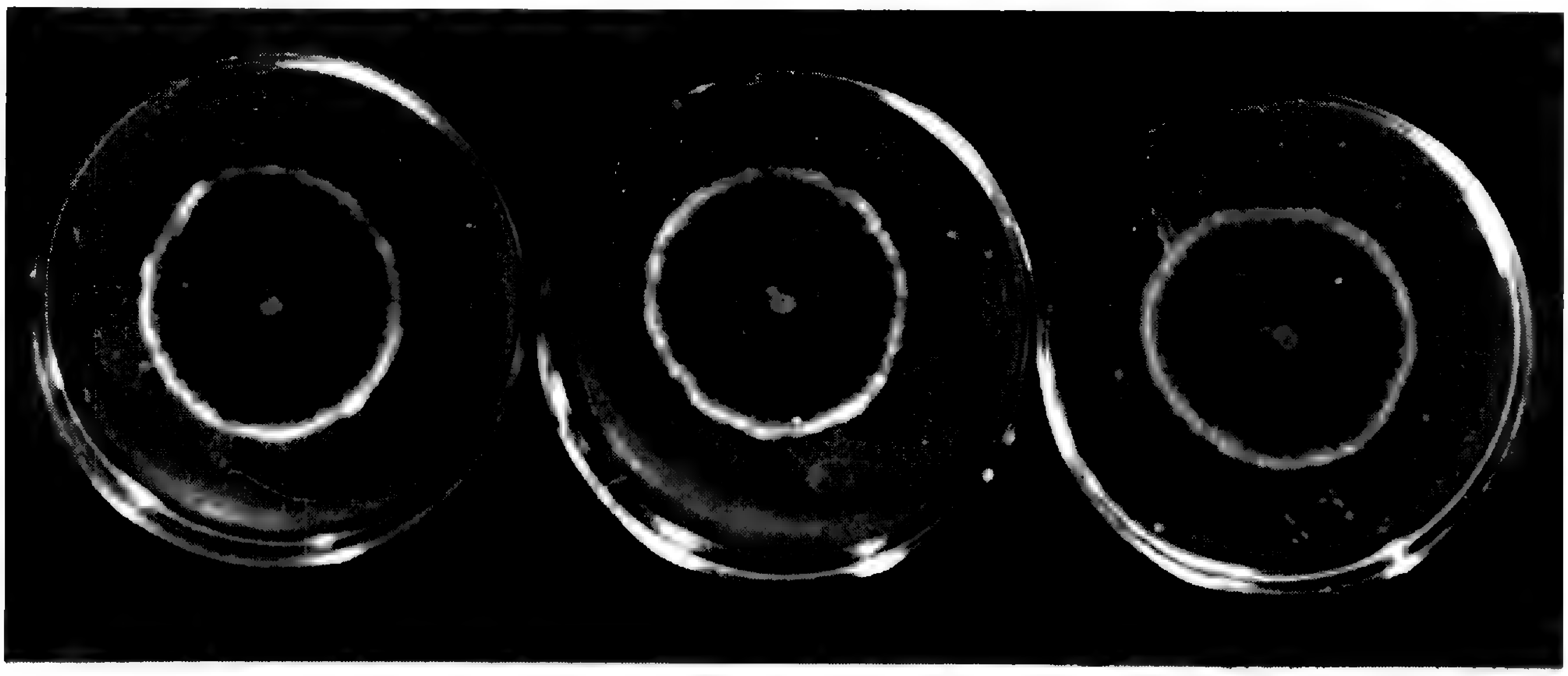
C

RAWLINGS—THIELAVIOPSIS BASICOLA

EXPLANATION OF PLATE

PLATE 43

A. Colonies of race A on onion agar nine days after inoculation.
B. Colonies of race B on onion agar nine days after inoculation.
C. Colonies of race C on onion agar nine days after inoculation.



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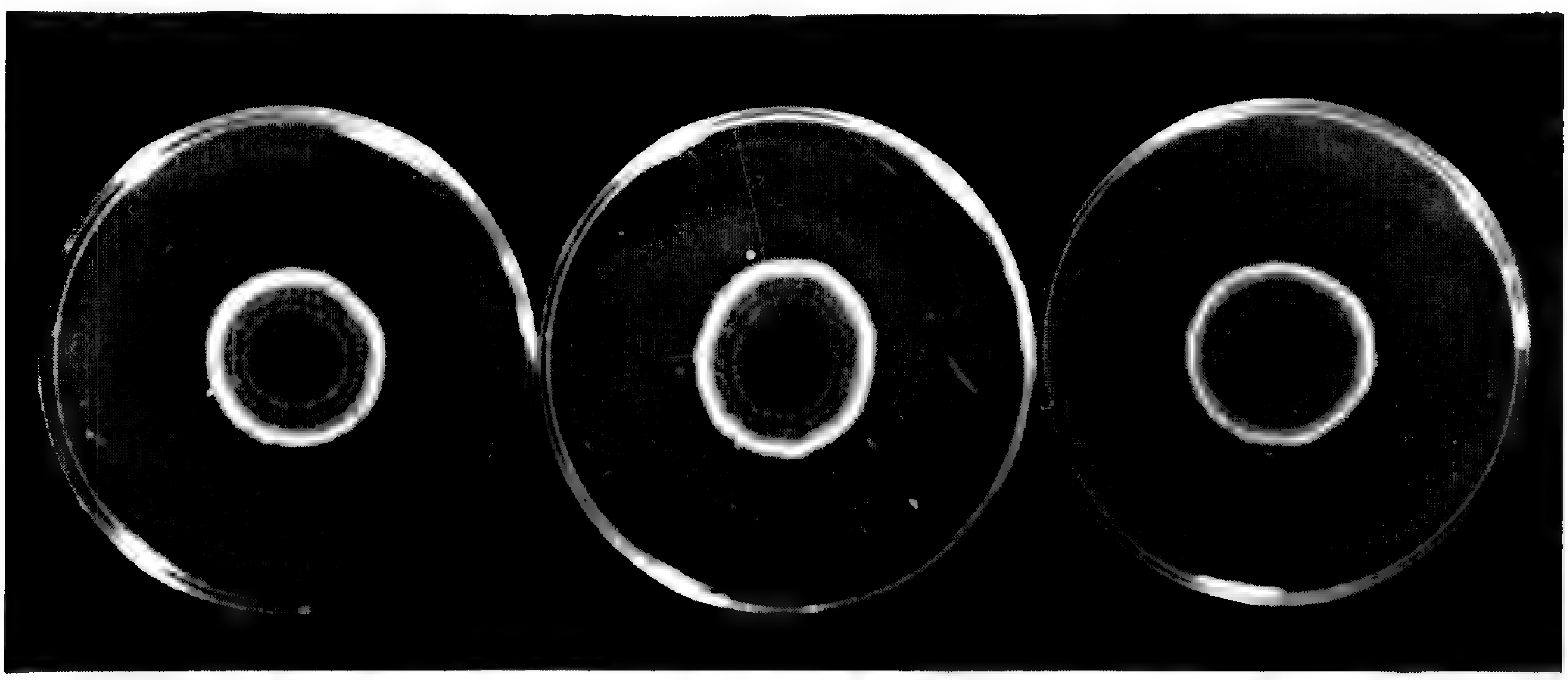

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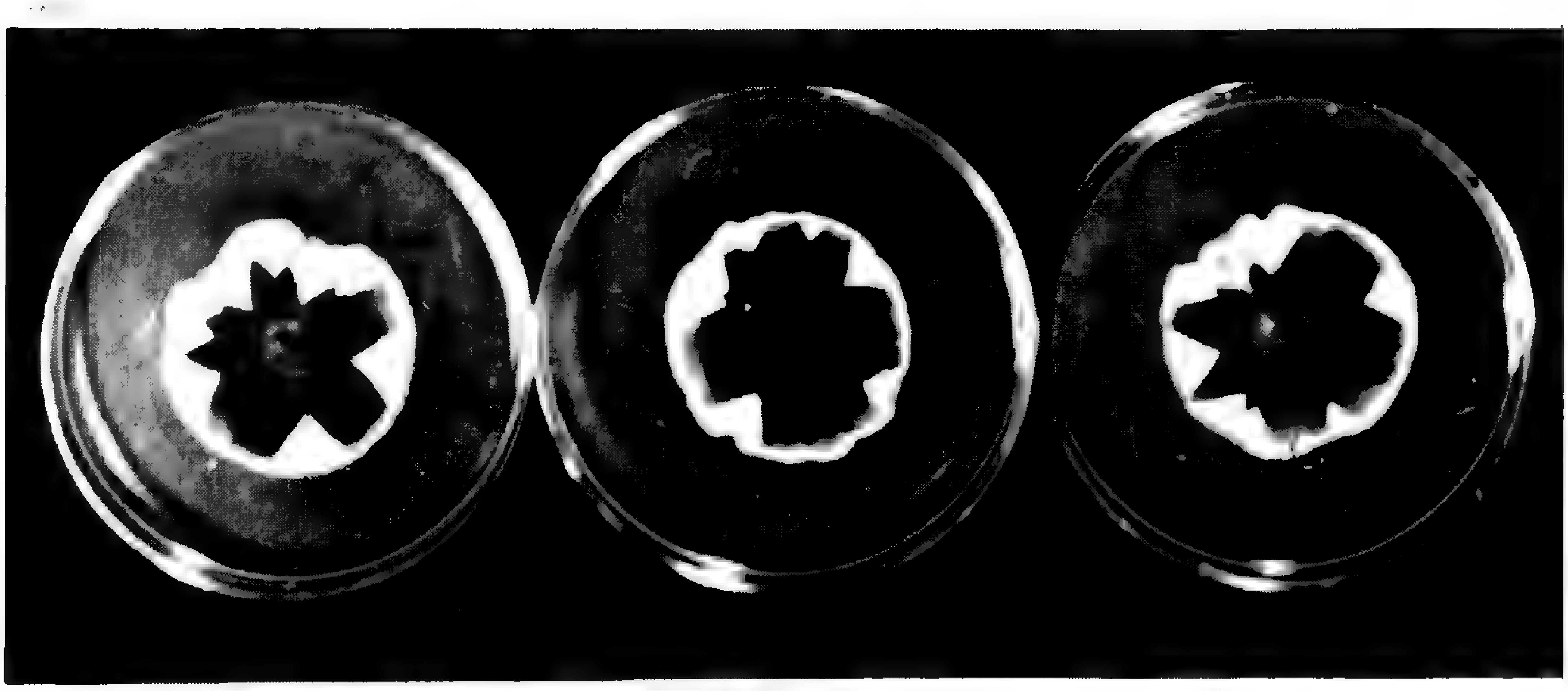


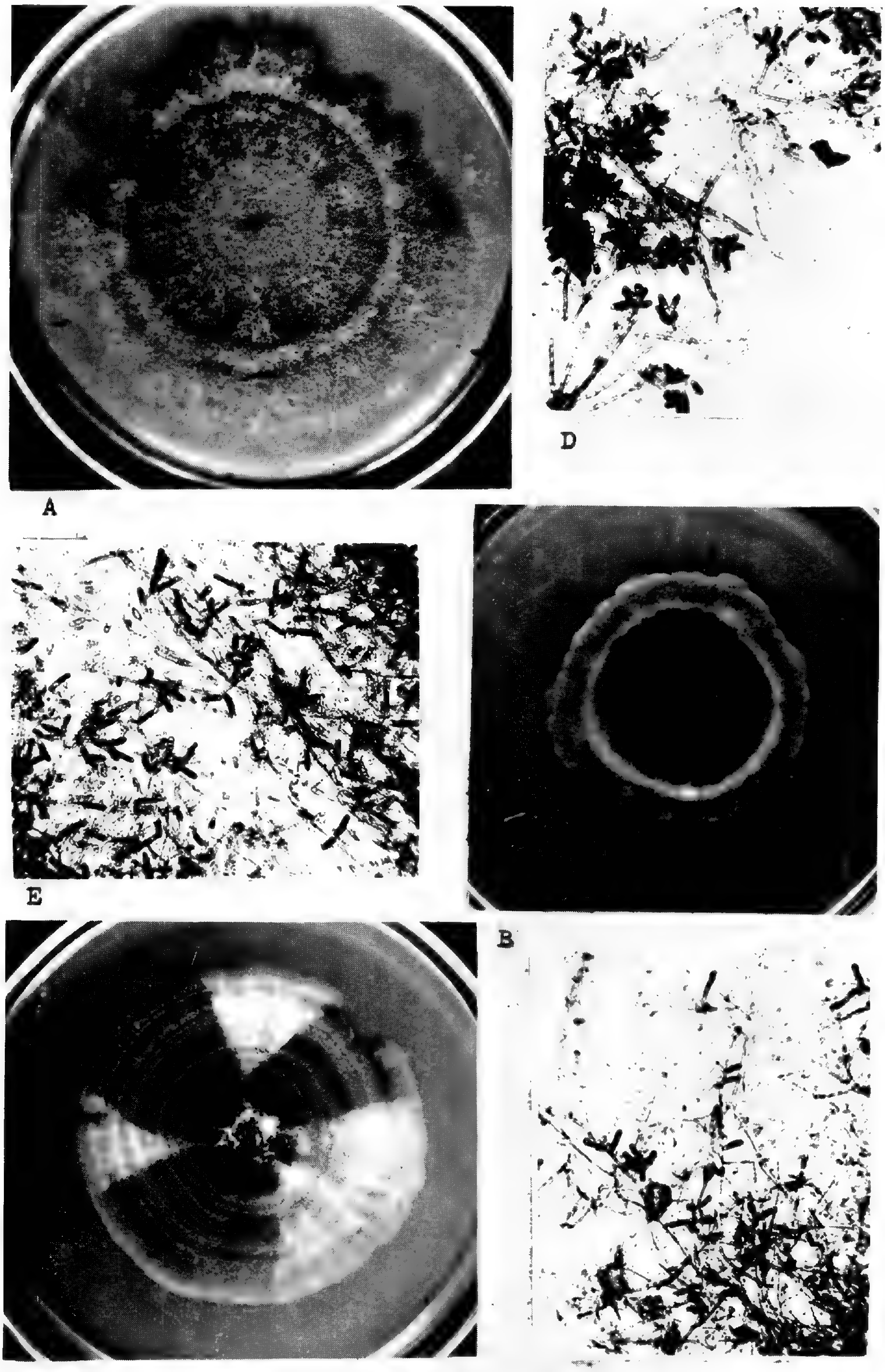
C

RAWLINGS—THIELAVIOPSIS BASICOLA

Explanation of Plate

PLATE 44

A. Race A on Leonian's agar twelve days after inoculation.
B. Race B on Leonian's agar twelve days after inoculation.
C. Race C on Leonian's agar twelve days after inoculation.
D. Photomicrograph of chlamydospores of race A on potato-dextrose agar.
E. Photomicrograph of chlamydospores of race B on potato-dextrose agar.
F. Photomicrograph of chlamydospores of race C on potato-dextrose agar.



A B C D E F

RAWLINGS—THIELAVIOPSIS BASICOLA

GENERAL INDEX TO VOLUME XXVII

New scientific names of plants and the final members of new combinations are printed in **bold-face type**; synonyms and page numbers having reference to figures and plates, in *italics;* and previously published names and all other matter, in ordinary type.

D

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Volume XXVII Number 1

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