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A Revision of *Phacelia* Subgenus *Cosmanthus* (Hydrophyllaceae)

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A REVISION OF PHACELIA SUBGENUS COSMANTHUS (HYDROPHYLLACEAE)

This paper continues the series of systematic revisions of members of the Hydrophyllaceae begun a decade ago with *Eucrypta* Nutt. (1938), and including *Pholistoma* Lilja (1939), *Ellisia* L. (1940), *Nemophila* Nutt. (1941), and *Hydrophyllum* L. (1942). These taxonomic studies have been supplemented by a steady accumulation of cytological data by Cave and Constance (1942, 1944, 1947), which has now become sufficient to provide information on the chromosome numbers of some of the species in all but a few genera. The family was originally selected for study primarily for reasons of size and propinquity, since the Hydrophyllaceae is a comparatively small group and the greatest number of species occurs in western North America.

The group treated here, however, is unrepresented in the West, and hence appeared a logical choice for investigation during the academic year 1947-1948, which I had the privilege of spending at the Gray Herbarium. The opportunity to observe and collect three of the species in the environs of Washington, D. C., in 1943-1945 had stimulated my interest. Three species were subsequently grown in the greenhouses of the Division of Genetics at Berkeley, in 1946-1947. Through a grant-in-aid from the Permanent Science Fund of the American Academy of Arts and Sciences and the generous sponsorship (arranged by Dr. C. L. Lundell) of Southern Methodist University and the Texas State Research Foundation, I was enabled to do field work in most of eastern Texas during March and April, 1948. This provided an unexcelled opportunity to obtain cytological materials and ample herbarium specimens, as well as to make field observations. In this way, *Phacelia glabra*, *P. hirsuta*, *P. laxa*, *P. patuliflora*, and *P. strictiflora* were studied at first hand. The satisfactory treatment of the last two species had proven difficult from dried material alone, and this excursion provided essential information.

The species included in this revision stand somewhat apart from the others of the genus, and it was anticipated that accumulating evidence might make desirable the bodily removal of *Cosmanthus* from *Phacelia*. Three lines of evidence—morphological, cytological, and distributional—support the conclusion that *Cosmanthus* is not very closely allied to the other groups comprising *Phacelia*. These points are discussed below, but it

may be said here that the alternative of setting up a separate genus has been abandoned or at least deferred in favor of elevating *Cosmanthus* to subgeneric rank but retaining it within *Phacelia*. This disposition would appear to accomplish the objective of indicating that these species have had a development quasi-independent from that of the rest of the genus, without necessitating a host of premature nomenclatorial changes. When the whole of *Phacelia* has been carefully investigated morphologically, cytologically, and distributionally, it may be desirable to reconsider the status here assigned to *Cosmanthus*.

All taxonomists are aware that the old Special-Creationist definition of a species as consisting of a central or normal "species" with or without "aberrant" satellite "varieties" has long been obsolete. This concept has a faint modern echo in the common practice of contrasting the characteristics of varieties with those of "the species" of which they are a part. Actually, of course, a species is a population of diverse individuals which may or may not show distinctive infraspecific morphological-geographical groupings: the modern varieties or subspecies. If a species does show such infraspecific differentiation, one of the resulting groups must necessarily contain the type specimen on which the species was founded. The nomenclature of this type-containing subspecific entity is considerably confused. According to existing provisions of our nomenclatorial code, this entity must bear the first name assigned to it in the proper rank, but it is recommended that the specific epithet be repeated, with or without a prefix, or that one of such customary epithets as "*typicus, genuinus, originarius, etc.*," be employed in the future for this purpose. In *Phacelia*, Brand has employed the prefix "*eu-*," Voss and Howell have applied the designation "*typica*," and McVaugh has utilized the tautonym. Since the last usage is the only one which has appeared in *Cosmanthus*, I am adopting it here. All of these devices have obvious shortcomings, but it would be a great advantage if the type-containing entity were always mechanically designated in exactly the same manner and if, this designation being uniform and automatic, the author of such a designation could be ignored.

TAXONOMIC HISTORY

The group of species combined here as the subgenus *Cosmanthus* has never been treated as a natural group with exactly the same circumscription. The first species described was doubtfully

assigned to *Polemonium*, the second to *Convolvulus*, and Michaux was the first to describe any of the species in the correct family and genus. Rafinesque erected the genus *Endiplus* in 1818 for *Phacelia bipinnatifida* Michx. In his "Review of the Order of Hydrophyllae," Bentham (1835) placed two species of this alliance under the genus *Eutoca* and two under *Phacelia*. A. DeCandolle (1845) published the genus *Cosmanthus* Nolte with the sections *Gymnobythus* and *Eucosmanthus*, the latter comprising three of the species treated in the present paper; three other species of the present group were, however, referred to *Phacelia* and two to *Eutoca*. Gray (1875), in his "A Conspectus of the North American Hydrophyllaceae," amplified the genus *Phacelia* by blanketing into it *Eutoca*, *Cosmanthus*, and certain other elements. One of the species under discussion appeared in section *Euphacelia*, two in section *Cosmanthus*, and five species and one variety in section *Cosmanthoides*. Section *Cosmanthus* was separated from section *Cosmanthoides* by the shape and fimbriation of the corolla; Small (1933) used exactly the same criteria to distinguish his two groups, *Fimbriatae* and *Dubiae*, and had also a group *Bipinnatifidae*. Brand (1913) combined all the above species, with the exception of *P. bipinnatifida*, in section *Cosmanthus* of *Phacelia*. This arrangement of the group represents the nearest approach to the treatment adopted in the present paper. A grand total of some forty species has been proposed in this group; fourteen entities are accorded specific rank in this revision.

SPECIAL MORPHOLOGICAL CHARACTERS

GLANDS. Corolla scales have been given considerable emphasis in classifying Hydrophyllaceae. In *Phacelia*, sections *Gymnobythus* and *Whitlavia* lack scales entirely, but these structures are usually present in sections *Euphacelia*, *Eutoca*, and *Euglypta* (*Microgenetes*). They consist of a pair of structures bracketing the base of each stamen and wholly or partially adnate to the corolla tube by one edge; the other edge may be free or adnate to the base of the filament or the free edge of the opposite scale, and the tip of the scale is often free. *Cosmanthus* completely lacks such scales but has an entirely different organ, which has been confused with them. This consists of a functional or abortive gland or nectary extending distally from the base of the corolla tube on the principal vein which projects into the middle of each corolla lobe. This gland is bordered lengthwise by two parallel flaps, which are adnate to the corolla tube on the

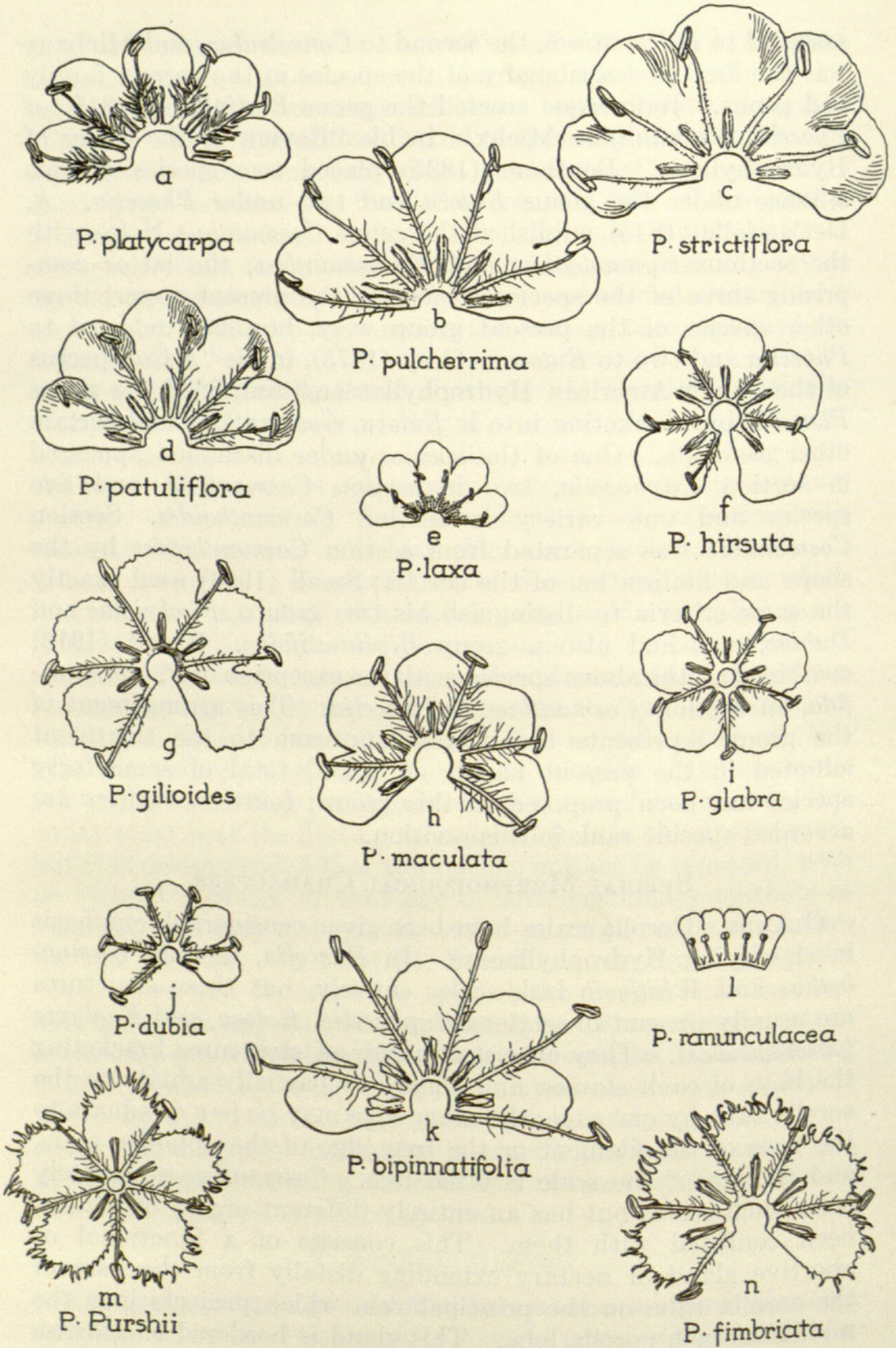


Fig. 1. Expanded corollas of *Phacelia* subgen. *Cosmanthus*, all ca. $\times 1\frac{1}{2}$.

side away from the vein, and free on the side toward the vein. The flaps may be adnate their full length, or the tips may be free (*P. platycarpa* and *P. fimbriata*), and the free edge may be either smooth or puberulent. These flaps appear to be quite distinct from the ordinary corolla scales found in other members of the genus. In *Phacelia bipinnatifida* the glands are apparently functional, being visibly depressed from above, and protruding on the outside. Because of the prominence of the glands and their accompanying flaps, this species has usually been kept out of *Cosmanthus* as possessing "evident corolla scales" but "remote from the stamens." The glands may be vestigial in all other species of *Cosmanthus*, but the parallel flaps are clearly visible in all species, even *P. ranunculacea*. In the last, the position of the aborted glands is indicated only by two minute ridges at the very base of the corolla tube, but in the proper relation to the vein and the filaments. The gland structure is not, so far as I am aware, found elsewhere in *Phacelia*, and is the chief morphological peculiarity of the species here referred to *Cosmanthus*. These glands are illustrated in fig. 1.

PUBESCENCE. The terminology of pubescence is so chaotic that the same conditions are habitually labeled differently by different authors, and the same terms are applied to quite unlike conditions. Some terms relate to the form and size of the individual hairs, others designate their arrangement, and still others denominate their "mass effect"—the product of the nature of the hairs plus their distribution. Terms denoting these different aspects cannot be contrasted successfully with each other, although that attempt is frequently made in keys and descriptions. A complete restudy of pubescence from a cytological and morphological basis, with a redefinition of descriptive terms, is sorely needed. The nature of the pubescence of the stem, peduncles, and pedicels has proven to be very useful in separating entities in *Cosmanthus*. Although the hairs are apparently terete trichomes in all species, in *P. platycarpa*, *P. pulcherrima*, and *P. dubia* they are so weak that they collapse and appear flattened in dried specimens. This is apparently true of the hairs on the stamen filaments in all species which possess them; the absence of stamen hairs in *P. ranunculacea* is a good diagnostic character. The presence or absence of hairs on corolla lobes, styles, and capsules affords distinguishing features between certain species. Four species, *P. pulcherrima*, *P. dubia*, *P. bipinnatifida*, and *P. ranunculacea*, possess stalked capitate glands in addition to the ordinary trichomes at least in the

inflorescence, although these are very small and easily escape detection in *P. dubia* and *P. ranunculacea*. Some plants of *P. patuliflora* var. *patuliflora* also appear to have glands in the inflorescence. The nonglandular pubescence of the vegetative parts is composed of simple tapering trichomes, which are closely appressed or ascending or spreading at right angles. If these hairs are large and rather stiff, the pubescence is spoken of as *hirsute*, if they are smaller and shorter, as *hirsutulous*, and if they are even smaller and finer, as *hirtellous*. When the hairs are closely appressed the condition is described as either *strigose* or *strigulose*, depending upon the size of the hairs. The pedicels in the species with appressed pubescence are often whitened by the abundance of hairs, a condition referred to as *canescent*. All but four of the species in *Cosmanthus* may readily be separated into one of two groups on the basis of the arrangement of hairs on the stem, peduncles, and pedicels. They are appressed in *P. platycarpa* var. *platycarpa*, *P. patuliflora* var. *teucrifolia*, *P. gilioides*, *P. maculata*, *P. dubia* vars. *dubia* and *georgiana*, *P. ranunculacea*, and *P. Purshii*. They are spreading in *P. platycarpa* vars. *bursifolia* and *madrensis*, *P. pulcherrima*, *P. laxa*, *P. hirsuta*, *P. bipinnatifida*, and *P. fimbriata*. These structures are normally hairless in *P. glabra*, but in exceptional specimens a few scattered appressed hairs occur. The two remaining species, *P. strictiflora* and *P. patuliflora*, show a bewildering polymorphism in pubescence, but it seems clear that the former has only appressed or ascending hairs except where it has been "contaminated" by genes from another species.

OVULES AND SEEDS. The species of *Cosmanthus* may be divided into three groups on the basis of the number of ovules to each placenta, a character which is reflected more or less accurately in the number of seeds borne in mature capsules. Species with 6–14 ovules to each placenta include *P. platycarpa*, *P. pulcherrima*, *P. strictiflora*, and *P. patuliflora*; species with usually 4 ovules, *P. laxa*, *P. hirsuta*, *P. gilioides*, *P. maculata*, *P. dubia* (rarely only 2 ovules); species with uniformly only 2 ovules, *P. bipinnatifida*, *P. ranunculacea*, *P. Purshii*, and *P. fimbriata*. There thus appears to be a trend within *Cosmanthus* toward the reduction of ovules to a pair to each placenta. This fact is significant because the sections *Euphacelia* and *Eutoca* of *Phacelia* have been kept apart solely on the basis of the number of ovules, the former having geminate ovules. I have elsewhere indicated doubt that this distinction and these resultant sections are natural. It seems probable that scrapping the old sectional

boundary and pretty completely rearranging the component species, perhaps into several sections, might achieve a considerably more satisfactory classification within the genus. Seed characters are of more value in differentiating these species than had been generally recognized. To emphasize the utility of these characters, photographs of a half-dozen seeds of each species are shown in Plate I. These photographs are the work of Dr. Ian D. Clement, now of the Atkins Garden and Research Laboratory of Harvard University, (Soledad) Cienfuegos, Cuba, to whom I am deeply grateful.

CHROMOSOME NUMBER

Chromosome numbers are now known for all but 3 of the 14 species, as follows:

<i>P. platycarpa</i>		
var. <i>platycarpa</i>	$n = 9$	Morley 728, 730, 813; Moore & Wood 3994
<i>P. strictiflora</i>		
var. <i>strictiflora</i>	$n = 9$	Constance & Lundell 3243
var. <i>Lundelliana</i>	$n = 9$	Constance & Cory 3249, 3250
var. <i>connexa</i>	$n = 9$	Constance 3251, 3252; Constance & Cory 3244; McVaugh 3382
<i>P. patuliflora</i>		
var. <i>patuliflora</i>	$n = 9$	Constance & Cory 3247; Constance & Lundell 3217, 3219, 3221, 3231, 3234, 3241, 3247
var. <i>teucrifolia</i>	$n = 9$	Constance & Cory 3248; Cory 41,473; McVaugh 7709
<i>P. laxa</i>	$n = 9$	Constance 3223; Constance & Lundell 3214, 3216, 3220
<i>P. hirsuta</i>	$n = 9$	Constance & Cory 3245; Constance & Lundell 3256, 3257; Demaree; Robbins 2359, 2407
<i>P. maculata</i>	$n = 5$	McVaugh 8645
<i>P. glabra</i>	$n = 8$	Constance & Cory 3246; Constance & Lundell 3212, 3255; Robbins 2352
<i>P. dubia</i>		
var. <i>dubia</i>	$n = 5$	Constance, Bomhard & Swallen 3019; Constance & McVaugh (Gray Herb. Exsic. 1388)
<i>P. bipinnatifida</i>	$n = 9$	Duncan 2431, Heiser 2065
<i>P. ranunculacea</i>	$n = 14$	Constance 3018
<i>P. Purshii</i>	$n = 9$	Constance 3023; Core; P. R. Stewart

Even with this amount of cytological evidence it is unwise to attempt any far-reaching generalizations, for experience elsewhere in the family has shown that there is no way of knowing what numbers the other entities may reveal. Two or three facts, however, deserve comment. The first is the absence of the number 11, the most common complement throughout the remainder of the genus. The second is that *P. platycarpa*, the

only perennial counted, has 9 pairs; all other perennial species of *Phacelia* have 11, except one which has 10. The cytological evidence, then, reëmphasizes the remoteness of *Cosmanthus* from other species of the genus. The 5 pairs shown by *P. maculata* and *P. dubia* var. *dubia* represent the smallest chromosome number known in the family. The arithmetical possibilities of synthesizing *P. ranunculacea*, with 14 pairs, from *P. maculata* or *P. dubia* and some 9-paired species are very attractive, but it is difficult to see whence one could derive the morphological characteristics that make *P. ranunculacea* so distinctive a plant. Chromosome-number is by no means an infallible taxonomic tool, and in this group the chromosomal data are largely negative. As is so often the case, the differential numbers are confined generally to those species best-marked morphologically; where the morphological distinctions are difficult to ascertain, the chromosome numbers are usually identical! Nevertheless, in dealing with a series of "intergrading" populations, it is reassuring to know that one does *not* have to consider the possibility of polyploidy.

GEOGRAPHICAL DISTRIBUTION

The linear sequence of species in the ensuing taxonomic treatment coincides, very roughly, with a south-to-north trend in distribution. The first two species, the only perennials, are of the Mexican and Guatemalan highlands, the next three are Texan or Oklahoman and, like the following three, perhaps fundamentally Ozarkian, and six are more or less Appalachian. The collective distributions thus suggest a northward migration from Mexico probably quite independent of the route of any of the other groups of *Phacelia*, which now occur to the westward of *Cosmanthus*. Only *P. congesta* Hook. and a few of its relatives appear to overlap the distribution of *Cosmanthus*, and they show no close affinity with it either morphologically or cytologically. Ecologically, the members of *Cosmanthus* appear to be closely associated with the deciduous hardwood forests, where they commonly occur in openings, glades, and forest edges, but human activities have made it possible for some species to spread into secondary habitats. The known distribution of all the species and varieties is represented in a series of outline maps (figs. 2-7).

ACKNOWLEDGMENTS

In this study I have been fortunate in having materials, help, and information from many friends, colleagues, and correspond-

ents. Herbarium material has been placed at my disposal by the following institutions; the designating symbols are essentially those recommended by Lanjouw (1938, 1939):

BRU	Brown University
DUKE	Duke University
F	Chicago Natural History Museum
GA	University of Georgia
GH	Gray Herbarium, Harvard University
K	Royal Botanic Gardens, Kew
KSA	Kansas State Agricultural College
KY	University of Kentucky
MEXU	Instituto de Biología, México, D. F.
MO	Missouri Botanical Garden
NY	New York Botanical Garden
OKL	Bebb Herbarium, University of Oklahoma
PA	The Academy of Natural Sciences of Philadelphia
PENN	University of Pennsylvania
SMU	Southern Methodist University
TAES	Tracy Herbarium, Texas Agricultural and Mechanical College
TENN	University of Tennessee
TEX	University of Texas
TULA	Tulane University
UC	University of California
US	Department of Botany, United States National Museum
WVA	West Virginia University

I have also had the privilege of examining specimens in the private herbaria of Dr. E. Lucy Braun, University of Cincinnati; Mr. Ira W. Clokey, whose herbarium is deposited with the University of California; and Mr. Francis W. Hunnewell. I am particularly indebted, however, to my associates at the Gray Herbarium, both staff and students, for their interest, their helpful comments and suggestions, and their patience.

TAXONOMIC TREATMENT

Phacelia subgen. **Cosmanthus** (Nolte ex A. DC.), comb. nov.

Cosmanthus Nolte ex A. DC. Prodr. **9**: 296. 1845, as a genus, excluding § *Gymnobythus*.

Phacelia § *Cosmanthus* A. Gray, Proc. Amer. Acad. **10**: 320. 1875.

Phacelia § *Cosmanthoides* A. Gray, op. cit.

Phacelia—*Bipinnatifidae* Small, Man. SE Fl. 1097. 1933.

Phacelia—*Fimbriatae* Small, op. cit.

Phacelia—*Dubiae* Small, op. cit.

Rather low and often delicate perennial, biennial, or annual pubescent or glabrate herbs with alternate, variously toothed to pinnate leaves, and white to lavender or bluish-violet flowers in secund cymes. Corollas semi-rotate to tubular-campanulate, the stamen bases entirely devoid of paired appendages, but a gland, bordered by parallel flaps, on the corolla tube between each pair of stamens. The ovary slightly compressed

laterally, divided into two locules by the intrusion of the two narrow parietal placentae, which are, however, not grown together. Ovules 2-14 to each placenta, the seeds finely reticulate to alveolate and even rugose in some species, but not transversely corrugated. Basic chromosome number apparently $n = 9$.

Species 14, from the highlands of Guatemala and Mexico north and east into the eastern half of the United States, primarily by way of the Appalachian and Ozarkian mountain systems.

KEY TO THE SPECIES

- A. Corolla lobes minutely crenulate to entire; corolla tubular-campanulate to rotate-campanulate.
- B. Corolla broadly campanulate to rotate-campanulate; stamens 3-10 mm. long; style 3-15 mm. long; capsule slightly compressed, not distended; seeds ovoid-angled.
- C. Branches and pedicels and the summit of the ovary variously and conspicuously hairy.
- D. Inflorescence variously pubescent, but not glandular.
- E. Pubescence of conspicuously flattened hairs; distal ends of the appendages free; Mexican or Guatemalan perennial. 1. *P. platycarpa*.
- EE. Pubescence of terete hairs; distal ends of the appendages adnate to the corolla; annual.
- F. Basal leaves conspicuously rosulate, shallowly toothed or lobed; fruiting pedicels usually strictly erect, short in comparison with the calyx. 3. *P. strictiflora*.
- FF. Basal leaves not conspicuously rosulate, pinnate or pinnatifid; fruiting pedicels spreading-ascending to reflexed, slender.
- G. Pubescence of the stems, peduncles, and pedicels spreading; calyx lobes spreading in anthesis.
- H. Cauline leaves all or nearly all petiolate; pubescence sparse. 5. *P. laxa*.
- HH. At least the upper cauline leaves sessile; pubescence dense.
- I. Cauline leaves dentate or shallowly lobed; ovules 6-12 to each placenta; seeds usually 10-15. 4. *P. patuliflora*.
- II. Cauline leaves deeply lobed to pinnatifid; ovules usually 4 to each placenta; seeds 6-8. 6. *P. hirsuta*.
- GG. Pubescence of the stems, peduncles, and pedicels closely appressed; calyx lobes erect or ascending in anthesis.
- J. Cauline leaves dentate or shallowly lobed; ovules 6-12 to each placenta. 4. *P. patuliflora*.
- JJ. Cauline leaves deeply lobed or pinnatifid; ovules usually 4 to each placenta.
- K. Lobes of the cauline leaves linear-lanceolate to oblong, usually acute; corolla lobes denticulate to fimbriate. 7. *P. gilioides*.
- KK. Lobes of the cauline leaves oblong to oblong-obovate, obtuse; corolla lobes minutely crenulate. 8. *P. maculata*.

- DD. Inflorescence beset with stalked capitate glands. (See also no. 4.)
 L. Cauline leaves all petiolate; corolla 10–15 mm. broad; pedicels recurved or pendent in fruit; seeds 2.5–4 mm. long, black, areolate and finely alveolate.
 M. Calyx lobes ovate-lanceolate to ovate, 5–6 mm. broad; capsule 10–12 mm. in diameter; ovules 8–10 to each placenta.....2. *P. pulcherrima*.
 MM. Calyx lobes linear, 0.5–1.5 mm. broad; capsule 4–6 mm. in diameter; ovules 2 to each placenta.....11. *P. bipinnatifida*.
 LL. Upper cauline leaves sessile; corolla 5–10 cm. broad; pedicels spreading-ascending to spreading in fruit; seeds 1.5–1.75 mm. long, brown, finely reticulate.....10. *P. dubia*.
 CC. Branches and pedicels and the summit of the ovary glabrous (or with a very few stiff hairs).....9. *P. glabra*.
 BB. Corolla tubular-campanulate; stamens 1.5–2 mm. long; style 1.5–2 mm. long; capsule markedly distended by the globose-ovoid seeds.....12. *P. ranunculacea*.
 AA. Corolla lobes fimbriate or coarsely denticulate; corolla subrotate.
 N. Corolla lobes conspicuously pilose on the back; ovules usually 4 to each placenta.....7. *P. gilioides*.
 NN. Corolla lobes glabrous or glabrate; ovules 2 to each placenta.
 O. Pubescence of stems and inflorescence closely appressed; lobes of cauline leaves mostly acute; corolla bluish-lavender; seeds 1.5–3 mm. long, areolate and finely alveolate.....13. *P. Purshii*.
 OO. Pubescence of stems and inflorescence spreading; lobes of cauline leaves mostly obtuse; corolla white, rarely lavender-tinged; seeds 3–3.5 mm. long, finely reticulate.....14. *P. fimbriata*.

1. **Phacelia platycarpa** (Cav.) Spreng. Syst. 1: 584. 1825.

- Convolvulus platycarpus* Cav. Icon. 5: 155, pl. 482. 1799.
Polemonium pimpinelloides Willd. ex Roem. & Schult. Syst. 4: 793. 1819.
Polemonium achilleaefolium Willd. ex Roem. & Schult. Syst. 4: 793. 1819.
Eutoca pimpinelloides Spreng. Syst. 1: 569. 1825.
Eutoca mexicana Benth. Trans. Linn. Soc. 17: 277. 1834.
Eutoca Andrieuxii A. DC. Prodr. 9: 294. 1845.
Cosmanthus mexicanus A. DC. Prodr. 9: 297. 1845.
Eutoca gracilis Mart. & Galeotti, Bull. Acad. Brux. 12²: 276. 1845.
Eutoca Ortgiesiana Heer ex Regel, Gartenfl. 10: 309, pl. 337. 1861.
Nemophila Ortgiesiana Roetzl ex Regel, loc. cit. (Nomen.)
Phacelia pimpinelloides A. Gray, Proc. Amer. Acad. 10: 321. 1875.
Phacelia pubescens Peter, E. & P. Pflanzenfam. 4^{3a}: 64. 1893, non Poir. 1804.
Phacelia patuliflora var. *mexicana* Brand; Engler, Pflanzenr. 4²⁵¹: 66. 1913.
 Perennial from a stout taproot, 5–40 cm. high, branching from the base, the branches prostrate to spreading-ascending; stems and inflorescence pubescent with conspicuously flattened hairs; basal leaves densely rosulate, petiolate, linear to oblanceolate or oblong, 3–15 cm. long, 0.8–6 cm. broad, pinnate with 4–8 pairs of oblong to obovate, entire to pinnatifid,

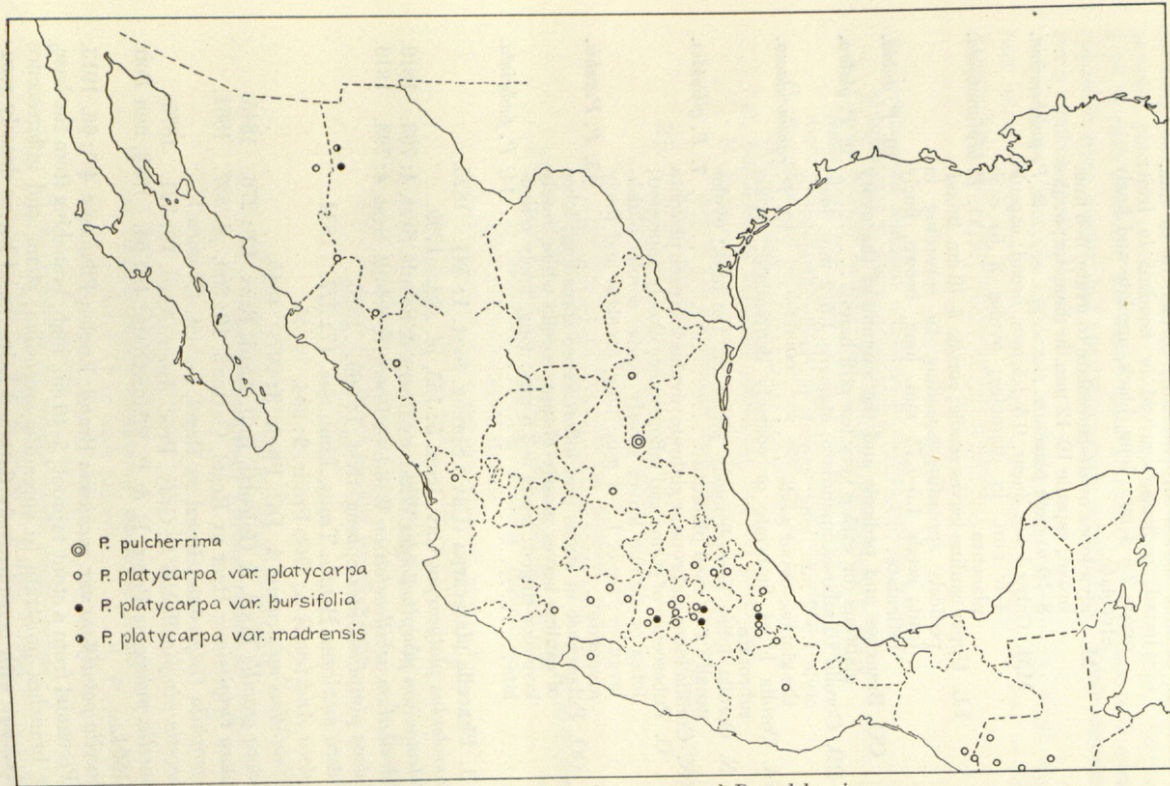


Fig. 2. Distribution of *P. platycarpa* and *P. pulcherrima*.
(Based on Goode's Series of Base Maps, map No. 112. Copyright by the University of Chicago. Used by permission)

distinct leaflets, or the terminal confluent, the cauline leaves usually petiolate, like the basal but reduced upwards, pinnate to merely toothed, strigulose to hirsute on both surfaces; inflorescence of simple or paired terminal 6–25-flowered cymes, the mature pedicels spreading-ascending to spreading-reflexed, 5–30 mm. long; calyx lobes linear-lanceolate to ovate-lanceolate, 3–6 mm. long, 1–2.5 mm. broad, usually unequal, acute or acutish, hairy; corolla pinkish-lavender to pale blue or white with rose-colored veins, rotate-campanulate, 7–15 mm. broad, the lobes oval to orbicular, entire, pilose on the back; gland flaps free at the tip, puberulent; stamens about as long as the corolla, 4–6 mm. long, the anthers oblong, 0.8–1.2 mm. long, the filaments villous on their lower $\frac{1}{2}$; style included in flower, when mature 3–6 mm. long, cleft about $\frac{2}{3}$, hirsutulous below the middle, the summit of the ovary hirsute; mature capsule globose, 4–6 mm. in diameter; ovules 8–10 to each placenta; seeds 9–15, ovoid-angled, 1.5–3 mm. long, brown, areolate and finely alveolate.

Pubescence of the pedicels and peduncles appressed, the inflorescence canescent.....a. var. *platycarpa*.

Pubescence of the pedicels and peduncles spreading, the inflorescence villous-hirsute.

Leaflets crowded, mostly entire; pubescence shaggy-villous.....b. var. *bursifolia*.

Leaflets rather remote, toothed or lobed; pubescence short-villous.....c. var. *madrensis*.

1a. ***Phacelia platycarpa* var. *platycarpa***

TYPE LOCALITY: "Habitat iuxta Chalma oppidum mexicanum," Cavanilles.

DISTRIBUTION: Nuevo León to Sonora, throughout montane Mexico to Guatemala, at elevations of 6,000–15,000 feet.

REPRESENTATIVE SPECIMENS: **MEXICO.** NUEVO LEÓN. Cerro Potosí, Mueller 2246 (F, GH), Schneider 937 (F, GH, MO, UC). CHIHUAHUA. Mt. Mohinora, Nelson 4842 (GH, US); Colonia Garcia, Nelson 6056 (GH, US); Mesa de Baseachic, LeSueur 868 (F, TEX). SONORA. Rancho de Cruz Díaz, S. S. White 2279 (GH). DURANGO. ———, Garcia 388 (US). SAN LUIS POTOSÍ. San Luis Potosí, Parry & Palmer 606 (GH, K, MO, PA, US). NAYARIT. Santa Teresa, Rose 2164 (F, GH, K, US). JALISCO. Ferreria, 1892, M. E. Jones 112 (MO, US). VERA CRUZ. Orizaba, Seaton 409 (F, GH, NY—part, US), Liebmann 15,241 (F, GH, US), Galeotti 3079 (K: isotype of *Eutoca gracilis* Mart. & Galeotti). HIDALGO. El Chico, 1929, Lyonnet 338 (GH, MO, NY, US); Sierra de Pachuca, Pringle 7583 (F, MO). MÉXICO. Monte de Rio Frio, Mexia 2680 (F, GH, MO, NY, PA, UC, US); 33 miles E. of Mexico City, Hitchcock & Stanford 7021 (GH, MO, NY, UC); Mexico City—Oaxaca, Karwinski (type collection of *P. pubescens* Peter, F & GH: photos); La Gavia, Sharp 44,288 (TENN, UC); Amecameca—Popocatepetl, Moore (GH, UC). D. F. Eslava, Pringle 9374 (GH, NY, US). MORELOS. Tres Marias, Pringle 13,122 (F, GH, US). MICHOACÁN. "mines of Tlalpujahua," 1830, Graham 253 (K: type of *Eutoca mexicana* Benth.); Pátzcuaro,

Pringle 4165 (F, GH, MEXU, MO, NY, PA, UC, US); Tancitaro, *Leavenworth* 265 (F, GH, MO, NY); Zitácuaro—Zirahuato, *Hinton* 11,961 (F, GH, MO, NY, TEX, US); Zitácuaro, *Hinton* 11,862 (F, GH, MO, NY, TEX, US). GUERRERO. Limon Mt., *Rusby* 359 (US). PUEBLA. Huauchinango, 22 April 1893, *Salazar* (MEXU, US). OAXACA. Cerro San Felipe, *Nelson* 1048 (US), 1083 (US), *Andrieux* 217 (K: isotype of *Eutoca Andrieuxii* DC., F: photo). CHIAPAS. Ventana, *Matuda* 4553 (GH, MO, NY); Mt. Male, *Matuda* 4611 (GH, MO, NY). **GUATEMALA.** HUEHUETENANGO. Chémal, *Standley* 81,135 (F), 50,312 (F); Chiantla, *Standley* 65,591 (F). CHIMALTENANGO. Santa Elena, *Skutch* 451 (US), *Standley* 58,676 (F), 61,004 (F). QUEZALTENANGO. Volcán de Santa Maria, *Standley* 67,519 (F); Volcán Zunil, *Steiermark* 34,639 (F); Palestina, *Standley* 84,302 (F). SOLOLÁ. Volcán Santa Clara—town, *Steiermark* 47,139 (F).

The type material of *Convolvulus platycarpus* Cav. ("habitat iuxta Chalma oppidum mexicanum") and *Eutoca Ortgiesiana* Heer ("in einer Sendung mexikanische Sämereien") have been figured, and I have seen types or isotypes of *Eutoca mexicana* Benth. ("in the neighbourhood of the mines of Tlalpuxahua, and between that place and the city of Mexico"), *E. Andrieuxii* A. DC. ("in editioribus montis Mexicana San Felipe locis humidis"), and *E. gracilis* Mart. & Galeotti ("au bord des ruisseaux du pic d'Orizaba, de 9,500 á 12,000 pieds"). The type of *Phacelia pubescens* Peter ("Guatemala, Mexico") is Negative no. 20,280 of the Field Museum series. There is no question that all of these names are applicable to *P. platycarpa* var. *platycarpa* as interpreted here. *Polemonium pimpinelloides* Willd. and *P. achilleae-folium* (both "in Mexico") were treated by Gray as synonyms of this entity, and there is no evidence available to dispute that reference. I have seen none of the three collections cited by Brand as the basis of his *Phacelia patuliflora* var. *mexicana*, and the description is decidedly anomalous. From the distribution cited (Jalisco, Hidalgo, and México), however, there seems to be little doubt that the entity should be referred here.

Despite its broad range and great variability, there appears to be little or no regional differentiation in this population. Seeds planted in the late autumn of 1946 germinated and grew profusely in a lath house in Berkeley in the late spring and summer of 1947. In these, the flowers were white with maroon veining, but from the descriptions, the species must vary widely in flower color.

1b. ***Phacelia platycarpa* var. *bursifolia*** (Willd.), comb. nov.
Polemonium bursifolium Willd. ex Roem. & Schult. Syst. 4: 793. 1819.
Eutoca bursifolia Spreng. Syst. 1: 569. 1825.

Eutoca acaulis Mart. & Galeotti, Bull. Acad. Brux. 12²: 276. 1845.

Polemonium acaule Schiede ex Mart. & Galeotti, op. cit. 277. (Nomen.)

Phacelia rupicola Rob. & Fern. Proc. Amer. Acad. 30: 119. 1894.

Phacelia acaulis Brand; Engler, Pflanzenr. 4²⁵¹: 67. 1913.

Acaulescent or nearly so, 5–15 cm. high, shaggy-villous throughout with soft spreading flattened hairs up to 3 or 4 mm. long; leaves pinnate or pinnatifid, the leaflets or lobes crowded, entire or with one or two teeth near the tip.

TYPE LOCALITY: "In Mexico," *Humboldt & Bonpland*.

DISTRIBUTION: High mountains, Strawberry Valley (Chihuahua) to Orizaba, Popocatepetl, Ixtaccihuatl, and Toluca (Vera Cruz and México) at or near timberline (10,000–14,500 feet).

REPRESENTATIVE SPECIMENS: **MEXICO.** CHIHUAHUA. Strawberry Valley, *Hartman 686* (GH: type of *P. rupicola* Rob. & Fern., F, NY, UC, US). VERA CRUZ. Orizaba, *Rose & Hay 5776* (US), March 1908, *Purpus* (UC), *Nelson 288* (US). MÉXICO. Ixtaccihuatl, *Purpus 193* (MO—part, UC—part, US—part), *Heilprin & Baker* (PA); Popocatepetl, *Barkley, Rowell & Webster 2340* (TEX, UC); Toluca, *Hinton 432* (K, US), *Karwinski* (F & GH: photos).

Notable principally for its shaggy-villous pubescence, this evidently overlaps *P. platycarpa* var. *platycarpa* altitudinally, since the two have been mixed in the same collection, notably by Purpus. The type of only *P. rupicola* ("on cliffs in a pine forest of Strawberry Valley, Chihuahua") has been seen, but specimens at the University of California have been annotated as *P. acaulis* ("Dans les endroits humides du pic d'Orizaba, à 12,800 pieds") by Brand. The distributional pattern is remarkable, but I am unable to detect any significant morphological differences between the Chihuahuan and the central Mexican plants.

1c. ***Phacelia platycarpa* var. *madrensis*** (Greenm.), comb. nov.

Phacelia madrensis Greenm. Proc. Amer. Acad. 39: 85. 1903.

Phacelia rupicola var. *madrensis* Brand; Engler, Pflanzenr. 4²⁵¹: 67. 1913.

Acaulescent, 20–30 cm. high, short-villous throughout with soft spreading flattened hairs up to 1 or 2 mm. long; leaves pinnate, at least below, the lobes and leaflets rather remote, coarsely toothed or lobed.

TYPE LOCALITY: Sierra Madre, near Colonia Garcia, Chihuahua, *Townsend & Barber 100* (GH: type, F, MO). Known only from this collection.

As stated by Greenman, this differs from the typical phase of the species by "the spreading not appressed pubescence," and from var. *bursifolia* by "the foliar characters" and "the shorter pubescence." The supposed characters in calyx and glands apparently are not important. This is an anomalous entity,

and its retention in varietal status indicates doubt as to its proper disposition until more material has been collected. Both this and the preceding variety, however, agree in the great majority of their characters with var. *platycarpa*, and it is believed that the joining of the three into a single species best indicates their relationship.

2. *P. pulcherrima*, sp. nov.

Herba perennis (?), 6-12 dm. alta, ramosa, ramosis adscendentibus, caulibus hirsutulis, pilis complanatis patentibus; inflorescentia patentihirsutula glanduloso-villosaque; folia strigosa ad strigulosa glanduloso-villosaque, basalia vel caulina inferiora petiolata, oblongo-ovala, 9-15 cm. longa, 6-8 cm. lata, pinnata, foliolis 2 vel 4, obovatis, brevis dentatis, distinctis, basi rotundati-cuneatis, terminale magnissimum, basi cordatum 3- vel 5-lobum, folia superiora petiolata, obovata, usque trilobata; inflorescentia scorpoidea, cymis terminalibus solitariis vel geminatis, 10-20-floris; pedicelli maturi recurvati vel declinati, 10-20 mm. longi; calycis lobae ovato-lanceolatae ovatae, 10-16 mm. longae, 5-6 mm. latae, subaequali, acutae, hirsutulae vel hirsutae glanduloso-villosae; corolla violacea rotato-campanulata 10-15 mm. lata, lobis orbicularis integris glabris; appendiculae omnino adnatae; stamina circa 10 mm. longa corolla vix longiora, antheris 1.5 mm. longis, filamentis sub medium villosis; stylus anthesis corolla subequalis, maturus 10-12 mm. longus, ad $\frac{1}{3}$ partitus, basi hirtulosus, ovario apice hirsuto; capsula matura globosa 10-12 mm. lata; ovula 8-10 ad quamque placentam; semina circa 12-16 irregulari-ovoidea, 2.5-3 mm. longa, nigra, areolata minutissime alveolata.

TYPE LOCALITY: On mountains near Miquihuana, altitude, 7,000-9,000 feet, Tamaulipas, Mexico, 10 June 1898, *E. W. Nelson 4495* (type: US 1492795; US 332531, GH). Known only from this collection.

Despite the fact that it has been collected but once, a half-century ago, and that the specimens are incomplete, this is a strikingly distinct species. Its relationship is undoubtedly with *P. platycarpa*, but its glandular pubescence and the remarkable size of all its parts make it sharply distinct.

3. *Phacelia strictiflora* (Engelm. & Gray) A. Gray, Proc. Amer. Acad. 10: 321. 1875.

Eutoca strictiflora Engelm. & Gray, Boston Jour. Nat. Hist. 5: 45. 1845.

Annual, 5-30 cm. high, simple and erect or branching at base and the branches erect or somewhat decumbent at base; stems hirsutulous to densely hirsute, the inflorescence canescent to loosely hirsute; basal leaves rosulate, petiolate, cuneate (occasionally truncate) at base, narrowly oblong or oblanceolate to oval, 1-6 cm. long, 0.5-3 cm. broad, toothed or shallowly lobed to deeply pinnately lobed with 1-6 pairs of obtuse or acute teeth or lobes, sparsely hirsutulous on the margins and upper

surface, the lower surface glabrate, to densely strigose on both surfaces; cauline leaves sessile, orbicular to linear-oblong, shallowly dentate to deeply pinnately lobed with 2-6 pairs of obtuse or acute teeth or lobes; inflorescence of simple terminal 3-20-flowered cymes, the mature pedicels strictly ascending (to somewhat spreading), 2-10 mm. long; calyx lobes linear to oblanceolate, 5-15 mm. long, 0.5-4 mm. broad, obtuse or acute, subequal pubescent, the calyces of the lower flowers often markedly accrescent; corolla purplish-lavender, rotate-campanulate, 8-20 mm. broad, the lobes obovate, finely crenulate, pilose on the back; gland flaps wholly adnate, puberulent; stamens included, 5-7 mm. long, the anthers oblong, 1.5-2 mm. long, the filaments villous on their lower $\frac{2}{3}$; style included in flower, when mature 5-12 mm. long, cleft about $\frac{1}{2}$, hirsutulous on the lower $\frac{1}{2}$ or $\frac{2}{3}$, the summit of the ovary densely hirsute; mature capsule globose-ovoid, 3-6 mm. in diameter; ovules 8-14 to each placenta; seeds 10-20, ovoid-angled, ca. 2 mm. long, black, areolate and finely alveolate.

Foliage dull, not succulent; basal rosette usually early-withering, the basal leaves hirsutulous or hirsute beneath, lobed or divided; cauline leaves narrower, lobed to nearly pinnatifid; lower calyces about equaling those above in fruit.

Stems spreading-hirsute, the inflorescence loosely hirsute; calyx lobes ovate-lanceolate to ovate.....a. var. *strictiflora*.

Stems strigulose, the inflorescence canescent; calyx lobes linear-lanceolate to linear.

Branches stout; cauline leaves crowded, linear-oblong, deeply saliently lobed, the lobes acute.....b. var. *connexa*.

Branches slender; cauline leaves rather remote, oval-oblong, nearly pinnatifid, the lobes usually obtuse.....c. var. *Robbinsii*.

Foliage bright green, slightly succulent; basal rosette persistent, the basal leaves glabrate beneath, shallowly toothed; cauline leaves broad, shallowly toothed; lower calyces markedly accrescent in fruit.....d. var. *Lundelliana*.

3a. *Phacelia strictiflora* var. *strictiflora*

TYPE LOCALITY: "Shady soil on the banks of the Brazos near San Felipe, Texas," 1843, *Lindheimer II-279*.

DISTRIBUTION: Central eastern Texas, in sandy soil of fallow fields and on the borders of deciduous woods.

REPRESENTATIVE SPECIMENS: TEXAS. "Texas," *Drummond III-298* (GH, NY, PA). Milam Co.: Milano, *Palmer 11,681* (MO, UC). Brazos Co.: Wellborn, *D. C. Bain 126* (TENN). Waller Co.: Hempstead, *J. E. Brodie 43* (US). Austin Co.: San Felipe, *Lindheimer II-279* (GH: type of *Eutoca strictiflora* Engelm. & Gray, MO, NY, PA). Lee Co.: Lincoln, *Constance & Lundell 3243*. Bastrop Co.: Bastrop, *Tharp 5647* (TEX, US), *M. J. Land* (CLOKEY, GH). Travis Co.: Austin, *Hall 472* (F, GH, MO, NY, US). Gonzales Co.: Ottine Swamp, *Cory 18,178* (GH, TAES).

3b. *Phacelia strictiflora* var. *connexa*, var. nov.

A var. *strictiflora* differt: caulibus adpresse ascendenterque hirsutulis,

inflorescentiis canescentibus, foliis lineari-oblongis, lobis angustioribus gracilioribus et plerumque acutis, lobis calycis linearibus.

TYPE LOCALITY: Sandy soil of roadsides, fallow fields, and openings in oak woods, 5 miles NW of Grapevine, Tarrant County, Texas, 14 April 1948, *Constance 3252* (UC: type).

DISTRIBUTION: Northeastern Texas and adjacent Oklahoma, in sandy soil, especially of fallow fields.

REPRESENTATIVE SPECIMENS: **OKLAHOMA.** Muskogee Co.: Agency Hill, *Bebb 3095* (OKL-part). Cleveland Co.: E of Noble, 4 May 1935, *S. S. Goodman* (GH, OKL, NY). Bryan Co.: Brown, *Mrs. W. L. Ducker 39* (OKL). **TEXAS.** Grayson Co.: Denison, *Constance & Lundell 3254*. Wise Co.: Denton-Decatur road, *Lundell & Lundell 8455* (GH, SMU). Dallas Co.: Dallas, *Reverchon (Curtiss 2131)* (F, GH, MO, NY, PA, US), *Bush 637* (GH, MO, NY, US); Carrollton, *Constance 3251*. Tarrant Co.: Lake Worth, *O. L. Killian 6798* (NY, TEX, US). Van Zandt Co.: Grand Saline, 13 March, *M. J. Land* (NY, TEX). Henderson Co.: Athens, *McVaugh 8382* (UC). Anderson Co.: 17 miles SE Athens, *Lundell & Lundell 11,114* (SMU, UC). Limestone Co.: Fort Parker, *Constance & Cory 3244*. Houston Co.: Grapeland, *Palmer 13,195* (MO, US). Bell Co.: Lake Polk, *Wolff 2779* (US). Harris Co.: Hockley, 1889, *Thurrow* (US).

3c. *Phacelia strictiflora* var. *Robbinsii*, var. nov.

A var. *strictiflora* differt: caulibus et pedicellis gracilioribus, caulibus adpresse hirsutulis, inflorescentiis canescentibus, foliis subpinnatifidis, lobis calycis linearibus vel lineari-lanceolatis.

TYPE LOCALITY: Open, grazed pasture 10 miles north of Tishomingo near Wapanucka road junction, Johnston County, Oklahoma, 29 May 1948, *G. T. Robbins 3063* (UC: type).

DISTRIBUTION: Western Alabama and Mississippi to eastern Oklahoma and adjacent Texas.

REPRESENTATIVE SPECIMENS: **ALABAMA.** Greene Co.: Miller, *Clausen & Clausen 5724* (CLOKEY, NY). **MISSISSIPPI.** Lowndes Co.: Columbus, *Spillman* (GH, NY). **OKLAHOMA.** Mayes Co.: Pryor Creek, *Bebb 2720* (OKL). Creek Co.: Sapulpa, April 1924, *C. B. Williams* (PA). Muskogee Co.: ———, *Bebb 5090* (GH, OKL); Muskogee, *Carleton 52* (KSA, US). Haskell Co.: Stigler, 12 April 1908, *Brainerd* (GH). Pittsburg Co.: ———, May 1935, *J. E. McClary* (OKL-part). Johnston Co.: Tishomingo, *Robbins 3027* (UC). McCurtain Co.: Beaver Bend State Park, 6 April 1941, *H. R. Griffith* (OKL). Choctaw Co.: ———, *Leavenworth* (NY, PA). Atoka Co.: Limestone Gap, 23 April 1877, *Butler* (GH, MO, PA, US). **TEXAS.** Grayson Co.: Denison, 27 April 1931, *K. Waltz* (TEX), 7 April 1896, *T. V. Momson* (US).

3d. *Phacelia strictiflora* var. *Lundelliana*, var. nov.

A var. *strictiflora* differt: foliis clare viridibus, succulentis, sparsim hirsutulis glabratisque, rosulis basalibus persistentibus, foliis leviter dentatis, caulibus adpresse hirsutulis, calycibus inferioribus in fructu valde auctis, lobis plerumque obtusis, corollis purpurei-coeruleis.

TYPE LOCALITY: Sandy soil of fallow field, 3 miles NNW of the center of Abilene, Taylor County, Texas, 12 April 1948, *Constance & Cory 3249* (US: type).

DISTRIBUTION: Western Oklahoma and northern "West" Texas, in sandy soils.

REPRESENTATIVE SPECIMENS: **OKLAHOMA.** Blaine Co.: Geary, 26 April 1937, *J. Englemann* (OKL). Oklahoma Co.: Spencer, *Waterfall 1954* (OKL). Canadian Co.: Devil's Canyon, *Hopkins 1404* (OKL). Caddo Co.: Devil's Canyon, *Goodman 2089* (GH, NY, OKL, US); Hinton, *Demaree 12,330* (GH, MO, NY, OKL, PA, US); Fort Cobb-Andarko, *Hopkins, Nelson & Nelson 234* (MO, OKL, SMU, TEX, UC). Custer Co.: Weatherford, *Waterfall 451* (GH, OKL). Grady Co.: Chickasha, 20 May 1926, *Mrs. G. McNair* (MO, US). Kiowa Co.: Snyder, *O. Baldock 211* (TEX). Stephens Co.: Duncan Lake, *L. W. Mericle 613* (OKL). **TEXAS.** Wichita Co.: Big Wichita, 1880, *J. Ball* (GH). Clay Co.: Henrietta, *McBryde 251* (F). Tarrant Co.: Lake Worth, 4 April 1928, *Ruth 1512* (F, US). Hood Co.: Falls Creek, *Reverchon 1241* (F, K, MO, US). Eastland Co.: Rising Star, 16 April 1931, *B. G. Joyce* (TEX). Jones Co.: Anson, *Constance & Cory 3250*. Taylor Co.: Abilene, *Tolstead 7522* (GH, SMU). Navarro Co.: Dawson, *Reverchon 3893* (GH, MO, NY, US). McLennan Co.: Waco, *Ricker 3366* (US).

This is one of the two notably complex species in the subgenus. The types of both *Phacelia strictiflora* and *P. patuliflora* were collected "on the Brazos near San Felipe," where the two species overlap in range and were at first thought to be subject to considerable "contamination" by reciprocal exchange of genes. Field work seems to show, however, that these two species belong to two quite distinct genetic systems.

The following attempted explanation of the polymorphism found in *P. strictiflora* must be recognized as largely circumstantial and highly conjectural. No breeding studies have been attempted and genetic data, when available, may necessitate modification of this proposed scheme. I assume that var. *Lundelliana* represents the "pure" or "original" form of *P. strictiflora*, relatively unaffected by genes from other species. It occurs over a wide area and is extremely uniform, and it does not share much of its range with any other species of the subgenus. Morphologically, it stands at one end of the series of variations exhibited by the species population. In one of his exsiccatae, Reverchon designated this as "*P. strictiflora* var.," mistaking var. *connexa* for typical *P. strictiflora*, but gave it no infraspecific name. The range of var. *Robbinsii* coincides with the zone of overlap between *P. strictiflora* and *P. hirsuta* Nutt., and the slenderness of the branches and pedicels and the dissec-

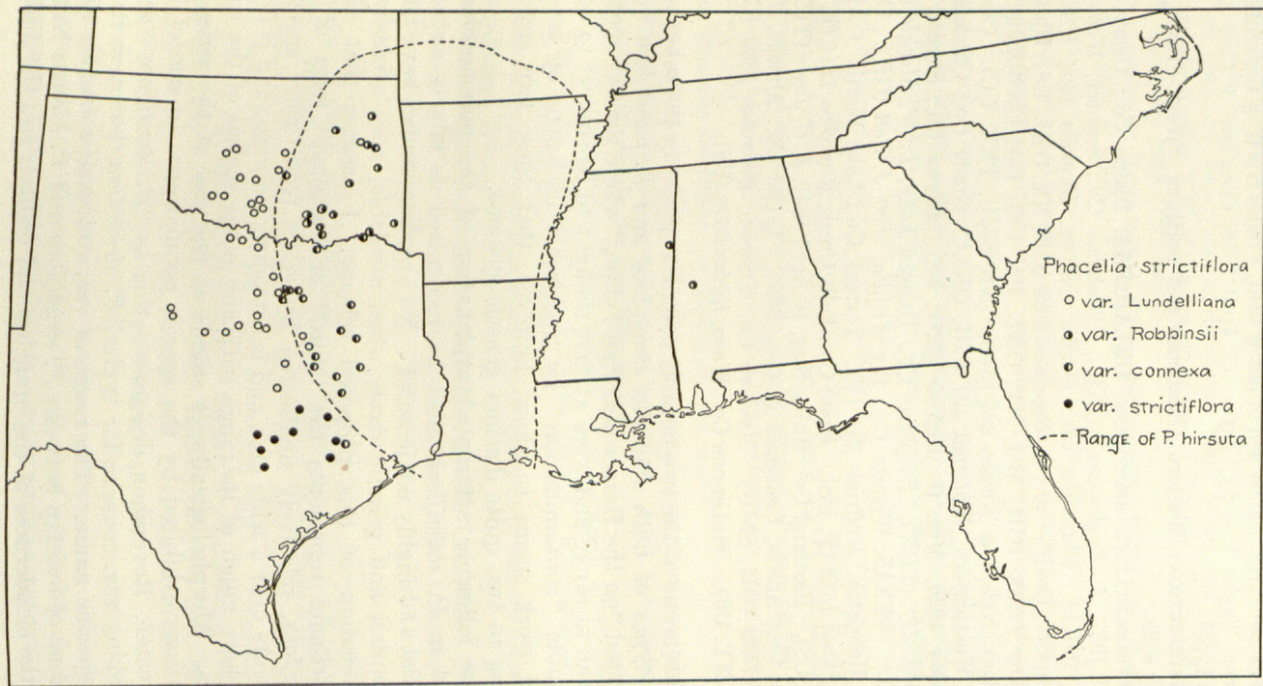


Fig. 3. Distribution of *P. strictiflora*.

tion of the cauline leaves are attributed to the influence of the latter species. Perhaps it was the existence of this phase that led Gray to remark (as quoted in Lindheimer's hand on sheet 217,098, MO): "*Ph. patuliflora* & *Ph. strictiflora* run all into *P. hirsuta* Nutt." In his critical discussion (1944) of *P. hirsuta*, *P. fallax* [*P. maculata*], and *P. gilioides*, Fernald confused var. *Robbinsii* with *P. gilioides*; his illustration of the seed of *P. gilioides* (op. cit., pl. 815, f. 6) is actually referable to *P. strictiflora*. Although both var. *Robbinsii* and *P. gilioides* have an appressed pubescence, a more or less canescent inflorescence, and somewhat erose corolla lobes, the former is clearly distinguished by its pronounced basal rosette, usually scapose appearance, and much shorter and strictly erect fruiting pedicels. *Phacelia strictiflora* var. *connexa* is intermediate in most respects between vars. *Robbinsii* and *strictiflora*. The numerous cauline leaves, mostly about as large as the basal, are saliently pinnately lobed, and the pubescence is somewhat coarser than in the preceding. Its characters likewise suggest the influence of *P. hirsuta*, but the case is less clear than with var. *Robbinsii*. Finally, the phase to which the type of *P. strictiflora* belongs shows the influence of *P. hirsuta* in the frequently decumbent branches and longer pedicels, and its coarser and longer spreading pubescence. On the other hand, it is as difficult to separate cleanly from var. *connexa* as that variety is from var. *Robbinsii*.

If these multiple assumptions possess any validity, the puzzling diversity within the present species may be at least partly resolved on the assumed basis of genic inflow (or "introgression") from *P. hirsuta*. The distributional pattern of the forms concerned (fig. 3) appears to lend itself to such an interpretation. It should again be emphasized, however, that the cytological data are inconclusive (*P. hirsuta* and *P. strictiflora* each having 9 pairs of chromosomes), and that no genetical evidence has been procured.

4. ***Phacelia patuliflora*** (Engelm. & Gray) A. Gray, Proc. Amer. Acad. 10: 321. 1875.
Eutoca patuliflora Engelm. & Gray, Boston Jour. Nat. Hist. 5: 45. 1845.
Phacelia hispida Buckl. Proc. Acad. Soc. Phila. 1861: 463. 1862, non A. Gray 1878.

Annual, 8–60 cm. high, branching from the base, the branches diffuse to rather stiffly ascending; stems densely spreading hirsute (especially at base) to finely strigulose, the inflorescence loosely hirsute to strigulose and canescent, rarely a little glandular; basal leaves neither conspicuously rosulate nor persistent, petiolate, truncate to cuneate at base, oblong to

oval, occasionally orbicular, 2–10 cm. long, 1–4 cm. broad, pinnately lobed, pinnatifid, or pinnate, with 1–7 pairs of smaller lobes or remote leaflets at base and a much larger terminal leaflet, all coarsely dentate or lobed with obtuse or acute teeth or lobes, the terminal leaflet often trilobed, strigulose to hirsute on both surfaces; cauline leaves mostly sessile, oblong to orbicular, coarsely dentate with 3–6 pairs of obtuse or acute teeth or lobes; inflorescence of simple terminal 5–30-flowered cymes, the mature pedicels widely spreading to weakly ascending or reflexed, 3–20 mm. long; calyx lobes narrowly oblong or lanceolate to obovate, 5–12 mm. long, 1–4 mm. broad, obtuse or acute, unequal or subequal, hirsute on the margins and strigulose to glabrate on both surfaces, spreading to ascending in fruit; corolla lavender to purplish-violet, usually with a conspicuous white center, broadly campanulate to rotate-campanulate, 8–20 mm. broad, the lobes obovate, finely crenulate, sparsely pilose on the back; gland flaps wholly adnate, puberulent; stamens included, 5–8 mm. long, the anthers oblong, 1–1.5 mm. long, the filaments villous on the lower $\frac{2}{3}$; style included in flower, 5–8 mm. long in fruit, cleft about $\frac{2}{3}$, hirsute below the middle, the summit of the ovary hirsute; mature capsule globose, 4–6 mm. in diameter; ovules 6–12 to each placenta; seeds 10–15, ovoid-angled, ca. 2 mm. long, brown, areolate and finely alveolate.

Branches decumbent; calyx lobes obtuse; fruiting pedicels spreading to reflexed; corolla pale lavender to violet. . . . a. var. *patuliflora*.
Branches rather stiffly ascending; calyx lobes acute; fruiting pedicels spreading-ascending; corolla bluish-lavender. . . . b. var. *teucrifolia*.

4a. *Phacelia patuliflora* var. *patuliflora*

TYPE LOCALITY: "woods near San Felipe, Texas," 1843, *Lindheimer II-280*.

DISTRIBUTION: Central and southeastern Texas and adjacent Mexico, chiefly on sandy soil of river terraces, and on alluvial soil of the Rio Grande valley and plain.

REPRESENTATIVE SPECIMENS: **TEXAS.** Falls Co.: Gurley, *Howell 366* (US). Burnet Co.: Burnet, *Wolff 1561* (TAES, US). Brazos Co.: Nellava, *Palmer 13,447* (MO, US). Austin Co.: San Felipe, *Lindheimer II-280* (GH: type of *Eutoca patuliflora* Engelm. & Gray, MO, NY). Bastrop Co.: opposite Bastrop, *Constance & Lundell 3241*. Travis Co.: Austin, April 1860, *Buckley* (PA: type of *P. hispida* Buckl., GH, MO), 7 April 1940, *Tharp* (CLOKEY, GH, MO, SMU, TAES). Harris Co.: Houston, *Bush 9* (MO, NY, US). Fort Bend Co.: Richmond, *Palmer 4946* (F, MO, US). Brazoria Co.: Columbia, *Bush 448* (MO, NY, US). Matagorda Co.: Matagorda, *Palmer 4859* (F, MO, US). Aransas Co.: Aransas Bay, *Constance & Lundell 3219*. Refugio Co.: Austwell, *Constance & Lundell 3217*. Bexar Co.: Elmendorf, *Parks 12,171* (GH, TAES). Uvalde Co.: Sabinal, *M. E. Jones 29,202* (MO). LaSalle Co.: Fowlerton, *Cory 28,544* (GH). Dimmit Co.: Carrizo Springs, *Palmer 33,744* (NY). San Patricio Co.: Nueces River, *Constance & Lundell 3221*. Nueces Co.: Flour Bluff, Padre Island, *Tharp 5609* (GH, TEX, US). Duval Co.:

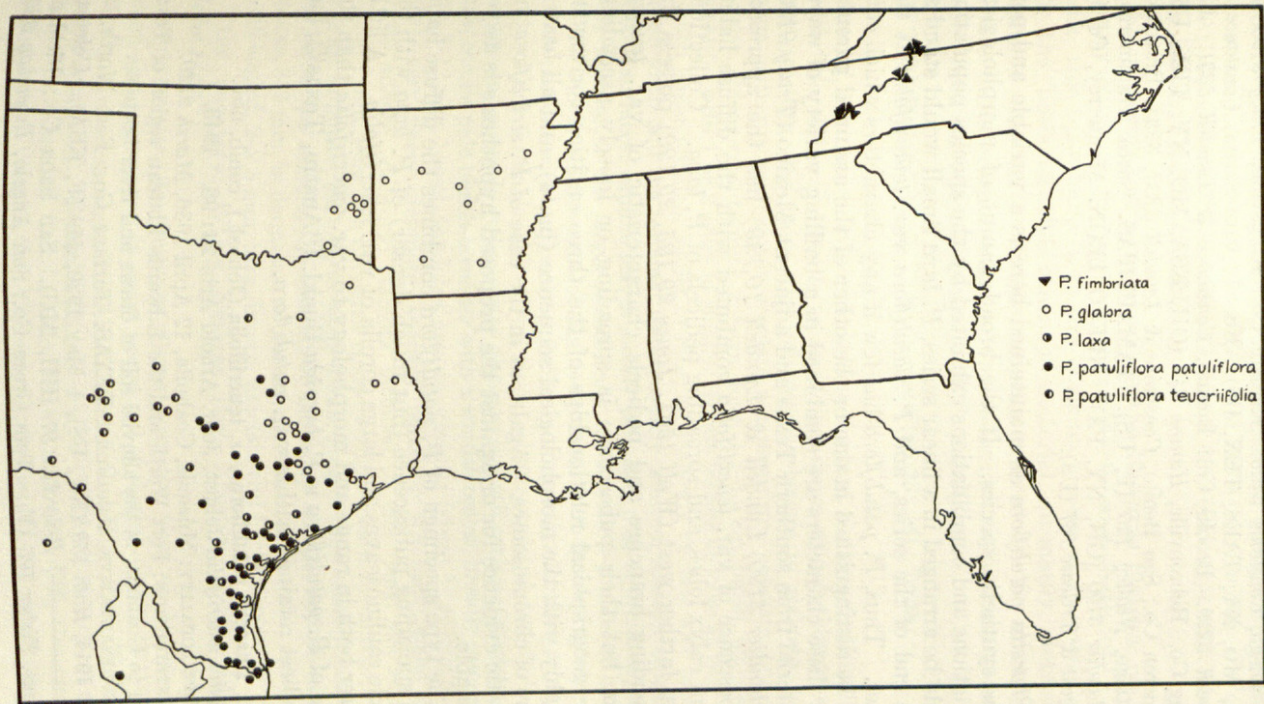


Fig. 4. Distribution of *P. patuliflora*, *P. laxa*, *P. glabra*, and *P. fimbriata*.

San Diego, *Constance* 3226. Kleberg Co.: Kingsville, *Tracy* 9190 (F, GH, MO, NY, TAES, TEX, US). Kenedy Co.: Sarita, *Constance & Lundell* 3229. Brooks Co.: Encino, *Constance & Lundell* 3231. Jim Hogg Co.: Hebronville, *Hanson* 342 (GH, KSA, MO, NY, TEX, US). Cameron Co.: San Benito, *Constance & Lundell* 3233, 3234; Brazos de Santiago, *Nealley* 120 (F, US). **TAMAULIPAS.** "circa Matamoras," *Berlandier* 3190 (GH, NY, PA). **NUEVO LEÓN.** Monterrey, *Canby, Sargent & Trelease* 167 (US).

Phacelia patuliflora as maintained here is a variable and perhaps synthetic species. If the broad gamut of morphological variations and combinations exhibited by the species population could be arranged in a linear series, *P. laxa* Small would stand at one end of the series, and *P. patuliflora* var. *teucrifolia* at the other. Thus, *P. patuliflora* has few if any characters which cannot be distinguished in one or the other of the assumed parents, but these characters are combined in a baffling variety of ways. Material from southern Texas and adjacent Mexico (*Tracy* 9190, *Berlandier* 3190, *Lundell & Lundell* 10,749) has the appressed pubescence of var. *teucrifolia* combined with the diffuse habit, blunt calyx lobes, and spreading pedicels of *P. laxa*. Collections from farther west (*Wolf* 1561, *Jones* 29,195, 29,199) possess the ascending branches and pedicels characteristic of var. *teucrifolia*, but their pubescence is spreading or loosely ascending. The geographical relationships of the three entities correspond roughly with the morphological sequence (fig. 4), and all have 9 pairs of chromosomes. Again, as in the case of *P. strictiflora*, no genetic evidence for or against the proposed hypothesis is as yet available.

The type specimen of *P. patuliflora* combines the diffuse habit and spreading pubescence (but much denser) of *P. laxa* with the sessile cauline leaves and large corolla of var. *teucrifolia*. A little nearer both in range and morphology to var. *teucrifolia* than the type of *P. patuliflora* is *P. hispida* Buckl. ("Austin, Texas"), but it is best retained within var. *patuliflora*.

4b. ***Phacelia patuliflora* var. *teucrifolia*** (Johnst.), comb. nov.

Phacelia teucrifolia Johnst. Jour. Arnold Arb. 24: 98. 1943.

TYPE LOCALITY: Múzquiz, Coahuila, 12 April 1936, *Marsh* 2120.

DISTRIBUTION: Fort Worth and the Edwards Plateau region of Texas south to Coahuila, in the alluvial soil of draws and river bottoms.

REPRESENTATIVE SPECIMENS: **TEXAS.** Tarrant Co.: Fort Worth, 22 April 1914, *Ruth* 459 (NY, US), 1 May 1920, 459 (F, KSA). Coleman Co.: ———, *Reverchon* 97 (GH, MO). San Saba Co.: Richland Springs, *Fisher* 103 (F). Tom Green Co.: San Angelo, *Reverchon* 3896

(MO, NY). Irion Co.: Mertzson, *Warnock 536* (Tex, US). Menard Co.: Menard, *Constance & Cory 3248*. Val Verde Co.: Pandale, *McVaugh 7709* (UC). **COAHUILA**. Múzquiz, *March 2120* (GH: type of *P. teucrifolia* Johnst., F), *2135* (F, GH).

An inhabitant of alluvial soil in the Edwards Plateau, on the Trinity River as far north as Fort Worth, and south into Coahuila, this may have been the "original" form of *P. patuliflora*. On the basis of the Mexican material, primarily, Johnston regarded this as a distinct species related to *P. strictiflora*. Whatever its primitive status, var. *teucrifolia* is now inseparably mixed into the species complex of *P. patuliflora*.

5. ***Phacelia laxa*** Small, Bull. Torrey Club **25**: 141. 1898.

Phacelia prostrata Brand; Engler, *Pflanzenr.* **4**²⁵¹: 68. 1913.

Annual, 5–45 cm. tall, branching from the base, the branches succulent and brittle, diffuse, prostrate to ascending; stems sparsely hirsute with long spreading stiff hairs, the inflorescence hirsute to glabrate; basal leaves neither conspicuously rosulate nor persistent, petiolate, truncate at base, oblong-oval to oval, 2–8 cm. long, 1.2–3.5 cm. broad, pinnate or pinnatifid with 1 or 2 pairs of smaller remote leaflets or lobes at base and a much larger terminal leaflet or lobe, all shallowly dentate with usually obtuse teeth and the terminal leaflet usually trilobed, sparsely strigulose on both surfaces; cauline leaves mostly petiolate, oval to orbicular, shallowly dentate or the larger occasionally lobed with 2–4 pairs of obtuse teeth or lobes; inflorescence of simple terminal 8–20-flowered cymes, the mature pedicels widely spreading, 5–20 mm. long; calyx lobes oblanceolate to obovate, 5–9 mm. long, 1–4 mm. broad, obtuse, unequal, hirsute on the margins and sparsely strigulose to glabrate on both surfaces, spreading in fruit; corolla pale bluish-lavender with a whitish center, broadly campanulate, 8–12 mm. broad, the lobes oval to orbicular (about $\frac{1}{2}$ as long as the tube), very finely crenulate, sparsely pilose on the back; gland flaps wholly adnate, glabrous; stamens included, 5 mm. long, the anthers oblong, 1 mm. long, the filaments sparsely villous below the middle; style included in flower, cleft $\frac{1}{2}$ to $\frac{2}{3}$, 3–5 mm. long in fruit, sparsely hirsutulous below the middle, the summit of the ovary hirsute; mature capsule globose, 3–5 mm. in diameter; ovules usually 4 to each placenta; seeds 4–8, ovoid-angled, 2–2.5 mm. long, brown, areolate and finely alveolate.

TYPE LOCALITY: "along Neueces Bay, Neueces County, Texas," Heller 1446.

DISTRIBUTION: Southeastern Texas near the Gulf of Mexico, and inland along the rivers, in moist heavy soil of shaded alluvial thickets.

SPECIMENS EXAMINED: **TEXAS**. ? Kendall Co.: Edge Falls, 26 March 1938, *Parks* (UC). Gonzales Co.: ———, 22 April 1938, *E. F. Owen* (GH, UC). Jackson Co.: Ganado, *Palmer 9022* (PA, US), *Constance & Lundell 3214*. Victoria Co.: Victoria, *Lindheimer III-479* (type collection

of *P. prostrata* Brand, F, GH, MO, PA, UC), *Constance & Lundell* 3216. San Patricio Co.: Sinton, *Constance & Lundell* 3220. Nueces Co.: Nueces Bay, *Heller* 1446 (NY: type of *P. laxa* Small, GH, K, MO, PA, UC, US); Calallen, *Constance & Lundell* 3222. Jim Wells Co.: *Constance* 3223.

This is exceedingly difficult to separate from *P. patuliflora* in the herbarium, as might be expected if my assumption as to the synthetic character and the ancestry of the latter species is correct. Since all the characters of *P. laxa*, except perhaps the low number of ovules, have been diffused into *P. patuliflora*, its distinctness rests solely upon a combination of characters, none of which is clearly distinguishing in itself. In the field, however, it is easily recognized by its small pale flowers, petiolate cauline leaves, sparse pubescence, and preference for shaded alluvial situations. I regard it as a species restricted rather closely to this type of habitat, and presume that it has been very nearly "swamped out" by the competition offered by its own recombination products with *P. patuliflora* var. *teucrifolia*. Macbride has pointed out that Brand overlooked the publication of *P. laxa* Small, and so described the same entity as *P. prostrata* ("bei Victoria am Guadalupe River").

6. ***Phacelia hirsuta*** Nutt. Trans. Amer. Philos. Soc. N. S. 5: 191. 1837.
Phacelia parviflora var. *hirsuta* A. Gray, Proc. Amer. Acad. 10: 321. 1875.
Phacelia dubia var. *hirsuta* Trel. Rep. Ark. Geol. Surv. 1888. 4: 205. 1891.

Annual, 10–50 cm. high, simple or usually branching at base or above, the branches erect or ascending; stems densely hirsute with stiff spreading hairs, the inflorescence hirsutulous and spreading-hirsute; basal leaves petiolate, oblong, 2–4.5 cm. long, 0.8–2.5 cm. broad, pinnate or pinnatifid with 2–4 pairs of oval to orbicular, entire or toothed, often petiolulate leaflets or lobes and a larger trilobed orbicular to obovate terminal leaflet or lobe, the cauline leaves oblong to orbicular, usually short-petiolate but sometimes sessile and somewhat clasping, pinnately lobed to pinnatifid, rarely merely toothed, with 2–4 pairs of linear to oval, acute or obtuse lobes, strigose on both surfaces; inflorescence of simple terminal 10–25-flowered cymes, the mature pedicels spreading-ascending to spreading, 3–15 mm. long; calyx lobes linear to oblanceolate, 5–10 mm. long, 1–3 mm. broad, unequal, obtuse, strigose and strigulose on both surfaces, spreading to slightly reflexed in anthesis, erect or ascending in fruit; corolla light bluish-lavender with a whitish center and 2 purple spots on the proximal edge of each lobe, rotate-campanulate, 8–13 mm. broad, the lobes orbicular, entire, pilose on the back; gland flaps wholly adnate, puberulent; stamens usually included, 4–6 mm. long, the anthers oblong, about 1 mm. long, the filaments densely villous on their lower $\frac{2}{3}$; style included in flower, when mature 5–6 mm. long, cleft $\frac{1}{3}$ to $\frac{1}{2}$, hirsutulous at base, the

summit of the ovary hirsute; mature capsule subglobose, 3.5–4 mm. in diameter; ovules usually 4 to each placenta; seeds 6–8, ovoid-angled, ca. 2 mm. long, brown, areolate and finely alveolate.

TYPE LOCALITY: "In sylvan prairies; common from the Cadron to the garrison at Belle Point, Arkansas," *Nuttall*.

DISTRIBUTION: Southern Missouri and southeastern Kansas, south to Louisiana and northeastern Texas, in borders and openings of deciduous woods.

REPRESENTATIVE SPECIMENS: **MISSOURI.** Oregon Co.: Alton, *Steyermark* 5155 (F, MO). Howell Co.: Lanton, *Steyermark* 5153 (F, MO). Webster Co.: Fordland, *Steyermark* 19,256 (MO). McDonald Co.: Pineville, *Palmer* 39,288 (US). **KANSAS.** Cherokee Co.: ———, *Hitchcock* 1087 (GH—part, KSA—part, MO, NY, US—part). Neosha Co.: Thayer, June 1890, *H. Darnell* (KSA). **ARKANSAS.** "Arkansas," *Nuttall* (type collection of *P. hirsuta* Nutt., GH, PA). Clay Co.: Corning May 1884, *Letterman* (F, MO, NY, PA, US—part). Carroll Co.: Eureka Springs, *Palmer* 5626 (MO, TENN). Drew Co.: Monticello, *Demaree* 21,122 (MO, NY, TEX). Hot Spring Co.: Magnet Cove, *Demaree* 14,830 (DUKE, F, GH, MO, NY, OKL, TENN, TULA, UC, WVA). Nevada Co. Prescott, *Bush* 258 (GH, K, MO, NY, US, WVA). **LOUISIANA.** Iberia Parish: Saline Island, *Langlois* 105 (NY, PENN, US). Rapides Parish: Alexandria, *Hale* 200 (PA). Calcasieu Parish: Lake Charles, *Benke* 5541 (F, US). **OKLAHOMA.** Creek Co.: Sapulpa, *Bush* 917 (K, MO, NY). Muskogee Co.: Webbers Falls, *Goodman* 2137 (GH, MO, NY, OKL. US). Le Flore Co.: Pine Valley, *Goodman* 2493 (GH, MO, NY, OKL). McCurtain Co.: ———, *Little & Olmstead* 1563 (OKL, US). Johnston Co.: Tishomingo, *Robbins* 2407 (UC). **TEXAS.** "Texas," *Drummond* III-299 (GH, K, NY, PA). Lamar Co.: Arthur City, *Constance & Lundell* 3256; Paris, *Constance & Lundell* 3257. Wood Co.: Golden, 16 April 1926, *E. McMullen* (TEX). Limestone Co.: Fort Parker, *Constance & Cory* 3244. Orange Co.: Sabine River—Orange, *Small & Wherry* 11,795 (NY). Chambers Co.: ———, 7–10 April 1936, *Tharp* (NY, TEX).

This well marked species, characterized by its long and spreading pubescence, is in serious danger of being confused only with *P. gilioides* and *P. maculata*, both of which have closely appressed hairs and a canescent inflorescence. Some apparent shade forms with atypically shallowly lobed cauline leaves have been incorrectly cited as evidence for the occurrence of *P. patuliflora* in Arkansas. The suggested relationship of *P. hirsuta* to *P. strictiflora* and to *P. gilioides* is detailed in the accounts of those species. Brand's description of this species as "planta biennis" is quite inexplicable; both in the field and under cultivation, *P. hirsuta* behaves as an orthodox annual.

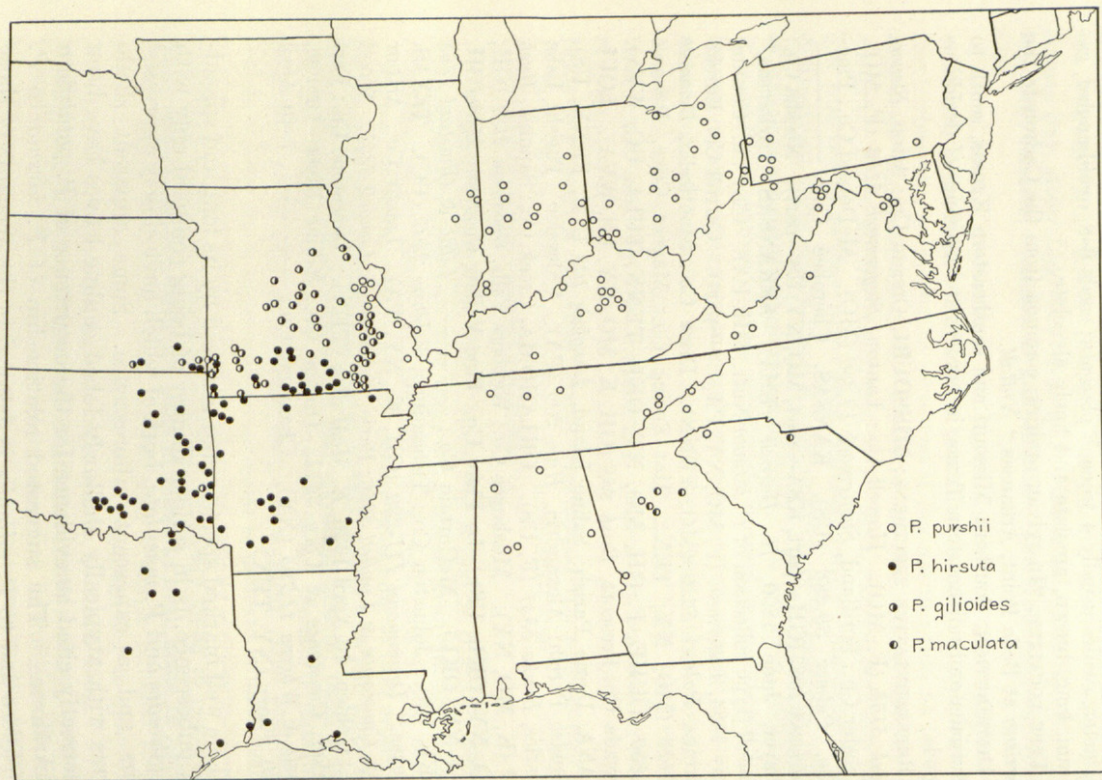


Fig. 5. Distribution of *P. hirsuta*, *P. gilioides*, *P. maculata*, and *P. Purshii*.

7. *Phacelia gilioides* Brand; Engler, Pflanzenr. 4²⁵¹: 63. 1913.

Annual, 10–40 cm. high, simple or usually branching at or above the base, the branches erect or ascending; stems thinly strigose with stiff afflexed hairs, the inflorescence densely strigulose and strigose, canescent; basal leaves petiolate, oblong, 1.5–5 cm. long, 0.8–3 cm. broad, pinnate to pinnatifid with 2–5 pairs of oblong to orbicular, entire or toothed, usually petiolulate leaflets or lobes and a larger entire or trilobed terminal leaflet or lobe, the cauline leaves short-petiolate to sessile and somewhat clasping, oblong to orbicular, pinnatifid or deeply pinnately lobed with 2–4 pairs of linear-lanceolate to oblong, usually acute lobes, strigose on both surfaces; inflorescence of simple terminal and axillary 8–25-flowered cymes, the mature pedicels loosely ascending to spreading, 5–15 mm. long; calyx lobes lanceolate to oblong, 5–8 mm. long, 0.5–2 mm. broad, subequal, acute or obtuse, hirsute-ciliate with stiff pustular-based hairs and strigulose on both surfaces, ascending in anthesis, ascending to spreading in fruit; corolla deep lavender, rotate-campanulate, 8–15 mm. broad, the lobes orbicular, fimbriate to denticulate, pilose on the back; gland flaps wholly adnate, glabrous; stamens usually included, 4–6 mm. long, the anthers oblong, about 1 mm. long, the filaments densely villous on their lower $\frac{4}{5}$; style included in flower, when mature 5–7 mm. long, cleft $\frac{1}{3}$ to $\frac{1}{2}$, hirsutulous on the lower $\frac{1}{4}$, the summit of the ovary hirsute; mature capsule subglobose, 3–4 mm. in diameter; ovules usually 4 to each placenta; seeds 6–8, ovoid-angled, 1.5–2 mm. long, dark brown, areolate and finely alveolate.

TYPE LOCALITY: "Missouri: Corn-Creek in Ozarkgebirge," Hoffman.

DISTRIBUTION: Central and southern Missouri to adjacent Kansas and Oklahoma, and probably Arkansas, in deciduous woods and on limestone barrens.

REPRESENTATIVE SPECIMENS: **KANSAS.** Cherokee Co.: ———, Hitchcock 1087 (GH—part, KSA—part, US—part). Labette Co.: Oswego, 5 May 1891, Newton (KSA, US). **MISSOURI.** Pike Co.: Cyrene, Steyermark 28,609 (MO). Cooper Co., ———, Bush 14,787 (DUKE, MO, US). Washington Co.: Potosi, 1861, Peck (F, GH, MO). Iron Co.: Ironton, 26 May 1918, Churchill (GH, MO, UC). Scott Co.: Benton, Steyermark 10,250 (CLOKEY, MO). Jasper Co.: Joplin, Palmer 1879 (GH, MO, US); Webb City, Palmer 1928 (GH, MO, US). Barry Co.: Eagle Rock, Bush 219 (F, GH, MO, UC, US, WVA), 180 (KSA, MO, UC, US, WVA). McDonald Co.: Noel, Bush 5617 (GH, MO, US). **OKLAHOMA.** Le Flore Co.: Page, Stevens 1377 (GH, OKL, US).

Phacelia gilioides differs from *P. hirsuta* by its closely appressed pubescence and the canescence of the inflorescence (as pointed out by Fernald), and from *P. Purshii* by the pubescent corolla lobes, more numerous ovules, and usually smaller seeds. It will be seen, indeed, that *P. gilioides* has no characters which cannot be referred to either *P. hirsuta* or *P. Purshii*, although it is usually more like the former in general appearance. The fact

that the geographical range of *P. gilioides* overlaps that of *P. hirsuta* on the southwest and that of *P. Purshii* on the east (fig. 5) suggests the possible explanation that *P. gilioides* is the result of hybridization between these two species. Neither cytological nor genetical data are as yet available to test this hypothesis, but it should afford an interesting problem for someone situated in the Missouri region. If this interpretation is borne out by further evidence, it will be an addition to those few species which are known to have been derived from others still living. Despite their frequently close resemblance, *P. hirsuta* and *P. gilioides* appear to have been mixed under the same number only by Hitchcock in his exsiccatae from southeastern Kansas. The second of the two collections cited by Brand in the original description is a representative of *P. hirsuta*.

8. **Phacelia maculata** Wood, Amer. Bot. & Flor. 244. 1870.

Phacelia fallax Fernald, Rhodora 46: 51, pl. 814, f. 1-4. 1944.

Annual, 10-40 cm. high, simple or usually branching at or above the base, the branches erect or ascending; stems strigose with rather stiff afflexed hairs; the inflorescence strigulose and strigose, canescent; basal leaves petiolate, oblong to oblong-oval, 1.5-5 cm. long, 0.8-2 cm. broad, pinnate or pinnatifid with 1-3 pairs of oval to orbicular, toothed or entire, often petiolulate leaflets or lobes and a much larger trilobed obovate-cuneate terminal leaflet or lobe, the cauline leaves short-petiolate to sessile, oblong-oval to orbicular, pinnately lobed with 2 or 3 pairs of oblong to oblong-obovate obtuse lobes, strigose on both surfaces; inflorescence of simple terminal 8-25-flowered cymes, the mature pedicels ascending to spreading-ascending, 4-10 mm. long; calyx lobes linear-oblong, 5-8 mm. long, about 1 mm. broad, obtuse, subequal, hirsute-ciliate with stiff pustular-based hairs and strigulose on both surfaces, ascending in anthesis; corolla deep lavender, rotate-campanulate, 7-11 mm. broad, the lobes orbicular, minutely crenulate, pilose on the back; gland flaps wholly adnate, glabrous; stamens usually included, 5-6 mm. long, the anthers oblong, 0.8-1.25 mm. long, the filaments densely villous on their lower 4/5; style included in flower, when mature 4-5 mm. long, cleft about 1/2, hirsutulous on the lower 1/2, the summit of the ovary hirsute; mature capsule subglobose, 3-4 mm. in diameter; ovules usually 4 to each placenta; seeds 6-8, ovoid-angled, ca. 2 mm. long, brown, areolate and finely alveolate.

TYPE LOCALITY: "Stone Mountain, Georgia, and westward," Wood.

DISTRIBUTION: Mountains of northern Georgia to adjacent South Carolina and Alabama, on granitic rocks.

REPRESENTATIVE SPECIMENS: **SOUTH CAROLINA.** Lancaster Co.: Forty-Acre Rock, *D. Huntley* 210 (DUKE); Greenville Co.: 14 miles north of Travelers Rest, *McVaugh* 8645 (UC). **GEORGIA.** Clarke Co.: Athens, 14 April 1930, *Pyron* (DUKE, GH), *Cronquist* 4371 (GA, GH).

Gwinnet Co.: Thompsons Mills, *Allard* 206 (US). DeKalb Co.: Stone Mt., *Biltmore Herb.* 4263 (GH, MO, PA, UC, US), May 1869, *Canby* (GH, MO, UC), 20 May 1897, *Eggert* (MO, US), *Palmer* 39,909 (GH, MO, US), *Curtiss* 6458 (GH: type of *P. fallax* Fern., F, KSA, MO, UC, US). Rockdale Co.: Big Haynes Creek, *Pyron & McVaugh* 2552 (GA). **ALABAMA.** Randolph Co.: Blake's Ferry, *McVaugh* 8605 (UC).

Fernald (1944) has ably assembled characters to distinguish *P. maculata* (as *P. fallax*) from *P. hirsuta*, but he apparently did not realize that an even more critical problem is to separate *P. maculata* from *P. gilioides*. Although the admittedly weak characters employed in the present key are the best I can find to distinguish them, I hesitated to consider them conspecific even before I was aware of the unusual chromosome number in the Appalachian species. *Phacelia maculata* is known only from granitic "flatrocks" in the southern Appalachians, and *P. gilioides* apparently grows mostly on or near limestone "barrens" in the Ozark region. Because of the suggestions made above as to the possible hybrid origin of *P. gilioides*, it is interesting to find so much difficulty in distinguishing that species from *P. maculata*. Although *P. Purshii* and *P. maculata* occur in approximately the same area, *P. hirsuta* is not known from anywhere near, and I cannot visualize any other species which might replace it as a potential ancestor of *P. maculata*. While *P. gilioides* is variable, pretty well bridging the morphological gap between *P. Purshii* and *P. hirsuta* and making it awkward to describe and key, *P. maculata* is extremely uniform and hence easier to recognize than my key would suggest.

McVaugh has been criticized by Fernald because the former's association of this species (as *P. hirsuta*) with granitic outcrops (1943) does not take into account a collection purportedly from Giles County, Virginia. This record, based on a single printed label of Canby's in the Gray Herbarium, is doubtless an error. According to his labels, Canby collected both on Stone Mountain, Georgia, and in Giles County, Virginia, in May, 1869. Canby specimens of *P. maculata* in other herbaria all bear a Georgia label. Furthermore, the only collections thus far seen from outside Georgia are from South Carolina or Alabama.

9. ***Phacelia glabra*** Nutt. Trans. Amer. Philos. Soc. N. S. 5: 192. 1837.
Cosmanthus nemophiloides Kunth, Ind. Sem. Hort. Berol. 12. 1846.
Annual, 5–40 cm. high, simple and erect or usually branched from near the base, the branches erect or ascending, slightly succulent; stems and inflorescence rarely with a few scattered stiff afflexed hairs; basal leaves petiolate, oblong to oblong-oval, 1.5–4 cm. long, 0.5–1.5 cm. broad, pinnate

or pinnatifid with 2-4 pairs of oval to orbicular entire or toothed leaflets or lobes and a larger 3- or 5-lobed terminal leaflet or lobe, most of the cauline leaves sessile and clasping, oval to broadly ovate, deeply pinnately lobed with 1-5 pairs of lanceolate to oblong, acute or obtuse lobes, strongly hirsute-ciliate and sometimes sparsely strigulose on one or both surfaces; inflorescence of simple terminal or axillary 5-15-flowered cymes, the mature pedicels spreading-ascending or spreading, 6-12 mm. long; calyx-lobes narrowly oblong to oval, 2-4 mm. long, 0.5-2 mm. broad, usually unequal, obtuse, hirsute-ciliate, the surfaces usually glabrous, erect or ascending in fruit; corolla deep bluish-lavender with a whitish center and 2 purple spots on the proximal end of each lobe, rotate-campanulate, 5-12 mm. broad, the lobes orbicular, entire, sparsely pilose on the back; gland flaps wholly adnate, glabrous; stamens about as long as the corolla, 3-5 mm. long, the anthers oblong, about 0.8 mm. long, the filaments densely villous on their lower $\frac{1}{2}$; style included in flower, when mature 3-5 mm. long, cleft about $\frac{1}{2}$, glabrous, the summit of the ovary glabrous, or with a very few stiff hairs; mature capsule globose, 3-4 mm. in diameter; ovules usually 4 to each placenta; seeds 4-8, ovoid-angled, ca. 2 mm. long, brown, areolate and finely alveolate.

TYPE LOCALITY: "In humid and elevated woods on the margins of rivulets, near the Dardenelles settlement, Arkansas river," *Nuttall*.

DISTRIBUTION: Arkansas and adjacent Oklahoma south to Louisiana (?) and northeastern Texas, in sandy loam of prairies or at the edge of deciduous woods.

REPRESENTATIVE SPECIMENS: **ARKANSAS.** "Red River," *Nuttall* (GH, K, NY, PA). White Co.: Bald Knob, *Demaree* 17,126 (F, MO, OKL). Bradley Co.: Warren, *Demaree* 18,947 (CLOKEY, GH, MO, NY, TULA). Pulaski Co.: Little Rock, *Demaree* 17,135 (CLOKEY, MO, NY). Nevada Co.: Prescott, *Bush* 254 (MO, NY, US). ? **LOUISIANA.** "Wet prairies, Louisiana, Georgia," *Leavenworth* (NY). **OKLAHOMA.** Haskell Co.: Stigler, *B. Osborn* 1510R (US). Le Flore Co.: Talihina, *Robbins* 2352 (UC). Choctaw Co.: Hugo, *Constance & Lundell* 3235. **TEXAS.** Kaufman Co.: Terrell, *Reverchon* 3894 (GH, MO, US). San Augustine Co.: San Augustine, *G. L. Crocket* (US). Falls Co.: S. of Kosse, *Constance & Cory* 3246. Harris Co.: Houston, *Lindheimer* I-134 (GH, MO, PA), *Hall* 673 (F, GH, MO, NY, PA, US). Austin Co.: San Felipe, *Constance & Lundell* 3212.

This is a quite distinct species, perhaps because of its unique chromosome number, which may have protected it from interbreeding with any of its relatives. It has been collected rather seldom and probably has a broader range than the available collections indicate. In some herbaria it has been hidden under the name "*P. dubia*," a species with which it has little in common except small flowers. *Cosmanthus nemophiloides* Kunth ("Texas") appears to be the same, the phrase "placentis biovulatis"

being in error, since no biovulate species of this group are known from Texas.

10. **Phacelia dubia** (L.) Trel. Rep. Ark. Geol. Surv. 1888. 4: 205. 1891.

Polemonium dubium L. Sp. Pl. 163. 1753.

? *Heteryta polemonioides* Raf. Med. Repos. N. Y. 5: 353. 1808.

Phacelia parviflora Pursh, Fl. Am. Sept. 140. 1814.

Eutoca parviflora R. Br. in Richards. Bot. App. Franklin's Journ. 764. 1823.

Phacelia pusilla Buckl. Amer. Jour. Sci. 14: 172. 1843, non Torr. 1871.

Cosmanthus parviflorus A. DC. Prodr. 9: 297. 1845.

Phacelia dubia var. *interior* Fernald, Rhodora 46: 5. 1944.

Annual, 5-40 cm. high, usually branching from the base and the branches ascending; stems and inflorescence strigose with stiff flattened afflexed hairs and beset with slender-stalked capitate glands, the inflorescence canescent; cotyledons usually withering by anthesis, ovate-orbicular, sparsely strigulose above, glabrous beneath; basal leaves petiolate, oval to oblong, 1.5-6 cm. long, 1-5 cm. broad, pinnate or pinnatifid with 1-5 pairs of oval to orbicular, entire or toothed leaflets or lobes and a larger or subequal terminal trilobed or entire leaflet or lobe, the cauline leaves oblong or lanceolate to orbicular, short-petiolate to sessile, rarely entire to deeply lobed with 1-4 pairs of lanceolate to ovate acute lobes, strigose and glandular on both surfaces; inflorescence of terminal and axillary 8-30-flowered simple cymes, the mature pedicels spreading-ascending, or the lower spreading, 3-22 mm. long; calyx lobes linear-lanceolate to ovate, 3-7 mm. long, 1-2 mm. broad, strigose on the dorsal surface, especially on the margins, obtuse or acute, often unequal; corolla blue to white, rotate-campanulate, 5-10 mm. broad, the lobes orbicular, entire, pilose on the back; gland flaps wholly adnate, glabrous, a little divergent distally; stamens a little exserted, 3-5 mm. long, the anthers oblong, about 1 mm. long, the filaments densely villous on their lower $\frac{2}{3}$; style included in flower, when mature 4-5 mm. long, cleft about $\frac{1}{2}$, glabrous, the summit of the ovary hirsute; mature capsule globose-ovoid, 2-3 mm. in diameter; ovules 2-4 to each placenta; seeds 4-6, ovoid-angled, 1.5-1.75 mm. long, brown, finely reticulate.

Basal leaves with 1-3 pairs of lateral and a larger usually 3-lobed terminal leaflet; cauline leaves with 1-3 pairs of rather broad lobes. a. var. *dubia*.

Basal leaves with 4-5 pairs of lateral and a subequal entire terminal leaflet; cauline leaves with 2-4 pairs of narrow lobes. b. var. *georgiana*.

10a. **Phacelia dubia** var. **dubia** McVaugh, Ecol. Monogr. 13: 160. 1943.

TYPE LOCALITY: "in Virginia," Clayton.

DISTRIBUTION: Central Pennsylvania (two stations in central New York) to Georgia and Alabama, west to West Virginia and Tennessee, on shaded rocks or on alluvial soil.

REPRESENTATIVE SPECIMENS: **NEW YORK.** Onondaga Co.: Jamesville,

21 May, Mrs. L. L. Goodrich (US); Green Lake, November 1903, Mrs. L. L. Goodrich (NY). **PENNSYLVANIA.** Snyder Co.: Blue Mt., Wiegand & Wiegand 2677 (F, GH). Lancaster Co.: York Furnace—Tucquan, 11 May 1901, Heller (F, GH, US). Fulton Co.: Harrisonville, C. E. Wood, Jr. 1981 (PENN). Washington Co.: California, Banker 768 (NY). **DELAWARE.** New Castle Co.: Ogletown, Tatnall 3295 (GH, PENN). **MARYLAND.** Cecil Co.: Octoraro, 30 May 1907, Williamson (PENN). Montgomery Co.: Plummers Island, Eggleston 4314 (F, GH, MO, PA, US), Constance, Bomhard & Swallen 3019; High Island, 6 May 1896, Steele (DUKE, GH, MO, US). Washington Co.: opposite Harpers Ferry, Constance & McVaugh (Gray. Exsicc. 1388) (GH, MO, PENN, SMU, TENN, TEX, UC). **D. C.** ———, 1897, Pollard (F, GH, KSA). **WEST VIRGINIA.** Jefferson Co.: Harpers Ferry, Pursh (type collection of *P. parviflora* Pursh?, K). Mineral Co.: Ridgeville, Core, Bartholomew & Myers (CLOKEY, WVA). Greenbriar Co.: White Sulphur Springs, 14–17 April 1914, Hunnewell (GH, HUNNEWELL). Raleigh Co.: Batoff Mt., Tosh 115 (KY). **VIRGINIA.** "Virginia," Clayton 556 (type of *Polemonium dubium* L., GH: photo). Stafford Co.: Falmouth, Hermann 10,545 (NY, PA). Shenandoah Co.: Woodstock, Allard 7678 (GH, MO, US); Mt. Jackson & Edinburg, Palmer 42,585 (GH, MO, NY). Dinwiddie Co.: Burgess Station, Fernald & Long 10,014 (F, GH, MO, PENN, US). Greenville Co.: Emporia, Fernald & Long 7995 (GH, NY, PENN), Fernald & Lewis 14,541 (GH, PA, SMU). Bedford Co.: ———, 18 May 1873, Curtiss (GH, MO, UC). Russell Co.: Carbo Station, Eggleston 17,635a (US). **TENNESSEE.** Knox Co.: Knoxville, April 1895, Ruth (MO, NY, PA, UC, US). Blount Co.: Walland, Jennison 2197 (Gray. Exsicc. 863) (F, GH, MO, OKL, PA, PENN, TENN, TEX, UC, US, WVA). Wilson Co.: Vesta, Svenson 7759 (DUKE, GH, NY, TENN). Rutherford Co.: Lavergne, Sharp & Shanks 443 (CLOKEY, MO, NY, OKL, TENN, TEX, WVA). Davidson Co.: Nashville, April 1878, Gattinger (GH: type of *P. dubia* var. *interior* Fern., MO), Gattinger (Curtiss 2131) (F, GH, MO, NY, PENN, US), Hubbard 2131 (KSA, MO—part, NY, UC). **NORTH CAROLINA.** Halifax Co.: Weldon, 27 April 1897, Small (NY). Craven Co.: Newbern, Leeds 2502 (PA). Buncombe Co.: Biltmore, Biltmore Herb. 786b (F, GH, MO, NY, PA, US). Swain Co.: Bryson City, 15 April 1937, L. Barksdale (DUKE, NY). **GEORGIA.** DeKalb Co.: Stone Mt., May 1869, Canby (F, NY, US). Muscogee Co.: Columbia, Boykin (GH, NY, PA). **ALABAMA.** "Alabama," 1840, Buckley (type collection of *P. pusilla* Buckl., MO, NY). Jackson Co.: Long Island, 14 May 1935, Porter (GH).

Phacelia dubia is another very distinct species, remarkable for possessing (with *P. maculata*) the lowest chromosome number known in the family. *Phacelia parviflora* Pursh ("on rocks near Harper's Ferry, on the Potowmac") and *P. pusilla* Buckl. ("prairies of Alabama") are the same. Fernald's var. *interior*

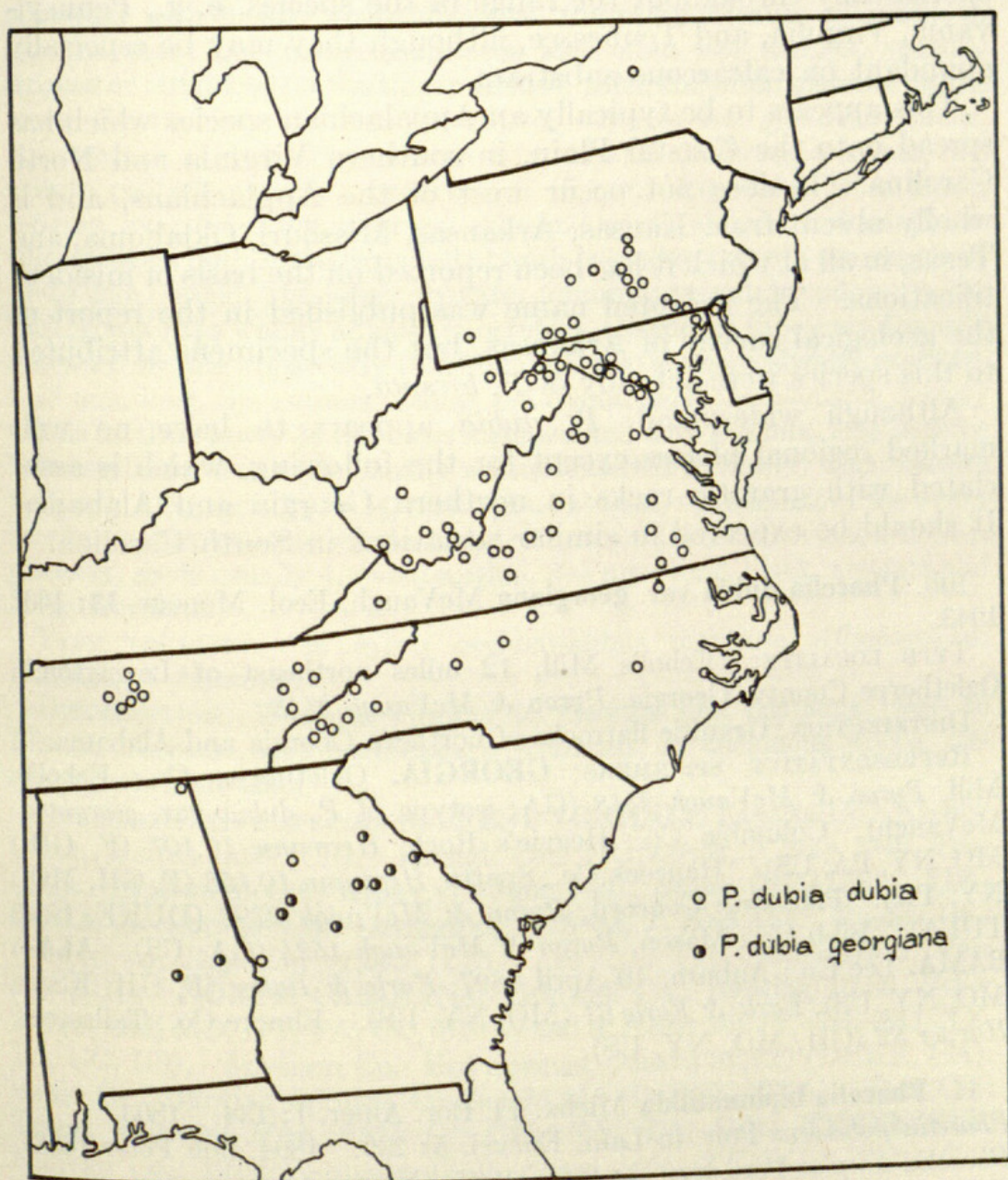


Fig. 6. Distribution of *P. dubia*.

("gregarious in open shrubberies and pastures or in open grounds, Nashville") was based upon dwarfed plants with short pedicels, which (on the basis of more material) are revealed to occur sporadically throughout the range of the species, e. g., Pennsylvania, Virginia, and Tennessee, although they may be especially abundant on calcareous substrata.

This appears to be typically an Appalachian species which has spread onto the Coastal Plain, in southern Virginia and North Carolina. It does not occur west of the Appalachians, and is wholly absent from Kansas, Arkansas, Missouri, Oklahoma, and Texas, in all of which it has been reported on the basis of misidentifications. The accepted name was published in the report of the geological survey of Arkansas, but the specimens attributed to this species were actually of *P. hirsuta*.

Although widespread, *P. dubia* appears to have no well marked regional phases except for the following, which is associated with granitic rocks in northern Georgia and Alabama. It should be expected in similar situations in South Carolina.

10b. ***Phacelia dubia* var. *georgiana*** McVaugh, Ecol. Monogr. **13**: 160. 1943.

TYPE LOCALITY: "Echol's Mill, 12 miles northeast of Lexington," Oglethorpe County, Georgia, *Pyron & McVaugh* 2448.

DISTRIBUTION: Granitic flatrocks of northern Georgia and Alabama.

REPRESENTATIVE SPECIMENS: **GEORGIA.** Oglethorpe Co.: Echol's Mill, *Pyron & McVaugh* 2448 (GA: isotype of *P. dubia* var. *georgiana* McVaugh). Columbia Co.: Heggie's Rock, *Hermann* 10,107 (F, GH, MO, NY, PA, US). Hancock Co.: Sparta, *Hermann* 10,153 (F, GH, MO, NY, PA). Pike Co.: Concord, *Pyron & McVaugh* 2296 (DUKE, GA, TULA). Bibb Co.: Mason, *Pyron & McVaugh* 1524 (GA, US). **ALABAMA.** Lee Co.: Auburn, 10 April 1897, *Earle & Baker* (F, GH, KSA, MO, NY, US), *Earle & Earle* 61 (MO, NY, US). Elmore Co.: Tallassee, *Harper* 82 (GH, MO, NY, US).

11. ***Phacelia bipinnatifida*** Michx. Fl. Bor. Amer. **1**: 134. 1803.
Phacelia pubescens Poir. in Lam. Encycl. **5**: 239. 1804, non Peter 1893.
Phacelia simplex Pers. Syn. **1**: 168. 1905. (Nomen.)
Endiplus bifidus Raf. Amer. Monthl. Mag. **3**: 356. 1818.
Endiplus phaceloides Raf. Jour. de Phys. 99. 1819.
Phacelia Endiplus Steud. Nom. ed. 2. **2**: 313. 1841. (Nomen.)
Phacelia brevistylis Buckl. Amer. Jour. Sci. I. **45**: 172. 1843.
Phacelia bipinnatifida var. *Plummeri* Wood, Class Book 438. 1847.
Phacelia bipinnatifida var. *brevistylis* A. Gray, Proc. Amer. Acad. **10**: 320. 1875.

Biennial, 10-60 cm. high, branching above the base, the branches ascending to erect; stems hirsute with spreading or deflexed stiff hairs,

more densely so at base, the inflorescence spreading-hirsutulous or -hirsute and glandular-villous with small slender-stalked glands; basal leaves petiolate, triangular-ovate, 3–12 cm. long and broad, pinnate with 1–3 pairs of large ovate to lanceolate leaflets, these pinnately toothed to pinnatifid with mostly acute divisions, the cauline leaves all petiolate, like the basal but reduced upwards and often less divided, sparsely strigose or strigulose on the upper surface, paler and often glabrate on the lower, the rachises and petioles sparsely hirsute and glandular-villous; inflorescence of paired or clustered terminal 5–25-flowered cymes, the mature pedicels arcuately recurved, 6–15 mm. long; calyx lobes linear, 4–8 mm. long, 0.5–1.5 mm. broad, subequal, acute, strigose and glandular-villosulous on both surfaces; corolla bluish-lavender, broadly campanulate, 10–15 mm. broad, the lobes obovate, minutely crenulate, pilose on the back; gland flaps wholly adnate, puberulent, the corolla tube conspicuously distended by the apparently functional glands; stamens slightly exserted, 8–12 mm. long, the anthers oblong, 1–1.5 mm. long, the filaments densely villous on their lower $\frac{2}{3}$ (stamens included and only 4–5 mm. long in some heterostylic forms); style usually a little exserted in flower, when mature 8–15 mm. long, cleft $\frac{1}{3}$ to $\frac{2}{3}$, hirsutulous at base, the summit of the ovary hirsute; mature capsule subglobose, 4–6 mm. in diameter; ovules 2 to each placenta; seeds usually 4, ovoid-angled, 3–4 mm. long, black, areolate and finely alveolate.

TYPE LOCALITY: "in sylvis occidentalibus montium *Alleghanis* et Kentucky," *Michaux*.

DISTRIBUTION: Western Virginia to Georgia and Alabama, west to Illinois, Missouri, and northeastern Arkansas, in deciduous woods, frequently on limestone.

REPRESENTATIVE SPECIMENS: **WEST VIRGINIA.** Fayette Co.: Keeney Creek, *Morton* 1858 (US). Raleigh Co.: Fitzpatrick, 5 May 1940, *Tosh* (UC). McDowell Co.: Iaeger, 13 June 1907, *Braun* (BRAUN). **VIRGINIA.** Rockbridge Co.: Lexington, 1828–34, *J. Hall* (F). Russell Co.: Cartertown, *Eggleston* 17,615 (US). Lee Co.: The Cumberland, *Carr* 929 (GH). **NORTH CAROLINA.** Caldwell Co.: Blowing Rock, *Heller* 259 (F, GH, MO, NY, PA, UC, US), *Small & Heller* 259 (F, GH, MO, NY, PA, UC, US). Madison Co.: Hot Springs, *Oosting* 35,239 (DUKE, GA). Swain Co.: Blowing Springs, *Oosting* 35,258 (DUKE, WVA). Polk Co.: Tryon, *Biltmore Herb.* 787b (F, GH, NY, PA, US). **TENNESSEE.** Sullivan Co.: Bristol—Shady Bluff, *Sharp* 1455 (TENN). White Co.: Bon Air, *Weatherby & Weatherby* 6261 (GH, NY, TENN, US). Polk Co.: Hiawassee Gorge, April 1893, *Kearney* (NY). Franklin Co.: Sewanee, *Svenson* 7632 (GH, MO, UC). Cheatham Co.: Kingston Springs, *Palmer* 35,518 (GH, MO). **SOUTH CAROLINA.** Oconee Co.: Tomassee Falls, *House* 2081 (MO, NY, US). **GEORGIA.** Walker Co.: Pigeon Mt., *Harper* 335 (K, NY, US). Dade Co.: Trenton, *Hermann* 10,205 (GH, NY, PA, US). **ALABAMA.** Madison Co.: Eason Mt., *Harper* 3412 (GH, NY, PA, US). Marshall Co.: Kennamer Cove, *Harper* 3414 (GH, PA, US). Colbert Co.: Sheffield, *Harper* 3320 (F, GH, NY, PA, US). Perry Co.:

Hamburg, May 1841, *Buckley* (type collection of *P. brevistylis* Buckl., GH, K, MO). **OHIO.** Hamilton Co.: Fernbank, *Short* (GH, PA, UC). **INDIANA.** Cass Co.: Georgetown, *Steysmark* 4251 (F). Parke Co.: Clinton, *Deam* 27,320 (PA). Franklin Co.: Brookville, *Deam* 789 (US). Martin Co.: Loogootee, *Palmer* 39,510 (GH, MO). Posey Co.: New Harmony, *Lindheimer* 409 (MO). **ILLINOIS.** Putnam Co.: Lake Senachwine, *Chase* 4008 (CLOKEY, MO, US). Coles Co.: Embarrass River, *Jones* 11,171 (GH). St. Clair Co.: bluffs, 23 May 1875, *Eggert* (MO, NY, US). Jackson Co.: Makanda, 1861, *Vasey* (MO, NY). **KENTUCKY.** Fayette Co.: Elk Lick Falls, *McFarland* 104 (KY, MO, US). Harlan Co.: Black Mt., *Braun* 358 (BRAUN). Edmonson Co.: Mammoth Cave, May 1899, *E. Palmer* (GH, KSA, NY, US). Union Co.: Grundy Knob, 25 April 1927, *Shacklette* (KY). **MISSOURI.** St. Louis Co.: St. Louis, 29 April 1879, *Eggert* (MO, NY, UC, US). Carter Co.: Big Spring, *Steysmark* 7782 (MO, US). Pulaski Co.: Piney River, *Steysmark* 7773 (MO). **ARKANSAS.** Independence Co.: Batesville, *Demaree* 17,065 (GH, KY, MO, NY, OKL, TENN). ? **MISSISSIPPI.** "Mississippi," 1856, *Spillman* (MO).

Because of its prominent glands and their associated scales, *P. bipinnatifida* has heretofore been placed in section *Euphacelia*, where its morphology and distribution make it anomalous, whereas it is thoroughly "at home" in the subgenus *Cosmanthus*. *Phacelia brevistylis* Buckl. ("limestone rocks, Hamburg, Wilcox [Perry] County, Alabama") and *P. bipinnatifida* var. *Plummeri* Wood ("Richmond, I[ndian]a") are based on a variation with sparser pubescence, larger and less divided leaf segments, smaller flowers, and sub-included stamens and style. These variations are not concomitant, and the distribution of forms showing a complete or partial combination of them is sporadic, as indicated by the location of the two type stations. There does, however, appear to be some heterostyly in the species. I am at a loss to understand Rafinesque's description of the fruit of his genus *Endiplus* as, "a double capsul, the exterior one monolocular bivalve hairy; the interior one bilocular bivalve 4-seeded, seeds one above the other." The following year, however, he associated his two species, *E. bifidus* ("Allegheny Mts. or Ohio") and *E. phaceloides* ("pres de Pittsburg, etc.") with *Phacelia bipinnatifida* as probably congeneric. A strikingly distinct species in the genus, *P. bipinnatifida* is more likely to be confused with comparably broad-leaved species of *Hydrophyllum* than with any other *Phacelia*.

12. *Phacelia ranunculacea* (Nutt.) Const. *Rhodora* 42: 39. 1940.
- Ellisia ranunculacea* Nutt. Trans. Amer. Philos. Soc. N. S. 5: 191. 1837.
- Phacelia Covillei* S. Wats. ex A. Gray, Man. N. Amer. Bot. ed. 6. 360. 1890.

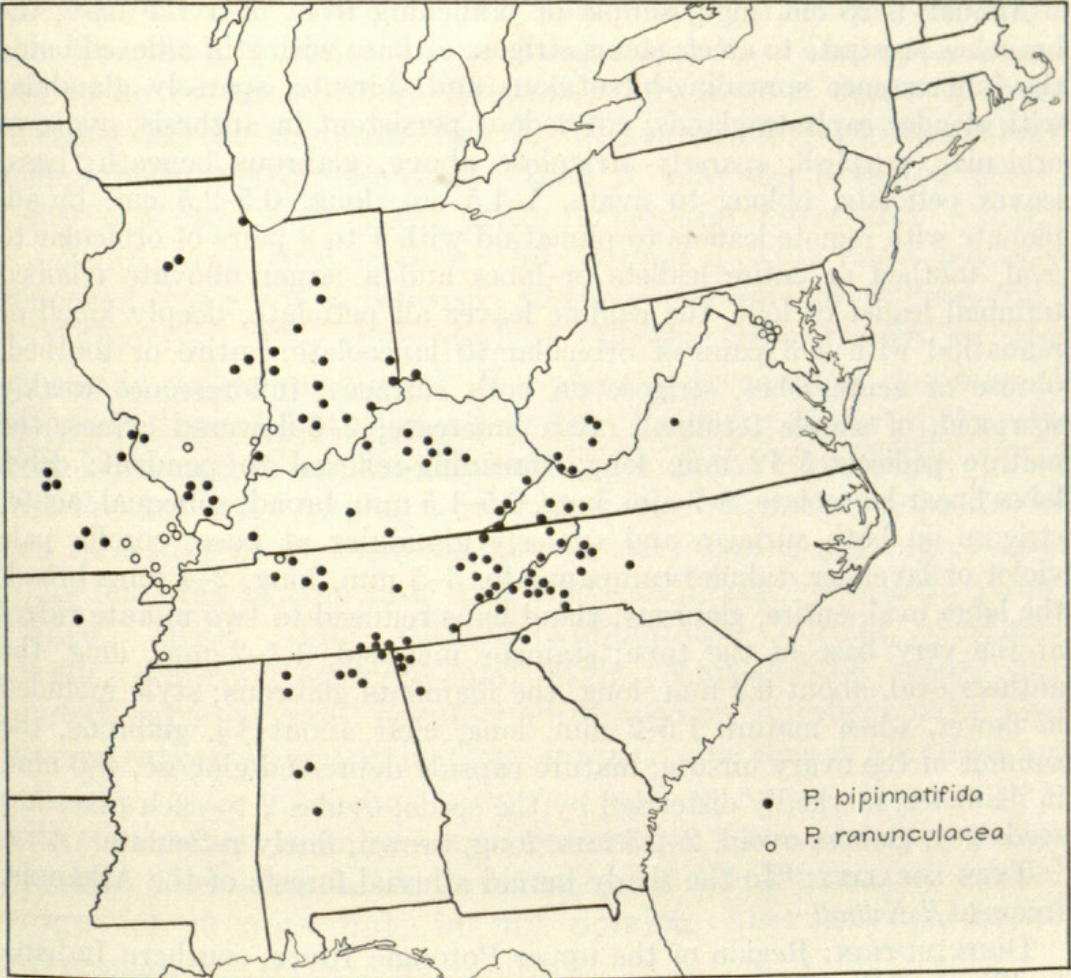


Fig. 7. Distribution of *P. bipinnatifida* and *P. ranunculacea*.

Annual, 5–25 cm. high, simple or branching from near the base, the branches prostrate to erect; stems strigose at base with stiff afflexed hairs, the inflorescence spreading-hirsutulous and -hirsute, sparsely glandular with slender capitate glands; cotyledons persistent in anthesis, ovate to orbicular, purplish, sparsely strigulose above, glabrous beneath; basal leaves petiolate, oblong to ovate, 1–4.5 cm. long, 0.5–2.5 cm. broad, pinnate with remote leaflets to pinnatifid with 1 to 3 pairs of orbicular to oval, toothed or entire leaflets or lobes and a larger obovate trilobed terminal leaflet or lobe, the cauline leaves all petiolate, deeply lobed or pinnatifid with 1–3 pairs of orbicular to lanceolate, entire or toothed, obtuse or acute lobes, strigose on both surfaces; inflorescence weakly scorpioid, of simple terminal, often bracteate, 2–6-flowered cymes, the mature pedicels 5–12 mm. long, spreading-reflexed to pendent; calyx lobes linear-lanceolate, 5–7 mm. long, 0.5–1.5 mm. broad, subequal, acute, strigose on both surfaces and sparsely glandular at base; corolla pale violet or lavender, tubular-campanulate, 3–5 mm. long, 2–4 mm. broad, the lobes oval, entire, glabrous; gland flaps reduced to two minute ridges at the very base of the tube; stamens included, 1.5–2 mm. long, the anthers oval, about 0.3 mm. long, the filaments glabrous; style included in flower, when mature 1.5–2 mm. long, cleft about $\frac{1}{2}$, glabrous, the summit of the ovary hirsute; mature capsule depressed-globose, 4–6 mm. in diameter, markedly distended by the seeds; ovules 2 to each placenta; seeds 2–4, globose-ovoid, 2–2.5 mm. long, brown, finely reticulate.

TYPE LOCALITY: "In the shady humid alluvial forests of the Arkansas, frequent," *Nuttall*.

DISTRIBUTION: Region of the upper Potomac River; southern Indiana to Illinois, Missouri, eastern Tennessee, and (?) northeastern Arkansas, in shaded alluvial soil.

REPRESENTATIVE SPECIMENS: **MARYLAND.** Montgomery Co.: Larkspur Island, 12 May 1889, *Coville* (GH: type of *P. Covillei* S. Wats., NY, US), *Hermann* 10,275 (F, MO, PA); Plummers Island, 30 April 1897, *Steele* (DUKE, GH, US, WVA); opposite Larkspur Island, 10 May 1933, *Hermann & Martin* (NY, TENN, US, WVA); Glen Echo, *Constance* 3021. **D. C.** Chain Bridge, *Constance* 3018. **VIRGINIA.** Arlington Co.: Clarendon, *Allard* 281 (DUKE, F, GH, KY, MO, NY, US), 4513 (GH, MO, NY, US). **INDIANA.** Knox Co.: Mt. Carmel, *Deam* 42,896 (GH, MO, NY, PA, US), 44,032 (GH, US). **ILLINOIS.** Wabash Co.: Cypress Pond, 11 May 1892, *J. Schneck* (NY). Washington Co.: Irvington, 1873, *G. H. French* (US). **MISSOURI.** "Lead mines of Missouri," *James* (NY). Dunklin Co.: Campbell, *Palmer* 39,064 (GH). Stoddard Co.: Heazy, *Steyermark* 5074 (F, US). **TENNESSEE.** Montgomery Co.: Clarksville, 16 April 1917, *H. Fox* (PA). Shelby Co.: Memphis, 29 March 1846, *Fendler* (MO). ? **ARKANSAS.** "In the shady humid alluvial forests of the Arkansas," *Nuttall* (type collection of *Ellisia ranunculacea* Nutt., GH & UC: photo).

Several years ago, I pointed out the identity of *Ellisia ranuncu-*

lacea Nutt. with *Phacelia Covillei* S. Wats. ("Larkspur Island in the Potomac, 5 miles above Washington"). The species has yet to be rediscovered in Arkansas, but since it occurs a short distance across the state line in Missouri and Tennessee, there seems little reason to doubt that it may be detected there. Gray confused this plant with *Nemophila microcalyx* (Nutt.) F. & M., and Steyermark and Palmer (1935) have recently repeated this error in referring to the occurrence of "*Nemophila*" in Missouri. The disrupted or bipolar distribution of the species is rather puzzling. The plant is exceedingly common in wooded alluvial bottoms along the Potomac River above the Fall Line, and is apparently rare west of the mountains. This distribution may perhaps represent the shrunken remnant of one like that of *P. bipinnatifida* or *P. Purshii*, although it has some features in common with that of *Ellisia Nyctelea* L. (Constance, 1940). The tubular-campanulate corolla, vestigial glands, glabrous stamens and style, semi-globose seeds, distended capsule, and peculiar chromosome number make this species rather aberrant in *Cosmanthus*. Its closest affinities are certainly with *Phacelia*, however, and it agrees more closely with the other members of *Cosmanthus* than with any other plants. The alternative treatment of constituting a special group for it does not, in my opinion, offer any particular advantage.

13. ***Phacelia Purshii*** Buckl. Amer. Jour. Sci. I. 45: 171. 1843.

Phacelia fimbriata sensu Pursh, Fl. Amer. Sept. 1: 140. 1814, non Michx. 1808.

Cosmanthus fimbriatus Nolte, Cat. Sem. Hort. Germ. 1838, not as to type.

Cosmanthus pectinatus E. Mey. Ann. Sci. Nat. III. 5: 366. 1846.

Phacelia fimbriata var. ? *Boykini* A. Gray, Proc. Amer. Acad. 10: 320. 1875.

Phacelia Boykini Small, Bull. Torrey Club 25: 136. 1898.

Phacelia Bicknellii Small, Bull. Torrey Club 25: 141. 1898.

Polemonium ciliatum Willd. ex Brand; Engler, Pflanzenr. 4²⁵¹: 62. 1913. (Nomen.)

Phacelia ciliata Raf. ex Brand, op. cit. (Nomen.)

Annual, 10–80 cm. high, simple or branching near the base, erect or ascending; stems strigose with stiff afflexed hairs, the inflorescence strigulose or strigose; basal leaves petiolate, oblong to oval, 1.5–5 cm. long, 1–2.5 cm. broad, pinnate or pinnatifid with 1–3 pairs of oblong to orbicular, entire or toothed leaflets or lobes and a larger 3- or 5-lobed terminal leaflet or lobe, the cauline leaves lanceolate-oblong to ovate, sessile and clasping, deeply pinnatifid with 2–5 pairs of lanceolate to ovate, usually acute lobes, strigose or strigulose on both surfaces; inflorescence of simple terminal

and axillary 10–30-flowered cymes, the mature pedicels spreading-ascending or spreading, 3–22 mm. long; calyx lobes linear to oblong-spatulate, 3–7 mm. long, 0.5–1.5 mm. broad, subequal, acute or obtuse, hirsute-ciliate and usually somewhat strigose or strigulose on one or both surfaces; corolla bluish-violet with a white center, often very pale, subrotate, 5–13 mm. broad, the lobes obovate, fimbriate, glabrous or glabrate; gland flaps wholly adnate, glabrous; stamens usually exserted, 4–7 mm. long, the anthers oblong, 0.8–1.2 mm. long, the filaments densely villous on their lower $\frac{1}{2}$; style included in flower, when mature 4–6 mm. long, cleft $\frac{1}{2}$ to $\frac{2}{3}$, glabrous, the summit of the ovary hirsute; mature capsule globose-ovoid, 2–5 mm. in diameter; ovules 2 to each placenta; seeds 2–4, ovoid-angled, 1.5–3 mm. long, brown, areolate and finely alveolate.

TYPE LOCALITY: "in montibus Carolinae et Georgiae," *Buckley*.

DISTRIBUTION: Pennsylvania and Maryland south to Georgia and Alabama, and west to Illinois and eastern Missouri, in alluvial soil in deciduous woods.

REPRESENTATIVE SPECIMENS: **PENNSYLVANIA.** Allegheny Co.: Darlington Hollow, *Shafer 181* (CLOKEY, F, MO, PENN, US). Greene Co.: Jefferson, *Bell 514* (CLOKEY, GH, OKL, PENN, TENN, WVA). **MARYLAND.** Montgomery Co.: Plummers Island, 6 June 1897, *Pollard* (GH, MO, NY, US); Glen Echo, *Constance 3023*. **D. C.** Washington, 22 June 1937, *Kearney* (NY, TENN, US). **WEST VIRGINIA.** Mineral Co.: Burlington, 30 May 1938, *Alexander* (NY). Monongalia Co.: Dent's Run, 4 June 1940, *J. C. Myers* (CLOKEY, NY). Ohio Co.: Wheeling, 26 May 1879, *Mertz* (F, PA, US). **VIRGINIA.** Fairfax Co.: Potomac River, June 1879, *Chickering* (F, US). Wythe Co.: Wytheville, 1 April 1876, *Shriver* (GH, K, US). Smyth Co.: Marion, 22 May 1892, *Small* (F, GH, MO—part, NY, PENN, UC—part, US), *Britton, Britton & Vail* (KSA, NY, PA). **NORTH CAROLINA.** Haywood Co.: Lake Junaluska, *Oosting 37,167* (DUKE). **TENNESSEE.** Sevier Co.: Sevierville, April 1842, *Rugel* (K, NY). Smith Co.: Carthage, *Shanks & Sharp 451* (MO, PENN, TENN). Davidson Co.: Nashville, 12–17 May 1894, *Bicknell* (NY: type of *P. Bicknellii* Small), April–May 1879, *Gattinger* (*Curtiss 2129*) (F, GH, MO, NY, PA, PENN, US), *Eggleston 4420* (GH, MO, NY, PA, US), *Svenson 10,109* (DUKE, GH, MO, PA, TENN, UC). **GEORGIA.** "In montibus Carolinae et Georgiae," *Buckley* (PA: type of *P. Purshii* Buckl., GH). DeKalb Co.: campus, 28 April 1936, *Whitaker* (CLOKEY). Muscogee Co.: Columbus, 1839, *Boykin* (GH: type of *P. fimbriata* var. ? *Boykini* A. Gray, K, NY). **ALABAMA.** Madison Co.: Huntsville, 1858, *Nevius* (GH). Tuscaloosa Co.: Warrior River, 1 May 1919, *Harper* (NY, US); North River, 20 September 1932, *Harper* (GH, NY). **OHIO.** Cuyahoga Co.: Bedford, 9 June 1897, *J. R. Watson* (F, KSA, PA, US), *Ashcroft* (F, MO, US). Belmont Co.: Barnesville, *E. E. Laughlin 968* (GH). Hamilton Co.: Cincinnati, 14 May 1890, *Lloyd* (GH, MO). **INDIANA.** Wells Co.: Harrison Township, 24 May 1903, *Deam* (GH, MO, NY, OKL, US). Franklin Co.: Metamora, *McCoy 3747* (DUKE, F, TEX, WVA). Montgomery Co.: Crawfordsville, 1889,

Cooms (KSA, US). Gibson Co.: Owensville, Kriebel 3801 (DUKE). **ILLINOIS.** "Illinois," *Rafinesque* (PA: basis for *P. ciliata* Raf.). Vermillion Co.: Danville, May 1909, Gleason (GH, PENN, UC). St. Clair Co.: ———, 6 May 1879, Eggert (GH, KSA, MO, NY, UC, US). Jackson Co.: Grand Tower, Gleason 2575 (GH). **KENTUCKY.** Fayette Co.: Lexington, April–May, Short (F, GH, KY, PA). Woodford Co.: Versailles, McFarland (*Fl. Kentucky* 92) (CLOKEY, DUKE, MO, NY, PENN, TENN, US). **MISSOURI.** St. Louis Co.: Allentown, 1 June 1901, Letterman (F, MO, NY, PA, TEX). Jefferson Co.: Peyely, Lode-wykes 116 (MO, US). Reynolds Co.: Piedmont, Steyermark 22,058 (F).

A beautiful, distinctive, and widely distributed plant, this is probably the best known species of the group, and was the original species of *Cosmanthus* Nolte. It includes *P. fimbriata* var. ? *Boykini* A. Gray ("upper part of Georgia") as well as *P. Bicknellii* Small ("near Nashville, Tennessee"), despite some serious errors in Small's descriptions. The two epithets just cited are based upon the same, perhaps ecological (in association with limestone?), variation with smaller flowers, shorter pedicels, and smaller capsules and seeds. The presence of appressed rather than spreading hairs and areolate and alveolate rather than simply reticulate seeds, clearly shows that Gray associated Boykin's plants with the wrong species.

14. ***Phacelia fimbriata*** Michx. Fl. Bor. Amer. 1: 134. 1808.

Cosmanthus fimbriatus Nolte, Cat. Sem. Hort. Germ. 1838, as to name only.

Annual, 10–40 cm. high, simple and erect or branching near the base, the branches usually decumbent below; stems very sparsely hirsute with rather stiff spreading or deflexed scattered hairs, often glabrate above, the inflorescence hirtellous (usually on only one side of the stem) and often with some stiff hairs; basal leaves petiolate, oblong to oval, 1.5–3 cm. long, 1–2.5 cm. broad, pinnate or pinnatifid with 1 or 2 pairs of oval or oblong, entire or toothed leaflets or lobes and a larger trilobed terminal leaflet or lobe, the cauline leaves oblong to oval, sessile and clasping, deeply lobed with 2–4 pairs of oblong to oval, usually obtuse lobes, sparsely strigose on the upper surface, paler and often glabrate on the lower; inflorescence of simple terminal 5–20-flowered cymes, the mature pedicels spreading-ascending to pendent, 10–22 mm. long; calyx lobes oblong to oblanceolate, 4–6 mm. long, 0.8–1.2 mm. broad, subequal, usually obtuse, hirsute-ciliate, the surfaces usually glabrous; corolla white or tinged with blue or lavender, subrotate, 5–15 mm. broad, the lobes obovate, strongly fimbriate, glabrous; gland flaps free at the tip, glabrous; stamens barely exerted, 4–6 mm. long, the anthers oblong, 0.8–1.2 mm. long, the filaments densely villous on their lower $\frac{1}{2}$; style included in flower, when mature 3–5 mm. long, cleft $\frac{1}{4}$ to $\frac{1}{3}$, glabrous, the summit of the ovary hirsute; mature capsule globose-ovoid, 4–6 mm.

in diameter; ovules 2 to each placenta; seeds 2-4, ovoid-angled, 3-3.5 mm. long, brown, finely reticulate.

TYPE LOCALITY: "in excelsis montibus Carolinae," *Michaux*.

DISTRIBUTION: Mountains of the Tennessee-Virginia-North Carolina boundary, at elevations of 3,500 to 5,000 feet, in openings in deciduous woods.

REPRESENTATIVE SPECIMENS: **VIRGINIA.** Grayson Co.: Mt. Rogers, 29 June 1892, *Britton, Britton & Vail* (NY). Smyth Co.: White Top Mt., 28-29 May 1892, *Small* (DUKE, F, GH, MO, OKL, PA, PENN, TENN, TEX, UC, US, WVA). Washington Co.: White Top Mt., June 1892, *Britton, Britton & Vail* (UC, US). **NORTH CAROLINA.** Avery Co.: Roan Mt., 1842, *Buckley* (GH, MO, NY), 18 June 1879, *Gray, Sargent Redfield & Canby* (F, GH, PA, PENN), June 1879, *Canby* (F, NY, PA, US). Swain Co.: Indian Gap, 28 April 1948, *Camp* (US). **TENNESSEE.** Carter Co.: Roan Mt., June 1870, *Parry* (GH, NY, US). Sevier Co.: Elkmont, *Jennison 2217* (*Gray. Exsicc. 862*) (F, GH, MO, OKL, PA, PENN, SMU, TENN, TEX, UC, US, WVA).

Although it has been badly confused with *P. Purshii* in the literature and in herbaria, pubescence and seed characters readily permit the recognition of *P. fimbriata* as a distinct species. It is remarkable for its narrow restriction to higher altitudes in the Great Smokies' region. Dr. W. H. Camp kindly made two collections for me near Indian Gap, at an elevation of 5,200 feet. He refers to the habitat as a "rocky woodland with considerable slope," and adds that the species forms dense vernal societies in several of the "beech gaps" before any of the trees expand their foliage. Out of several thousand plants with corollas white except for their "powder-blue" anthers, he selected seven which had "pale, lavender-blue flowers of varying intensities." Although the dried specimens are at once reminiscent of *P. Purshii*, the pubescence is that of *P. fimbriata*. A mixup of the two species would not be at all surprising, but thus far I have seen no convincing evidence of its occurrence.

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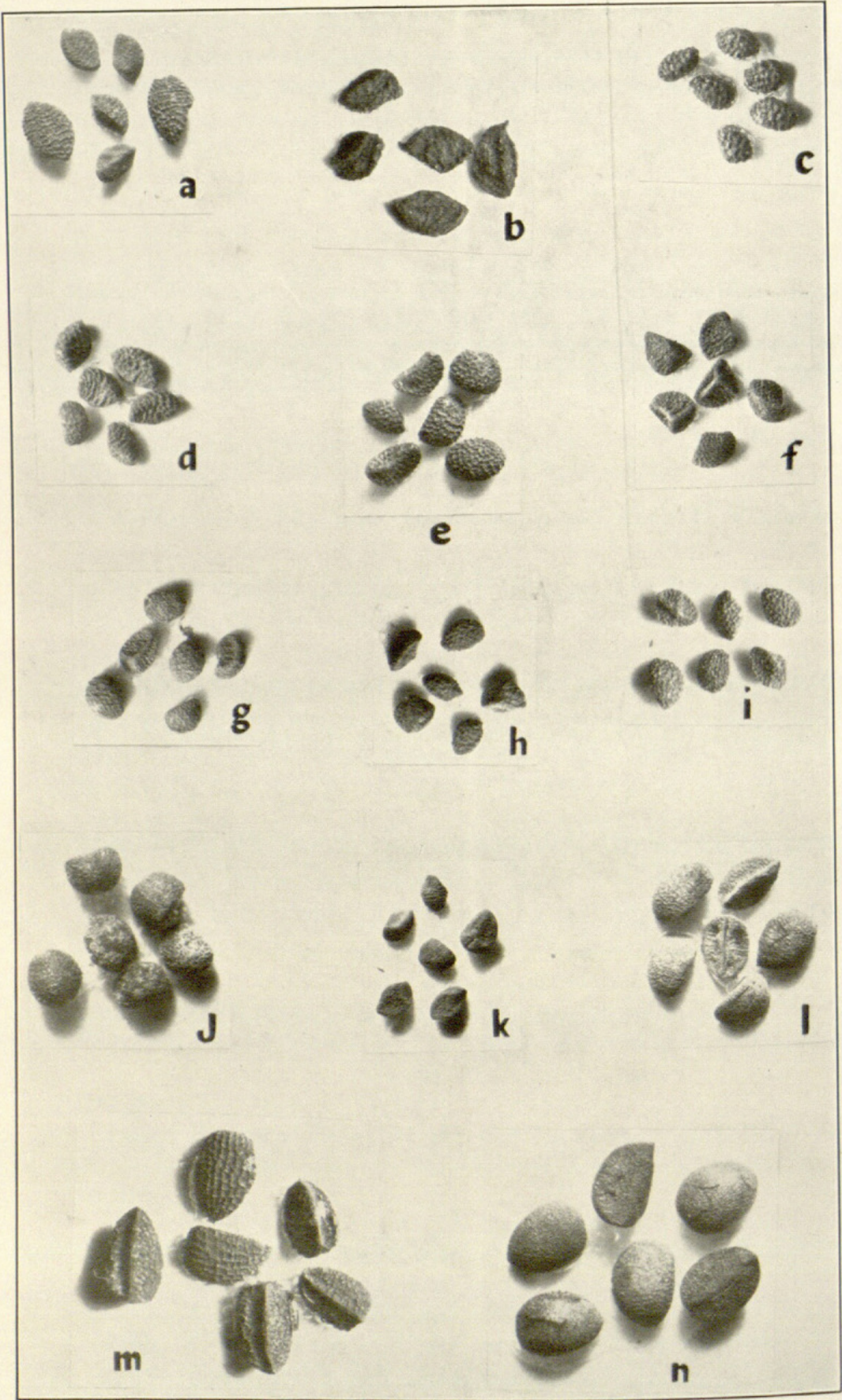
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EXPLANATION OF PLATE

PLATE I. Seeds of *Phacelia* subgen. *Cosmanthus*, all ca. $\times 2\frac{1}{2}$. Fig. a, *P. platycarpa*; fig. b, *P. pulcherrima*; fig. c, *P. strictiflora*; fig. d, *P. patuliflora*; fig. e, *P. laxa*; fig. f, *P. hirsuta*; fig. g, *P. gilioides*; fig. h, *P. maculata*; fig. i, *P. glabra*; fig. j, *P. dubia*; fig. k, *P. bipinnatifida*; fig. l, *P. ranunculacea*; fig. m, *P. Purshii*; fig. n, *P. fimbriata*.



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