6-30-1975

A revision of the *Phacelia* Crenulatae group (*Hydrophyllaceae*) for North America

N Duane Atwood

*Brigham Young University*

---

Follow this and additional works at: [https://scholarsarchive.byu.edu/gbn](https://scholarsarchive.byu.edu/gbn)

**Recommended Citation**


Available at: [https://scholarsarchive.byu.edu/gbn/vol35/iss2/1](https://scholarsarchive.byu.edu/gbn/vol35/iss2/1)

This Article is brought to you for free and open access by the Western North American Naturalist Publications at BYU ScholarsArchive. It has been accepted for inclusion in Great Basin Naturalist by an authorized editor of BYU ScholarsArchive. For more information, please contact scholarsarchive@byu.edu, ellen_amatangelo@byu.edu.
A REVISION OF THE PHACELIA CRENULATAE GROUP
(HYDROPHYLLACEAE) FOR NORTH AMERICA

N. Duane Atwood

INTRODUCTION

The Crenulatae group of Phacelia belongs to the subgenus Phacelia, section Phacelia, and may be distinguished from other members of the section by the four-seeded capsule and excavated ventral surface of the seeds. Many of the species are viscid and ill-scented desert plants confined mostly to western North America and Mexico. The remaining species occur in South America and in the midwestern and the west central parts of the United States.

The lack of phenologic, edaphic, morphologic, and distributional data plus the description of additional species since the monograph by Voss (1937) have necessitated a thorough study of the group. Very little was known about the species occurring in Texas, New Mexico, Arizona, Utah, and California or species in Mexico and South America. Previous revisions were based entirely on herbarium specimens, and, possibly because of this fact, numerous errors and misconceptions appeared in them. Therefore it became necessary to conduct extensive field work wherein most of the entities were examined in living condition.

Phacelia integrifolia Torr. was the first species of the Crenulatae group to be described. It was collected by James in June 1820 but was not described until 1826. The next taxon was described in 1835 when Hooker named P. congesta from plants collected by Drummond in the vicinity of Galveston Bay, Galveston County, Texas. In 1848 Nuttall described P. glandulosa from specimens collected the same year, "about Ham's Fork Colorado of the West." Hooker (1851) assigned P. glandulosa to the genus Eutoca. Since 1849, 41 nominate species have been described. Of the 78 names proposed in this group, fewer than half of them are recognized as valid taxa in the present study.

MATERIALS AND METHODS

Research materials for this study have come from two major sources: a large quantity of plants borrowed from herbaria in Germany, Mexico, and the United States, and from field studies made during the growing season of 1968 in Utah, Arizona, and Wyoming; in 1969 in Arizona, California, Colorado, Utah, and Wyoming; and during 1970-1971 in Texas, Mexico, Arizona, New Mexico, California, and Utah.

Measurements of such large plant parts as stems, leaves, and inflorescences were made with a metric ruler. Small structures such as calyces, flowers, capsules, and seeds were measured with the aid of
The specimens were coated with gold (200-300 angstroms) using a rotating stage and examined with a Hitachi SSM-2 microscope. All specimens were examined with the microscope beam voltage set at 20 kv.

**General Morphology**

Members of the Crenulatae group are annual, biennial, or perennial herbaceous plants. They possess a simple taproot, which varies in size depending on the species and even on the individual plant. The stem pattern varies considerably between species but basically consists of an axis which is usually foliate and bears several to many scorpoid cymes. The majority of species are annuals which complete their life cycle in two to three months. However, the seeds of some species, such as *P. corrugata*, generally germinate in the fall and produce a rosette of leaves. This rosette is small at first but continues to grow during the warmer periods of the winter months. Then in the spring it produces a flowering shoot. These are winter annuals. The biennial species, as well as some annuals, generally have thick stems and produce a basal rosette of leaves. The perennial species have a thickened woody caudex which produces one to several herbaceous branched or simple stems. These are terminated by a series of scorpoid cymes.

**Leaves**

The leaves vary from simple to bipinnately compound, with a series of intermediate types. About half the species have simple leaves with the margins crenate to dentate, irregularly serrate, or incised. Those taxa having compound leaves are usually quite distinct from the foregoing, but variations between the two types exist. The margins of some leaves, such as those of *P. constancei*, *P. intergrifolia*, and *P. welshii*, are often revolute. A basal rosette is usually present in biennial, perennial and some robust annual species. The basal and lower cauline leaves are typically larger and longer-petiolate than the gradually reduced upper cauline leaves. Leaf pubescence varies depending on the species, but the leaves possess either one or, more often, a combination of pubescence types. In general, leaf characters have not been used to delineate species.
since other less variable and more important taxonomic characters are available.

Inflorescence

Heckard (1960) indicated that agreement is generally lacking as to the exact terminology used to describe a branched system of scorpioid cymes. However, the inflorescences are generally best described as being composed of compound scorpioid cymes. In some species, such as *P. coerulca* and *P. bombymena*, the inflorescences appear to be racemose. The flower cluster is actually a false raceme because the flowers are all borne on one side of the peduncle. In most species the inflorescence is open but with terminally congested clusters. In *P. palmeri*, *P. utahensis*, and *P. vossii* the inflorescence is congested into a spicate thyrsus. The inflorescences are generally more glandular than the stems and leaves. The individual cymes of *P. integrifolia* elongate to as much as 2.1 dm in fruit.

Flower

Corolla: The flowers are crowded along a coiled peduncle that uncoils as flowering advances. The shape, size, and color of the corollas are taxonomically important. The corollas are funneliform to rotate or campanulate in shape, and blue, purple, violet or lavender in color. One series of taxa has white to lavender tubular corollas. The corolla lobes are normally entire or, at the most, merely crenulate and finely pubescent. However, in *P. neomexicana* and its relatives the lobes are either fimbriate or denticulate. The pedicels are commonly less than 3 mm long with exceptions in *P. pedicellata* and *P. scariosa*, in which the pedicels are 6 and 8 mm long respectively.

Corolla scales: Corolla scales are present in all species of this group and occur in pairs at the base of each filament. The variation in size, shape, and attachment of the scales offers some variation, but as a whole it is not as useful in delineating species as are other characters.

Androecium: The filaments are attached at the base of the corolla tube and vary in length depending on the taxa involved. Even in individual plants filament length varies considerably. The filaments are glabrous in all species. The anthers are dorsifixed, ca. 1 mm long and 0.5 mm broad, and open their full length by two longitudinal slits. The pollen has not been studied systematically. The stamens as well as the style in *P. coerulca*, *P. denticulata*, and *P. andersonii* are included within the corolla, or nearly so. This feature has been given taxonomic importance, but it varies in some populations, as noted in *P. coerulca* and *P. denticulata*. In these instances, the stamens are barely exserted from the tube. Some confusion may occur in keying out collections of plants that are in early anthesis, since the stamens of most species are folded in the bud and become exserted only when the flower is fully opened.

Gynoecium: The gynoecium consists of an ovoid to subglobose or oblong, usually puberulent and commonly glandular ovary. The persistent bifid style is terminated by small stigmatic areas. The bifurcation of the style varies from two-thirds to three-fourths of its length, with the lower undivided portion being pubescent. The ovary is 1-celled or incompletely 2-celled by union of the placentae. Four ovules are commonly produced; however, sometimes one is reduced in size or, less frequently, lacking altogether. This condition appears only sporadically and is probably influenced by environmental and nutritional factors.

Calyx: The calyx is five-parted to the base, or nearly so. The lobes vary in size and shape from species to species. There is consistent variation in flowering and fruiting calyces with those in fruit being larger and sometimes scarious, as in *P. scariosa*.

Seeds

The seeds are geminate, elliptic to oblong and ovoid, and generally cymbiform in shape. Size, shape, and surface markings are diagnostically important. The seeds are unique in having the ventral surface excavated on one or both sides of a prominent ridge. However, the seeds of *P. bakeri* have the dorsal surface flat, with only a faint longitudinal groove down the center. On the ventral surface, the raphe is elevated above the normally excavated portions, thus giving the seed a triangular shape in cross section. In other taxa, the dorsal surface may be transversely ridged, as in *P. arizonica*.
P. palmeri, and P. popei, and reticulate to scabrous in P. congesta and P. rupestris. P. howelliana, P. serrata, and P. utahensis have the dorsal surface smooth and shiny with faint alveolations, while the seeds of P. pedicellata are tuberulate. The remaining species are alveolate (pitted). The ridge is corrugated on one side in over half the taxa, while the remainder lack corrugations. The seed margins can be entire as in P. alba, P. denticulata, and others, or corrugated along part or all of the marginal edge. Corrugated margins are well represented in seeds of P. bombycina, P. coerulea, and P. corrugata.

Color variations occur, but brown predominates as in P. neomericana and P. pedicellata. In such taxa as P. constanccii, P. pallida, and P. palmeri the seeds are black, while in P. bombycina, P. coerulea, and P. formosula, they are dark brown. Reddish or reddish brown seeds are typical of P. glandulosa, P. rafaeleisii, and P. utahensis.

The smallest seeds occur in P. coulteri (1.6 mm long), and the largest known are in P. denticulata (4 mm long). The light-colored, glutinous thickened band spoken of by Voss (1937) is a feature that develops during the ontogeny of the seeds. When immature, the seeds are either dark and turn light in color through a mottling pattern, or they are light and become dark when mature. The descriptions of seeds in this treatment are based on mature examples. They are considered the most important single feature in delineating taxa, and on the basis of the size, shape, and surface characters, several distinct groups can be arranged in an apparent phylogenetic order. These groupings are supported by other morphological features as well, namely leaf shape, pubescence, corolla shape and color, and duration of the plant. The branching pattern of the stem and inflorescence, the type of calyx segments, and the stamens and style, whether included or exserted, are also useful features.

Vesture

Considerable confusion exists as to the terminology used in describing the vesture of plants. The terms employed herein are defined in Appendix II to lend uniformity to their interpretation. The pubescence often consists of two or more types of intermixed hairs. There are two main types of trichomes, each exhibiting variation in size: (1) simple, unicellular trichomes, which vary in length and rigidity and may be erect, straight, or appressed; and (2) a stipitate-glandular type, which is usually multicellular. The stalk in the stipitate-glandular type varies in length and in number of cells. Sometimes the gland is sessile, or nearly so, and the stalk is often flattened.

Phylogeny

Constance (1963) indicates that the family appears to be a collection of morphological and geographical odds and ends, held together by floral and capsular features. He states, "I am not prepared to offer a complete system for Phacelia." However, Constance (1963) appears to have arrived at the most natural grouping of the genus Phacelia by recognizing three subgenera, Cosmanthus, Howellanthus, and Phacelia. The latter is the largest and most complex of the three and has been subdivided by Constance (I.c.) into the following species-groups: Crenulatae, Eugypta, Gymnobythus, Militizia, Pulchella, Tanacetifoliae, and Whitlavia. The Crenulatae group, revised by Voss (1937), was the most complete study of the group prior to the present work. Gillett (1960b) indicates, "The current infrageneric classification of Phacelia is generally considered to be inadequate . . . and that considerably more evidence must be accumulated before the various species groups can be accorded classification that properly relates them to each other." The author agrees that natural generic and infrageneric relationships cannot be proposed until additional morphological, distributional, and cytological data have been accumulated. However, he is prepared to offer a tentative phylogenetic summary of relationships within the Crenulatae group. These data are subject to change as additional research may warrant.

Those species occurring from Mexico to South America present a problem in the formulation of a complete phylogenetic scheme. These southern taxa appear to be the most primitive and are certainly the least understood of all the Crenulatae group. Most are known only from the type collections. It would seem likely that the Crenulatae group has been derived
from some form of Phacelia, past or present, somewhere in Mexico or South America. The modern species suggest several avenues of migration from Mexico, which have contributed to the present diversity in morphology and distribution. Furthermore, the morphological, cytological, and distributional relationships of the subgeneric and sectional groups of Phacelia suggest either a polyphyletic origin or, if a monophyletic one, then a derivation possessing several major lines of development. Those main lines of development occurring within the Crenulatae group are outlined in Figures 1-7. The species are grouped together and arranged on the basis of similar morphological features and distribution. The following discussion is given to indicate which characters are considered to be advanced or primitive in this group.

Seeds provide the most important characters in differentiating entities. The most primitive species, which occur in Mexico, all have small seeds, which suggests that large seeds are probably a derived feature. This character seems to follow a south-to-north trend with the largest seeds occurring to the north. There have been several avenues of specialization with the primitive seeds having more surface markings and being thicker and narrower. The seeds of most taxa, except in P. bakeri and P. argillacea, uniformly have the ventral surface excavated on both sides of a prominent ridge. These latter entities have the raphe elevated above the usually excavated portions and would appear to have diverged from the more typical form. Seeds with a corrugated ridge appear to be primitive, and those with pitted (alveolate) and entire margins appear to be advanced. Light brown seeds are apparently primitive, and dark brown, black, and reddish types are apparently derived. Reticulate, transversely ridged, and smooth-surfaced seeds are also probably derived.

The corolla has developed along three basic lines. Primitive plants are those having blue to purple colored campanulate corollas and exserted stamens and styles. However, some of the less advanced species have small, pale, campanulate corollas with included stamens and styles. Thirdly, pale to white tubular corollas are present in the more advanced entities. These advanced forms have less attractive flowers and long exserted stamens and styles. The corolla lobes have developed along two major lines, with the P. neomexicana complex having denticulate or erose margins and the remainder having entire margins. The former feature is
probably advanced, entire margins being primitive.

The scarious calyx segments of *P. scariosa* and *P. pedicellata* seem to be an advanced feature. This is supported by the fact that the calyx lobes are persistent in fruit and probably aid in dispersal. Small, narrow calyx segments are considered to be primitive.

Fig. 3. A phylogenetic arrangement of the species in the *welshii* complex.

The spicate thyrsus type of inflorescence of the perennial, biennial, and some robust annual species is apparently advanced, while the variously branched systems developed in most annual and some biennial taxa appear to be primitive.

The primitive taxa do not follow the generalization that the perennial habit is more primitive than the biennial or annual type. The majority of entities are robust annuals, probably an inherited feature; biennial and perennial types appear to be derived. The primitive taxa

Fig. 4. A phylogenetic arrangement of the species in the *palmeri* complex.

possess an erect, usually branched, stout stem with a compound scorpioid inflorescence. Some advanced biennial and perennial entities have become specialized in the development of a spicate thyrsus inflorescence.

Entire or subentire leaves are apparently derived from compound leaves. The narrowly revolute type exhibited by *P. constancei* is considered to be a specialization, while the basal rosette common in the biennials and robust annuals appears to be a feature that has been retained during the phylogenetic development of leaves.

Members of the Crenulatae group are probably monophyletic and have developed along six major lines. These are

Fig. 5. A phylogenetic arrangement of the species in the *crenulata* complex.
treated as complexes but are not accorded taxonomic status.

The hypothetical ancestor(s) of the Crenulatae group were apparently robust, densely glandular annuals with a branched stem, compound leaves and inflorescences, nonscarious sepals, and broadly campanulate blue or purple corollas. The seeds were light brown, small, excavated on both sides of the corrugated ridge, with thick entire margins, cymbose, and elliptic to oblong in shape. Biennial and perennial types developed later in the phylogeny of the group. The primitive members of the neomexicana complex are apparently the most primitive and are considered to be closest to the ancestral forms. The palmeri complex arose somewhat later and extended more to the west of the neomexicana complex in its migration northward. The congesta complex had its origin somewhere in north central Mexico and possibly arose from the multi-ovulate P. infundibuliformis or some similar form. The crenulatae and scariosa complexes probably arose from taxa now extant in western Mexico. These six complexes are discussed and outlined in Figures 1-7.

**Neomexicana complex**

This complex is characterized by noncorrugated seeds, densely glandular pubescence, light brown seeds (except in P. glandulosa), compound leaves, and branched habit. P. coulteri is closest to the ancestral species. P. alba, P. denticulata, and P. neomexicana are related to P. coulteri but possess the advanced features of small, white to pale-colored corollas, and less robust habit. The migrational pattern of this complex has been northward out of Mexico through New Mexico to Wyoming and Montana. P. popci and P. arizonica have developed from a common ancestor, as indicated by their similarity in seed, pubescence, and vegetative features. The same is true of P. formosula, P. glandulosa, P. barkeri, and P. argillacea; however, the latter two have become specialized in the development of noncorrugated seeds. This is the only specialization away from the typically excavated seed type present in the rest of the Crenulatae group.

**Welshii complex**

This complex is characterized by the large reddish seeds, showy corollas, and generally long exserted stamens and style. All taxa are narrowly restricted endemics occurring in Utah, Arizona, and western Colorado. P. welshii is considered to be the most primitive on the basis of its smaller, somewhat brownish seeds and branched habit. P. utahensis and P. splendidus probably had a common ancestor but have adapted to different edaphic situations and have therefore been isolated and selected out; judged on its robust branching habit and glandular pubescence, the former is probably more primitive. P. rafaelensis is related to P. utahensis and may have been derived from it. P. serrata is the most advanced species as characterized by its smaller, lighter-colored corollas, and shortly exserted stamens and styles.

**Palmeri complex**

P. vossii and P. pallida are the most primitive and, along with P. robusta, are restricted to the south central part of the U.S. and adjacent Mexico. The remaining two species, occurring in Utah, Arizona,
and Nevada, are disjunct from the others. The species are distinguished by their pale tubular corollas, small black seeds, and perennial or biennial habit. *P. robusta* is related to *P. pallida* but is considered to be advanced on the basis of its larger, reddish seeds. *P. palmeri* possesses the advanced features of less-divided leaves and thin-margined seeds.

**Crenulata complex**

Although not lacking in a glandular pubescence, this complex displays more divergence from this primitive feature than does any other complex. There appears to be a bilateral development, with *P. crenulata* and its relatives becoming specialized with a mixed pubescence of long stipitate glands and short hairs and dark brown seeds. *P. anelsonii* and *P. coerulea* have small corollas with included stamens and style. The former is more advanced and possesses a thyrsoid inflorescence and more or less scarious sepals. The other line, of which *P. corrugata* is the primitive taxon, is characterized by light brown or dark brown seeds, short stipitate glands, and yellowish stems. *P. howelliana* and *P. integrifolia* are the most highly developed species in this line, the latter apparently being the most advanced on the basis of its lavender corollas and large, noncorrugated seeds. The former has large, dark brown seeds and bicolored corollas. The entire complex, with the exception of *P. integrifolia*, possesses distinctly corrugated seeds.

**Congesta complex**

This complex is related to and has possibly been derived from *P. infundibuliformis* or some form close to it. *P. infundibuliformis* differs from other taxa in this complex only in its multiovulate, narrowly oblong capsule and overall vegetative appearance. The small white corollas, barely exserted stamens and style, and perennial habit of *P. rupestris* indicate that it is the most advanced species in this complex. The species of the *congesta* complex occur in the east central part of the range of the Crenulatae group.

**Scariosa complex**

This most advanced complex is characterized by distinctly scarious sepals, bicolored corollas, and large, corrugated, transversely ridged seeds. The species occurs in the southwesternmost part of the range of the group.

**Distribution and Ecology**

Members of the Crenulatae group occur mostly in western North America. The remaining species, *P. boliviana* Brand, *P. pinnatifida* Griseb. ex Wedd., and possibly others, occur in Peru, Bolivia, and Argentina. The center of distribution in North America, based on the greatest concentration of taxa, is Arizona and New Mexico.

In general, members of this group are desert plants that occur from near sea level to 5,000 feet elevation (up to 11,000 feet). Some are restricted to a particular geologic formation, such as *P. utahensis*, which grows only on the Arapian Shale formation. *P. bakeri* is restricted to montane or subalpine regions on talus or alpine slopes in Colorado, whereas *P. integrifolia* occurs mostly in deep sand. *P. splendens* is endemic to gypsiciferous soil in western Colorado and northwestern New Mexico. The majority of taxa occur in the Lower Sonoran zone and are restricted to an isolated mountain range or valley. *P. corrugata*, *P. denticulata*, *P. glandulosa*, and other species occur in the Upper Sonoran zone and generally have a wider distribution. *P. denticulata* is limited by the continental divide, occurring only on its eastern side. *P. congesta*, *P. pedicellata*, *P. arizonica*, *P. denticulata*, and *P. rupestris* are able to survive in the shade of overhanging ledges or as an understory of trees and shrubs.

An important isolating mechanism that helps to account for the wide distribution is the seasonal variation in phenology. The palmeri complex flowers in late summer and fall, whereas members of the welshii complex flower in spring and early summer. The fetid odor of some species is known to attract beetles, while bees and other insects are important pollinating agents in other species.

The light, cymbiform seeds are probably wind-dispersed. In addition to wind, birds are probably an important dispersing agent.

**Cytology**

Cave and Constance (1942, 1944, 1947, 1950, 1959) and Constance (1963) have
made chromosome counts on about half the Crenulatae group, all of which are n=11. The uncounted members are mostly narrowly restricted endemic plants and include the following: P. anelsonii, P. bakeri, P. boliviana, P. bombycina, P. constanctei, P. coulteri, P. formosa, P. glandulosa, P. howelliana, P. integrifolia, var. terrana, P. intermedia, P. pallida, P. serrata, P. utahensis, P. vossii, and P. welshii.

**Taxonomic Treatment**

Section *Phacelia* Brand. Das Pflanzenreich IV. 251:72. 1913

Annual, biennial, or perennial herbs from a taproot; stems simple to much branched, erect, ascending or prostrate, leafy, puberulent to hispid, strigose or variously glandular; leaves prevailingly alternate, entire to bipinnate, sometimes revolute, sessile to long petiolate; inflorescence of terminal, axillary, or thyrsoid, compound, scorpionid cymes; calyx divided nearly to the base, elliptic to linear, oblanceolate or spatulate, variously pubescent and sometimes accrescent; corolla white or lavender to blue, tubular, campulinate to rotate-campanulate, a pair of variously shaped scales attached to the base of each filament, these partially free from or completely attached to the tube, filament, or adjacent scale; stamens exserted or included within the tube, and inserted at the base of the corolla tube; style exserted or included within the tube, bifid 1/2-3/4 its length, capsule nearly bilocular by union of the placenta, ovoid to subglobose, variously pubescent and mostly glandular; mature seeds 4 (1, 2 or 4 in *P. amabilis* and *P. congesta*), light brown to black, favose, reticulate, entire to corrugated or tranversely ridged, excavated on both sides of a prominent ridge (except in *P. bakeri*) and mostly cymbiform.

**Key to the species of the Crenulatae group**

1a. Stamens and style included or nearly so ........................................ 2
1b. Stamens and style exserted 2 mm or more ........................................ 4

2a. Corolla tubular, light blue, lobes denticulate; plants of Colorado and Wyoming ................................................................. 15. *P. denticulata*
2b. Corolla campulanulate or rotate-campanulate, lobes entire or at most crenulate .................................................. 3

3a. Plants brittle, breaking easily; corolla 3-4 mm long, pale mauve to light blue; mature seeds dark brown ........................................ 9. *P. coerulea*
3b. Plants not brittle; corolla 6 mm long, lavender or white; seeds brown .................................................. 4. *P. anelsonii*

4a. Pedicels shorter than the calyx; sepals not scarious in fruit .............. 6
4b. Pedicels filiform (at least as long as the calyx lobes); sepals scarious in fruit; leaves pinnately compound, the divisions broad ......... 5

5a. Sepals less than 3 times longer than broad; mature seeds 2.5 mm long or less; plants of lower Baja California and southwestern Sonora, Mexico .................................................. 30. *P. scariosa*
5b. Sepals 3 or more times longer than broad; mature seeds 2.5 mm long or more; plants of central Baja California north to California, Arizona, and Nevada ........................................ 25. *P. pedicellata*

6a. Corolla over 4 mm long, white or variously colored ............................ 13
6b. Corolla small (4 mm long or less), white, blue, or lavender ............... 7

7a. Plants prostrate, diffusely branched (at the base); mature seeds 1.8-1.9 mm long, ovate, transversely ridged; corolla white .......... 6. *P. arizonica*
7b. Plants erect, mature seeds mostly over 2 mm long, if smaller then
not with the above combination of characters .......................... 8

8a. Corolla lobes entire; mature seeds with the ridge corrugated or the dor-
sal surface reticulate ..................................................... 11

8b. Corolla lobes erose or denticulate; mature seeds pitted, margins and
ridge entire ........................................................................ 9

9a. Corolla white or pale colored, 3-4 mm long ............................ 1. *P. alba*
9b. Corolla blue or purple, 4-5 mm long .................................... 10

10a. Stems thick, robust; corolla 4-5 mm long, bluish purple; mature
seeds 1.6-1.9 mm long; plants endemic to the states of Hidalgo and
Zacatecas, Mexico ......................................................... 13. *P. coulteri*

10b. Stems weak; corolla 4 mm long, blue; mature seeds 3.2-3.3 mm long;
plants of Arizona and New Mexico .......................... 22. *P. neomexicana*

11a. Corolla white; mature seeds 2.1-2.7 mm long, the ridge not corrugated,
dorsal surface reticulate; plants from southeastern Arizona eastward
........................................................................................ 29. *P. rupestris*

11b. Corolla blue to light violet; seeds 2.5-3.2 mm long, the ridge corrugated
........................................................................................ 12

12a. Corolla bicolored (tube white, lobes blue to lavender), campanulate;
seeds ovate, ridge corrugated, margins entire; plants from western Ar-
zona westward ............................................................. 3b. *P. ambigua* var. *minutiflora*

12b. Corolla not bicolored, light blue to lavender, rotate; seeds elliptic to ob-
long, ridge and margins corrugated; endemic to Coconino County,
Arizona .............................................................. 31. *P. serrata*

13a. Corolla distinctly tubular, white or pale colored ........................................... 14
13b. Corolla campanulate, purple, blue, lavender, or white (appearing tu-
bular in some pressed specimens) ........................................ 19

14a. Plants annual or biennial (possibly perennial in *P. pallida*); north of Nu-
evno León, Mexico ......................................................... 15
14b. Plants perennial; endemic to the state of Nuevo León, Mexico ........................ 34. *P. vossii*

15a. Seeds brown or reddish brown, 2.9 mm long or more ..................................... 16
15b. Seeds black, 2.9 mm long or less ............................................................... 17

16a. Seeds 3.5-4 mm long; cauline leaves sessile (or nearly so), auric-
ulate; plants of Utah ......................................................... 27. *P. rafaclensis*
16b. Seeds 2.9-3.7 mm long; cauline leaves distinctly petiolate, not auric-
ulate; plants of Kansas, Oklahoma, Texas, and Mexico 28. *P. robusta*

17a. Inflorescence thyrsoid; stems solitary or if branched then near the base 24. *P. palmeri*
17b. Inflorescence open; stems branched throughout, especially at base ........... 18

18a. Leaves revolute, narrowly linear or lanceolate (less than 1.5 cm
wide); plants of Utah and Arizona ..................................... 11. *P. constancii*
18b. Leaves not revolute, broadly oblong or lanceolate (mostly over 1.5
cm wide); plants of Texas and adjacent Mexico 23. *P. pallida*

19a. Leaves pinnately or bipinnately compound, finely dissected .......... 20
19b. Leaves simple or if compound not finely so, the divisions broad (over 5
mm wide) ....................................................................... 25
20a. Corolla violet; plants endemic to Jackson County, Colorado

20b. Plants not as above

21a. Pubescence of the leaves mostly unicellular, puberulent to hispid; plants native from western and southern New Mexico, southward and eastward (except in P. argillacea which is endemic to Utah)

21b. Leaves mostly with multicellular, stipitate-glandular hairs; native from central New Mexico northward and westward

22a. Flowers violet to light blue; seeds more or less excavated on one side of the ventral ridge; plants endemic to the Green River Shale formation in Utah County, Utah

22b. Flowers blue to purple; seeds excavated on both sides of the ventral ridge

23a. Seeds 1.8 mm long, ovate; ultimate leaf divisions mostly less than 4 mm wide

23b. Seeds over 1.8 mm long, elliptic to oblong; ultimate leaf divisions mostly over 5 mm wide

24a. Seeds not excavated ventrally; plants east of the Continental Divide in Colorado and New Mexico

24b. Seeds excavated ventrally; plants west of the Continental Divide in Wyoming, Montana, and Idaho

25a. Corolla not distinctly bicolored, blue, purple, or white

25b. Corolla distinctly bicolored, the tube white or yellow, the lobes blue

26a. Cauline leaves sessile, auriculate, plants robust, 0.8-5.8 dm tall, endemic to Sanpete and Sevier counties, Utah

26b. Cauline leaves distinctly petiolate; plants not especially robust, less than 2.7 dm tall, more eastern in distribution

27a. Stems branched at base; leaves simple, strigose and glandular; corolla tube white; seeds corrugated on the margins and ridge, dorsal surface smooth

27b. Stems simple or branched above; leaves essentially glabrous, some of the lower usually compound; corolla tube yellowish; seeds essentially lacking corrugations, dorsal surface deeply pitted

28a. Corolla white; plants endemic to Saline Valley, Inyo County, California

28b. Corolla pale blue, purple, or lavender (rarely white); plants widespread or if endemic not as above

29a. Corolla lavender; seeds lacking ventral corrugations

29b. Corolla pale blue to purple; seeds corrugated ventrally

30a. Stamens and style exserted 4 mm or less; mature seeds 2.9 mm long or less

30b. Stamens and style exserted over 4 mm; mature seeds over 2.0 mm long

31a. Mature seeds 2.2-2.5 mm long; dark brown; plants very brittle annuals

31b. Mature seeds 2.7-2.9 mm long; brown; plants not especially brittle

16. P. formosula

21. P. argillacea

23. P. popei

24. P. congesta

25. P. integrifolia var. integrifolia

29. P. amabilis

19a. P. concolor

30. P. bombycina

20. P. intermedia
GREAT BASIN NATURALIST
Vol. 35, No. 2
138

32a. Mature seeds corrugated only on the ridge; pubescence of the stems densely hispid, glandular above
32b. Seeds with the margins and ridge corrugated; pubescence of the stems mostly glandular, sometimes finely so

33a. Glandular pubescence of the stems and herbage mostly multicellular
33b. Glandular pubescence of the stems and herbage stipitate but not multicellular

34a. Corolla lavender to purple, 4.5-6 mm long; anthers blue green; stems often reddish; mature seeds reddish brown, 2.4-3 mm long; plants of southeastern New Mexico and adjacent Texas

35a. Leaves narrowly oblong, mostly less than 1 cm wide, glandular pubescence of the leaves and lower part of the stems short stipitate, the nonglandular hairs mostly fine, retrorse
35b. Leaves mostly well over 1 cm wide, glandular pubescence of the leaves and stems stipitate-multicellular, nonglandular hairs spreading

36a. Stems usually reddish at least below; mature seeds with a dark center dorsally and lighter margins; plants of western Utah and Arizona westward to California and Nevada
36b. Stems green; mature seeds uniform in color dorsally; plants endemic to Coconino County, Arizona

37a. Corolla lavender to white, campanulate, 5-6 mm long; leaves undulate to regularly dentate, oblong to lanceolate; seeds uniformly brown; plants endemic to Kane and Garfield counties, Utah
37b. Corolla dark blue, tubular to funnelform, 5-8 mm long; leaves irregularly crenate to dentate, lanceolate; seeds brown ventrally and reddish dorsally; plants endemic to Coconino County, Arizona

1. **Phacelia alba** Rydberg


Holotype: Colorado: Costilla Co.: Sangre de Cristo Creek, 2 July 1900, Rydberg and Vreeland, 5755. (NY); Isotype (RM).

Paratypes: Colorado: Clear Creek County: Valley of Upper Arkansas River, 1873, J. Wolfe, 99, (NY); head waters of Clear Creek, 1861, C. Parry, 314 (G), (NY); New Mexico: Lincoln Co.: Ruidoso Creek, White Mountains, 1 July 1895, E. Wooton, s.n. (NY).


Isotypes (CAS, MEXU, POM, RM, UC, UC, US).


Plants annual, 0.5-7 dm tall; stems simple to much branched, erect or ascending, leafy, puberulent, setose to hisurate and stipitate-glandular, especially in the inflorescence; leaves irregularly lobed to bipinnate, 2-10 cm wide, strigose to setose, slightly to moderately stipitate-glandular, long petiolate below to sessile or subsessile above; inflorescence of dense terminal compound *scorpioid* cymes, densely glandular and puberulent to hir-
sute, the cymes 1-2 cm long in flower to 8 cm long in fruit; pedicels 0.8-1 mm long; sepals linear to oblanceolate, 3.5-4 mm long, 0.5-1 mm wide, finely glandular and somewhat setose; corolla campanulate, white (sometimes pale purple), 3-4 mm long and broad, lobes pubescent and dentate; capsule ovoid to subglobose, 3-3.3 mm long, 2.5-2.9 mm wide, puberulent and quite glandular (the partition oblanceolate); mature seeds elliptic to oblong, light to dark brown, 2.4-3 mm long, 1.4-1.5 mm wide, uniformly alveolate throughout and cymbiform, the ventral surface shallowly excavated on both sides of the ridge and lacking corrugations, the margins thick and entire (Fig. 9). Collections: 207 (5); representative: C. Parry 314, 1861 (GH, NY); D. Atwood 1975, 1962, 1963a (BRY, NY, US); M. Jones 511 (FOM).

Habitat.—Dry clay-loam or sandy draws and flats, fields, meadows, and gravelly hillsides. From 6,000 to 9,500 feet. Growing on the short grass prairie, sagebrush belt, and pinyon-juniper communities at the lower elevations and associated with aspen, spruce, fir, or pine forests at the higher elevations. Late May to early October.

Distribution.—Laramie and Albany cos., Wyoming, southward through central Colorado, New Mexico, and adjacent Chihuahua, Mexico, westward to Graham and Apache cos., Arizona, and Sevier, Wayne, Garfield, and Washington cos., Utah (Map 1).

The material cited by Brand (1913) for P. glandulosa ssp. eu-glandulosa var.
elatior Brand (Nelson 8053) belongs to *P. alba*.

2. *Phacelia amabilis* Constance


Holotype: California: Inyo County: Saline Valley, 21 April 1942. A. Alexander and L. Kellogg 2681 (UC); Isotype (UC).

Plants annual; stems stout, branched above, stipitate-glandular, puberulent, and hispid; leaves petiolate, oblong to oblong-ovate, 8-15 cm long, 3-5 cm wide, pinnatifid, upper leaves reduced and less deeply divided; inflorescence of compound scorpionoid cymes, the cymes 5-12 cm long, pedicels 2-3 mm long; sepals lanceolate, 3.5 mm long, 1.2 mm wide; corolla broadly campanulate, white, 7-8 mm long, 8-12 mm wide; stamens and style exerted 5 mm or more; capsule ovoid, 3-4 mm long, 2-3 mm wide; immature seeds apparently 2 or 4, 3-4 mm long, thin and pale, ventral surface excavated on each side of the prominent ridge; collections: 1 (0); representative: A. Alexander and L. Kellogg 2681 (UC).

**Distribution and Habitat.**—Apparently endemic to Saline Valley, Inyo County, California, along Hunter Creek at an elevation of 1,800 feet.

3. *Phacelia ambigu*a Jones

Plants annual, 0.2-5.7 dm tall; stems simple to much branched, hispid, puberulent, and stipitate-glandular; leaves simple to pinnately compound, petiolate to sessile above the margins various, strigose to hispid and stipitate-glandular, 0.5-13 cm long, 0.5-4.5 cm wide; inflorescence of compound scorpionoid cymes, the cymes elongating to 12 cm in fruit, pubescence as for the stem; sepals elliptic to ob lanceolate, 2.7-5.1 mm long, 1.1-3.3 mm wide, puberulent, hispid, and stipitate-glandular; corolla campanulate to rotate-campanulate, purple or dull lavender, 4-10 mm long and broad, pubescent; stamens and style exerted 2-10 mm; style bifid, pubescent below; capsule globose to subglobose, 3.3-5.5 mm long, 2.5-3.4 mm wide, puberulent and glandular; mature seeds 4, ovate, reddish to brown, 2.5-3.3 mm long, 1.3-1.8 mm wide, alveolate, cymbiform, the ventral surface excavated on both sides of the ridge, the ridge corrugated on one side.

**Key to the varieties of *P. ambigu*a**

1. Corolla 4 mm long or less; style 6.5 mm long or less; calyx in fruit less than 4 mm long .......................... var. *minutiflora*

1. Corollas over 4 mm long; style 9 mm long or more; calyx in fruit 4 mm long .......................... var. *ambigua*

3a. var. *ambigua*


Plants annual, 0.5-5.7 dm tall; stems simple to much branched, usually more leafy toward base; leaves 0.5-13 cm long, 0.5-4.5 cm wide, strigose to hispid, usually only with scattered glands, reduced from the base upward; cymes elongating to 12 cm in fruit; sepals 3.2-5.1 mm long, 1.1-3 mm wide; corolla campanulate, purple to blue, 5-10 mm long and wide, pubescent; stamens and style exerted 9 mm or more; style bifid 2/3 its length, puberulent and glandular below; capsule 3.3-3.5 mm long, 3.3-4.4 mm wide, puberulent and stipitate-glandular; mature seeds 3.3 mm long, 1.5 mm wide. Collections: 250 (30); representative: E. Palmer 625 (NY); M. Jones 5018 (NY, FOM, BM, UC, US); C. Pringle s.n. (CAS, GH, NY); J. Howell 3504 (RSA); D. Atwood 2210, 2220a, 2294, 2296, 2303, 2310, 2319, 2353 (BRY).

**Habitat.**—Growing on a wide variety of soils in the lower Sonoran Desert from 490 to 5,000 feet elevation. February to mid-June.

**Distribution.**—Southern Nevada and southwestern Utah in Washington Co.,
southward through Arizona (except for Navajo and Apache cos.,) and southeastern California (Map 2).

*Phacelia ambigua* has been treated as a variety of *P. crenulata*, which it closely resembles. However, the former species appears to be more uniform throughout its range than does the latter. Also, to treat *P. ambigua* at infraspecific rank would require the inclusion of other closely related taxa, namely *P. bombycina* W. & S. and *P. anabilis* Constance. In order to understand the complete relationships between these taxa additional field and greenhouse studies are needed. These studies may demand nomenclature changes, but until such studies are carried out the present treatment provides a more uniform arrangement of the entities involved.

3b. var. *minutiflora* (Voss in Munz) Atwood comb. nov.  

Fig. 10


Holotype: California: Imperial Co., 2 miles north of Cargo Muchacho Mountains, 5 April 1932, P. Munz and L. Hitchcock 12141 (nys!).


Plants annual, 0.2-4.5 dm tall; stems simple or variously branched, hispid, puberulent and stipitate-glandular (especially in the inflorescence); leaves 0.5-11 cm long, 0.5-3.5 cm wide, strigose to hispid and often quite glandular, the lower with longer petioles than the upper reduced leaves, cymes elongating to 7 cm in fruit; sepals 2.7-3.8 mm long, 1 mm wide, corolla rotate-campanulate, tube white, lobes lavender to blue, pubescent, 4 mm long and broad; stamens and style exerted 2 mm or less; style bifid 2/3 its length, puberulent and glandular below; capsule 3-3.2 mm long, 2.5-3 mm wide, puberulent and glandular; mature seeds 2.5-3.2 mm long, 1.3-1.8 mm wide (Fig. 11). Collections: 89 (+); representative: E. Palmer 626 (NY); T. Kearney and R. Peebles 10941, 10963, 11016 (US); D. Atwood 2320, 2355, 2352, 2341 (BRY); I. Wiggins 9669 (RSA, UC).

**Habitat.**—Sandy to rocky desert flats, washes and slopes from near sea level to 2,200 feet. Common in *Larrea, Ambrosia, Atriplex, Fouquieria*, and *Cercidium* communities. Late December to late April.
Fig. 10. *Phacelia ambiguа* Jones var. *minutiflora* (Voss in Munz) Atwood. D. Atwood 2341 (BRY).

**Distribution.**—Southwestern Arizona in Maricopa, Pima, and Yuma cos., and westward to San Bernardino Co., California, south into Baja California and Sonora, Mexico (Map 2).

4. *Phacelia anelsonii* Macbride

*Fig. 12*


Holotype: Nevada: Lincoln Co.: Meadow Valley Wash, 28 April 1902, L. Goodding 635 (RM!).

Erect annual, 1-5.5 dm high; stems terete, usually simple covered with brownish stipitate glands, leafy throughout; leaves narrowly to broadly oblong, pinnately cleft, 1.5-8 cm wide, pubescence brownish, stipitate-glandular, with a few non-glandular hairs, pedicels from 3 cm long on the lower part of the stem to nearly sessile on the upper part, the pin-
plant which Goodding, when he described his *P. foetida* . . . took to represent *P. palmeri* Wats., a very different plant with exserted stamens and corrugated

Habitat.—Commonly in shady places at the base of sandstone and limestone cliffs or among rocks and in sandy to gravelly washes, 2,000 to 5,000 feet elevation. Usually locally scattered, April to May.


Macbride (1917) in his original description of *P. anelsonii* says, "this is the
seeds.” It is not known from whence Macbride drew this conclusion, but it supports the observations of the author that \textit{P. foetida} is the same entity as \textit{P. palmeri}.

\textit{P. anelsonii} is related to \textit{P. crenulata} and \textit{P. amabilis} as indicated by both leaves and seed characters. \textit{P. anelsonii} is easily distinguished from them by the included stamens and style, a feature which it has in common with \textit{P. coerulea} and \textit{P. denticulata}. Detailed observations of the type specimens, as well as other collections, revealed the presence of corrugations along one side of the ridge in some seeds of \textit{P. anelsonii}. Both \textit{P. crenulata} and \textit{P. amabilis} have the corrugated ridge. Macbride (1917) and Voss (1937) have indicated that the seeds lack corrugations.

John Thomas Howell was the first to report this taxon for Washington Co., Utah, and San Bernardino Co., California (1941), and for Inyo Co., California (1942). Two collections from Washington Co., Utah (R. Barneby 2937 and B. Wood 140), are more robust in habit and have unusually large parts.

5. \textit{Phacelia argillacea} Atwood


\textit{Phacelia glandulosa} Nutt. var. \textit{argillacea} Atwood in Welsh & Moore, nomen. nudum.

Holotype: Utah Co.: Spanish Fork Canyon, Clear Creek ca. 6 mi west of Soldier Summit, 18 August 1971, D. Atwood et al. 3091 (US); Isotypes, to be distributed; Pleasant Valley Junction (Colton), Wasatch Moun-

tains, August 1883, M. E. Jones s.n. (US); Isotypes (CAS, CAS, NY, UC, UC). Paratypes: Utah: Utah Co.: Clear Creek near Soldier Summit, 6 July 1894, M. E. Jones 5591 (NY, UC).

Plants annual, 1-3.6 dm tall; stems finely pubescent; leaves oblong in outline, pinnatifid, 0.8-5 cm long, 0.5-1.5 cm wide, strigose, petiolar; inflorescence of compound scorioid cymes, stipitate-glandular and setose to hisrate, pedicels 0.7-1 mm long, cymes elongating to 7.5 cm in fruit; sepals elliptical to oblanceolate, 2.3-3.8 mm long, 1 mm wide, stipitate-glandular and hisrate to setose; corolla campanulate, bluish violet, ca. 5 mm long and broad, lobes pubescent; stamens and style exserted ca. 7 mm; capsule subglobose, 3.2-3.3 mm long, 2.3-2.4 mm wide, glandular and setose; mature seeds 4, brown, ovate to elliptic, 2.4 mm long, 1.1 mm wide, pitted, the ridge curved and more or less excavated on one side. Collections; 3 (1); representative: M. Jones s.n. (CAS, NY, UC); M. Jones 5591 (NY, UC, UC); D. Atwood 3091 (BRY).

Habitat.— The species apparently grows on gravelly hillsides of the Green River formation between 6,500 and 7,000 feet, July to August.

Distribution.— Known only from Utah Co., Utah.

This species is related to both \textit{P. glandulosa} and \textit{P. bakeri} but can be distinguished by its more nearly glabrous herbage, smaller capsule, flowers, and different seeds.

Fig. 13. Dorsal and ventral view of the seeds of \textit{P. anelsonii} Macbride. R. Barneby 2937 (CAS).
6. **Phacelia arizonica** A. Gray

**Fig. 14**


Lectotype: Arizona: Maricopa Co.; plains of the upper Gila, 15 April 1880, E. Greene s.n. (gh!); duplicate (CAS).


Low diffusely branched (at the base), prostrate annual, 0.2-2.1 dm tall (up to 4 dm in extreme forms); stems slender, 1-many, hispid to villous and glandular, often reddish; leaves larger and denser at the base, oblone to linear in outline, sessile above to short petiolate below deeply lobed to pinnaatifid, 1.5-5 cm long, 0.5-2 cm wide, densely strigose, inflorescence terminal, cymes densely flowered, the flowers sub sessile (pedicels to 0.5 mm long), densely covered with small glandular and short simple hairs, with some longer simple hairs intermixed; sepals oblong to elliptic, 2.5-4 mm long, 1 mm wide, hirsute; corolla campanulate, white or rose white, (often reddish in bud), 3-4 mm long and broad, lobes pubescent and shallowly erose; stamens and style exserted 3-4.5 mm; style bifid 3/4 its length, the lower 1/2 puberulent and sometimes finely glandular; mature seeds 4, ovate and more or less cymbiform, brown, 1.8-1.9 mm long, 1.2-1.3 mm wide, alveolate, ventral surface excavated on both sides of the ridge, dorsal surface alveolate and transversely ridged (Fig. 15). Collections: 104 (2); representative: C. Pringle s.n. (NY); L. Goodding 1035 (NY, UC, US); M. Jones 28501, 28503 (POM); D. Atwood 2200a (BRY, CAS, NY, WTS, B); L. Higgins 2814 (BRY); D. Atwood 2186 (B, BRY, CAS, NY, WTS).

**Habitat.**— Common along roadsides, sandy flats, and gravelly hill sides, from 1,600 to 2,500 feet. Often growing with *Prosopis, Quercus, Juniperus,* or grass communities, mid-February to late June.

**Distribution.**— Arizona from Maricopa Co. southward into Sonora, Mexico, and eastward to Sierra and Luna cos., New Mexico (Map 4).

This species was treated as a variety of *P. popei* T. and G. by Voss (1937), but is easily distinguished as a species on the basis of its smaller, white, glandless corolla, prostrate habit, less-dissected leaves, and nearly leafless stems. However, the two are similar in seed characters and in the much-branched habit. *P. popei* has erect to ascending and more rigid stems in contrast to the slender, prostrate stems of *Phacelia arizonica*. Gray (1878) did not designate a type specimen. Therefore, the author has chosen the collection of Greene, “on the plains of the upper Gila,” as the lectotype.

7. **Phacelia bakeri** (Brand) Machrude

**Fig. 16**


Annual, 0.5-4.8 dm tall; stems simple or branched, with multicellular stipitate glands, pilose to somewhat hirsute; leaves pinnately divided, the pinnae irregularly crenate to dentate, 2-8 cm long, 0.5-3 cm wide, reduced upwards, petioles 0.5-4 cm long, dorsal surface strigose, ventral surface strigose, glandular and setose along...
Fig. 14. *Phacelia arizonica* Gray. L. Higgins 2814 (BRV).
Fig. 15. Dorsal and ventral view of the seeds of *P. arizonica* Gray. D. Atwood 2186 (bry).

the veins; inflorescence of compound scorpioid cymes, terminal on the main stem and lateral branches, setose to puberulent and glandular; pedicels 1-2 mm long; sepals oblanceolate to narrowly spatulate, 1-1.5 mm longer than the capsule, setose to puberulent and glandular; corolla campanulate, violet to dark blue, 7-8 mm long, 5-7 mm wide, pubescent; stamens exserted 5-9 mm, anthers greenish, filaments bluish; style exserted bifid 2/3 its length and pubescent on the lower 1/3; capsule oblong to oval, 2.5-4 mm long, 3-3.2 mm wide, setose and glandular; mature seeds elliptic, brown, 2.7-3 mm long, 1.3-1.6 mm wide, ventral surface pitted with a central ridge gradually tapering toward the margins, excavations lacking on each side of ridge, dorsal surface flattish with a faint longitudinal groove down the center, pitted (Fig. 17).

Collections: 83 (0); representative: T. S. Brandegee 1139 (UC); M. Jones 511 (POM); C. Baker 549 (GH, NY, POM, RM, US); L. Higgins 2235, 2236, 2244, (BRY, WTS); A. Nelson 9812 (RM, UC); W. Weber 9416 (RSA, UC, UT); R. Hartman 2782 (BRY, RM).

**Habitat.**—Gravelly and sandy soils and talus slopes from 7,050 feet elevation upward to timberline. Commonly in open tundra and grassy alpine slopes of spruce, fir, pine, or aspen communities. Sometimes growing as a weed along roadsides and in waste field, July to September.

**Distribution.**—Mostly along or east of the Continental Divide in central and south central Colorado, south to Colfax Co., New Mexico (Map 5).

This taxon was misinterpreted by Brand (1913). The type specimen is the only material cited by him that belongs to *bakeri* in a strict sense. Macbride (1917) and Voss (1937) present additional information on Brand's treatment of this entity. *P. bakeri* is related to *P. glandulosa* Nutt., differing in the lack of excavations on the ventral surface of the seeds, usually greener herbage, later flowering time, and distribution.
8. Phacelia bombycina Wooton & Standley


Phacelia tenuipes Wooton & Standley, Contrib. U.S. Natl. Herb. 16:163. 1913. Holotype: Carizalillo Spring, 17 April 1902, E. Mearns 91 (us!).

Annual 0.9-4.1 dm tall; stems 1-several, often branched throughout, erect and very brittle, setose to puberulent and glandular at least in the inflorescence; basal leaves petiolate (the petiole up to 5 cm long), oblong to nearly orbicular, pinnatifid into oblong to ovate, crenate lobes, setose and often glandular on both surfaces, 1.5-8 cm long, 0.5-2.5 cm wide, upper reduced, short petiolate, lobed; inflorescence paniculate, narrow, with a few branches; individual cymes with numerous, crowded flowers, pedicels short, stout, setose to puberulent and glandular; sepals oblong to elliptical, up to 3.5 mm long, setose to glandular; corolla blue to violet, 5-6 mm long and wide, campanulate, lobes pubescent; stamens exerted, anthers yellow; filaments bluish violet; style exerted, bifid to about the middle, pubescent below the middle, bluish violet; capsule 2.5-2.7 mm long and broad, globose, pilose and glandular especially at the apex; mature seeds oblong to elliptical, cymbiform, 2.2-2.5 mm long, 1.1-1.4 mm wide, dark brown, ventral surface pitted and divided by a prominent ridge, the ridge corrugated on one side, margins corrugated, lighter than the center, dorsal surface pitted (Fig. 19). Collections 89 (9); representative: L. Goodding 2230 (rm, uc); W. Cottam 10198 (uc); D. Demaree 42048 (uc); L. Higgins 2877 (bry, wts). H. Ripley and R. Barneby 4218 (rsa); D. Atwood 2195, 2241, 2256, 2280 (bry); D. Atwood 2230, 2253, 2255 (bry, cas, ny, wts).

Habitat.— Sandy, gravelly, or lava slopes and mesas from an elevation of 1,500 to 7,500 feet. Commonly found in the Larrea, Prosopis, and other Lower Sonoran mixed shrub communities, late March to late May.

Distribution.— Sierra Co., New Mexico, southward to Chihuahua and Sonora, Mexico, westward through southern and central Arizona to Yavapai and Coconino cos. (Map 6).

The character differences that Wooton and Standley (1913) used to separate P. tenuipes and P. bombycina vary depending on the maturity of the plants.
and environmental conditions. Of the two taxa, the original description of the latter better fits the entity concerned. For these reasons *P.tenuipes* is placed in synonomy. The holotype data indicate that *P. bombycina* was collected in March and April; however, an isotype in the U.S. herbarium gives the exact data as 25 March 1880.

This entity has been confused with both *P. intermedia* and *P. crenulata*. It is readily distinguished from the former by the exserted stamens, larger blue lavender corollas, very brittle and less glandular stems, and smaller seeds. It differs from the latter by its brittle stems and smaller, darker seeds.
9. Phacelia coerulea Greene


Annual, 0.5-6 dm tall; stems erect, branched throughout, reddish, puberulent to setose and sparsely to densely stipitate-glandular, leafy throughout; leaves oblong to ovate, gradually reduced from the base upward, upper deeply sinuate, lower pinnatifid, dorsal surface with setose appressed hairs, dorsal surface setose to glandular, 0.6-8 cm long, 0.3-2.5 cm wide, petioles from 5 cm long at the base to nearly sessile at apex, margins crenate; inflorescence terminal, commonly loosely paniculate or cymose, setose, stipitate-glandular and puberulent; scorpoid cymes compact in flower but loosening in fruit, 1.5-7 cm long; flowers nearly sessile in flower to 1 mm long in fruit; corolla campanulate, lobes pale mauve to blue (turning white in fruit), tube yellowish, 3-4 mm long and broad, glabrous; sepal narrowly oblanceolate to elliptical, 2.5-4 mm wide, setose to brownish stipitate-glandular, 3/4 as long as the corolla, shorter or sometimes longer than the cap-
sule; stamens mostly included to slightly exserted, anthers yellow, ovate, filaments bluish; style included to slightly exserted, equaling the stamens; capsule globose, 2.5-3.5 mm long, 1-1.8 mm wide; mature seeds dark brown, ventral surface pitted and divided by a prominent ridge, the ridge corrugated on one side, margins usually corrugated, dorsal surface pitted, 0.3-0.4 mm of the margin slightly elevated and smoother than the pitted center (Fig. 21). Collections: 112 (6); representative: M. Jones s.n. (POM); W. Wooton s.n. (NY); C. Parry 934 (NY); E. Greene s.n. (GH); C. Wright 1579 (GH, GH, GH, NY); D. Atwood 2137, 2132, 2196a, 2573 (BRY); D. Atwood 2197, 2281 (BRY, CAS, NY, WTS); L. Higgins 3126, 3134, 2978, 2999 (BRY, WTS).

Habitat.—Gravelly and arid calcarious hills and banks, sandy-gravelly stream beds, and rocky ledges from 2,000 to 6,000 feet. Commonly associated with the paloverde and creosote mixed shrub communities. Usually locally scattered, late February to early July.
DISTRIBUTION.—Southern Nevada in Clark Co., southeastern California in San Bernardino Co., eastward through Mohave Co. to southern Arizona and southern New Mexico from Socorro and Lincoln cos. to El Paso, Presidio, and Brewster cos., Texas, and adjacent Mexico in the state of Chihuahua. Only one collection
is known from Nevada and California (Map 7).

Greene cited no material on which he based his original description in November 1881. Voss (1937) noted this fact and selected Greene’s collection at the Gray Herbarium as the type, since he had collected *P. coerulaea* in the spring (23 April 1881) of the same year. However, Howell (1943), in Sertulum Greeneanum, indicates that a part of the type collection chosen by Voss is present in the Greene Herbarium at Notre Dame and that this specimen should be the type. Since Voss selected the specimen at the Gray Herbarium as the type, it should probably stand as such even though Greene’s original is at Notre Dame.

This taxon is most closely related to *P. bombycina* and secondarily to *P. crenulata*. It differs from these species in its included stamens and smaller corollas. Jones (1908) contended that *P. coerulaea* and *P. invenusta* Gray were separate species. The author believes, as did Gray (1886) and Voss (1937), that the latter is the same entity as the former. Howell (1941) reported *P. coerulaea* from San Bernardino Co., California (H. Ripley and R. Barneby 3361 (CAS, RSA)). To my knowledge this is the only collection from California.

No type was selected by Gray when he described *P. invenusta*; therefore I have selected the Pringle collection (GH) as the lectotype. Duplicates are located at CAS and a fragment at US.

10. **Phacelia congesta** Hooker


**Phacelia dissecta** (Gray) Small. Fl. Southeastern U.S. pp. 972, 1337. 1903.


Erect, often robust, annual plants, 1-10 dm tall; stems simple or diffusely branched throughout, with multicellular stipitate glands and puberulent to hispid unicellular hairs; leaves oblong in outline, pinnately compound, the 3 terminal lobes usually not completely lobed to the midrib, often somewhat larger than the lower, usually petiolate lobes, 1-12 cm long, 0.5-4 cm wide, strigose and sometimes glandular; inflorescence of
terminal, compound, scorpoid cymes, the individual cymes 1.5-15 cm long, pedicels 2.5 mm long or less, pubescent; sepals narrowly linear, 3-4.5 mm long, 0.5-0.7 mm wide, setose to hispid and often glandular; corolla campanulate, blue (rarely white), 4-6 mm long and wide, the lobes pubescent; stamens and style exerted, ca. 2-4 mm long, anthers pale yellow, filaments purplish; style 7-8 mm long, bifid 3/4 its length, lower 1/4 pubescent; capsule subglobose to oval, 2.3-3.6 mm long, 2.3-3 mm wide, puberulent and often glandular; mature seeds usually 4, sometimes 1 or 2, 2.6-3.2 mm long, 1.2-1.4 mm wide, elliptical to oblong, brown, reticulate to scabrous, ventral surface excavated on both sides of the ridge (Fig. 23). Collections: 222 (21); representative: V. Cory 28060 (GH); R. McVaugh 7780 (UC); E. Palmer 33743 (NY, US); H. Ripley and R. Barneby 11107 (CAS); E. Tyler s.n. (US); L. Higgins 2671, 3162 (BRY); D. Atwood 2048a, 2049, 2063, 2098, 2099, 2104-2107, 2111, 2117 (BRY).

Habitat.—Commonly associated with Prosopis, Larrea, Acacia, and Opuntia in sandy to sandy loam, rocky limestone, or sandstone flats and outcrops. Along the coast of southern Texas it grows on low shoreline dunes and is usually associated with Quercus, February to September, 300 to 7,000 feet.

Distribution.—Scattered throughout most of central and southern Texas, west to Eddy and Doña Ana cos., New Mexico; northeastern Mexico and Caddo and Com-
manche cos., Oklahoma. Specimens from Florida, Massachusetts, and Sweden are presumably cultivated (Map 8).

Some plants from Tamaulipas, Zacatecas, and adjacent Nuevo Leon, Mexico, are fall-flowering and differ in sufficient morphological features to warrant further investigation. They are apparently rhizomatous perennials and possess a congested inflorescence and small, pale lavender flowers.

This taxon varies throughout its range in pubescence and in leaf size and shape. The number of seeds per capsule was used by former workers as an important character in separating var. dissecta from var. congesta. However, the author has examined capsules from the type material of var. dissecta and found that they possess 4 seeds. Other material examined varies in the number of seeds per capsule. This variation probably results from environmental conditions and is hardly consistent enough to warrant taxonomic recognition.

The seeds of P. congesta are dark when immature and are light brown upon reaching maturity. A more or less mottled pattern can be observed in the different stages of development.

11. Phacelia constancei Atwood

Fig. 24


Erect biennial herb, 1.5-4.3 dm tall, leafy throughout; stems stout, simple or branched throughout, reddish, from hirsutulous to hirsute, and finely glandular; leaves mostly petiolate, 1-10 cm long, 0.3-1.5 cm wide, revolute, from undulate to pinnatifid, linear to lanceolate, upper surface hirsutulous with scattered glandular hairs; inflorescence of compound scorpionid cymes; pedicels to 1 mm long; sepals elliptic to oblanceolate, 3-4 mm long, hirsutulous to hirsute and stipitate-glandular; corolla tubular, whitish, 5-6 mm long; stamens exserted 3-4 mm; style bifid, lower 1/3 pubescent, exserted 3-4 mm longer than the stamens; capsule subglobose, glandular, and hirsutulous throughout, shorter than the sepals, mature seeds 4, black, 2.5-2.8 mm long, 1-1.2 mm wide, elliptic, the margins corrugated. ventral surface finely pitted, excavated, and divided by a prominent ridge, the ridge corrugated on one side, the dorsal surface finely pitted. Collections: 12 (10); representative: H. Ripley and R. Barneby 4836 (CAS, RSA); D. Atwood 1529 (BRY, GH, UC); D. Atwood 1785 (ARIZ, BRY, CAS, NY, UC, US, UTC); D. Atwood 1792b (BRY, CAS, GH, NY, POM, RM, US).

Habitat.—Alkaline clay bluffs and flats of the Moenkopi formation, 5,500 feet. Late May to early August.

Distribution.—Mohave Co., Arizona, and Kane Co., Utah (Map 9).

Taxonomically P. constancei appears to be most closely related to P. palmeri Torr. ex Wats, but is distinguished from that species by the smaller growth form, narrower and more revolute leaves, the reddish stems with shorter and fewer hairs, and the leafier lateral inflorescence branches.
Fig. 24. *Phacelia constancei* Atwood. D. Atwood 1835a (BR).
12. Phacelia corrugata A. Nelson

Fig. 25


Phacelia crenulata Torr. ex Wats. var. corrugata (A. Nels.) Brand, Das Pflanzenreich IV, 251:79. 1913.


Plants annual or winter annuals, 0.5-4.3 dm tall; stems greenish, from puberulent to finely stipitate-glandular and sometimes with a few longer hairs intermixed; leaves 1-10 cm long, setose to strigose and stipitate-glandular; sepals 4.5 mm long; corolla campanulate, deep blue, 6 mm long or more; stamens and style exserted over 3 mm, filaments and style blue; capsule elliptic, 3.8-4.5 mm long; mature seeds oblong to elliptic, light brown, 3.1-4 mm long, 1.3-1.7 mm wide, pitted, the ventral surface corrugated on the margins and one side of the ridge (Fig. 26). Collections: 216 (4+); representative: R. Barneby 13033 (CAS, NY); C. Parry s.n. (CAS, UC); A. Eastwood and J. Howell 9358 (CAS, GH, UTC); L. Higgins 3304, 3303, 3305 (BRY, WTS); D. Atwood 1314, 1489, 1856, 2539, 2523, 2583, 2581, 2618 (BRY).

Habitat.—This species grows in a large number of habitats from dry, gravelly hillsides and flats, sandy soil, and red shaly clay to heavy clay soils. It grows with Atriplex, Sarcobatus, Ephedra, Coleogyne or grass, from 3,500 to 7,000 feet elevation. Late April to mid-July.

Distribution.—Eastern Nevada, eastward to Colorado from Garfield and Gun-
nison cos., southward through Ouray and Montezuma cos. to northwestern New Mexico and northern Arizona (Map 10).

This species is related to *P. crenulata* and apparently intergrades with it in eastern Nevada and western Utah. In general, however, it is easily distinguished from the latter by its greenish yellow stems, finer pubescence, and lighter, narrower seeds.

13. Phacelia coulteri Greenman


Stout annual, 3.4-5.4 dm tall; stems solitary or branched, brownish to reddish, hirsute and provided with a softer indument; leaves pinnately compound, finely dissected, 0.2-1 dm long, 3-4.5 cm wide, hispid, with small dark glands, midrib and some of the lateral veins prominent ventrally and therefore producing a furrowlike appearance dorsally, the margins of the pinnae thick ventrally, lower leaves petiolate, the pedicels gradually reduced upward; inflorescence of terminal compound scorpionid cymes, hispid, with brownish glandular hairs, the cymes congested, up to 7 cm long, pedicels 1 mm long or less; sepal linear to oblanceolate, 3.3-3.6 mm long, 0.5-1.3 mm wide, hirsute and brownish glandular; corolla campanulate, bluish purple, 4-5 mm long and broad, finely pubescent petals barely fimbriate; stamens and style exserted 1-3.5 mm, the anthers yellow, filaments bluish; style ca. 6 mm long, bifid 1/2 its length, lower 1/2 glabrous and puberulent; capsule oval, 2.4-3 mm long and broad, glandular and puberulent; mature seeds 4, oblong, brown, 1.6-1.9 mm long, 0.9-1 mm wide, pitted over the entire surface, the ridge level with the margins and deeply excavated on both sides (Fig. 27). Collections: 3 (0); representative: C. Pringle 8988 (CAS, GH, MEXU, NY, POM, UC, US); G. Rzedowski 16995 (MEXU); Linsley et al. 8 (UC).

Habitat.—A weed of fields and road-sides as well as meadows and well-vegetated areas in the mountains, 7,350 to 8,500 feet. July to August.

Distribution.—Known only from the states of Hidalgo and Zacatecas, Mexico.

Greenman did not select a holotype but Pringle 8988 was cited and is probably the type material.
Phacelia coulteri is related to P. alba but differs from that taxon in having smaller seeds (2 mm long) and larger campanulate corollas (4.5 mm long). The stamens and style are exserted up to 3.5 mm, the corolla lobes are only shallowly erose, and the leaves are more finely dissected.


Plants annual, 0.25-8.3 dm tall; stems 1-several, simple to much branched, stipitate-glandular, setose or puberulent, reddish purple to green; leaves 0.4-1.2 dm long, 0.2-4.0 cm wide, strigose to setose and stipitate-glandular, sessile to petiolate; inflorescence of compound scorioid cymes, setose and stipitate-glandular, the pedicels 0.5-2 mm long; sepals cleft to near the base, the lobes elliptic to oblongellate, 3-3.5 mm long, 1-1.4 mm wide, glan
dular and setose; corolla campanulate to rotate-campanulate, violet, blue, or purple, pubescent, 4.5-10 mm long and broad; stamens and style exserted 5.5-11 mm; style bifid 3/4 its length, glandular below; capsule globose to subglobose, 2.6-4.1 mm long, 2-3 mm wide, puberulent and glandular; seeds 4, elliptic to oblong, 2-3.6 mm long, 1-2 mm wide, the dorsal surface with a dark center and lighter margins, the ventral surface corrugated.

14a. Phacelia crenulata var. angustifolia
Atwood, var. nov.

Phacelia crenulatae Torr. in Wats. var. crenu-
latae affinis sed brevioribus et ramosioribus,
mm long, 2-3 mm wide; seeds 4, elliptic, 2-3 mm long, 1-1.75 mm wide.

_type_.— Arizona: Coconino Co.: Small mesas just north of Wupatki National Monument Headquarters, sandy soil covered with volcanic ash, 18 May 1970, N.D. Atwood 2597 (Holotype: bry; Iso-
types: to be distributed).

Additional materials examined: Ar-
izona: Coconino Co.: D. Atwood 1784,
2602, 2600, 2606, 2604, 3650, 4559, 4555,
2597 (bry); L. Higgins 5187, 5396 (bry);
L. Williams 5993 (bry); L. Cureton 45
(bry). Utah: Beaver Co.: D. Atwood and
L. Higgins 3839 (bry). Garfield Co.: D.
Atwood 1356 (bry). Kane Co.: D. Atwood
1532B, 3603, 3612 (bry); L. Higgins and
D. Atwood 5247 (bry); R. Allen 211, 243
(bry).

Habitat.— Sandy, clay, or rocky
ground in the canyons and benches be-
low 5,000 feet elevation, April-June.

Distribution.— Coconino Co., Arizona,
north to Kane, Garfield, and Beaver cos.,
Utah (Map 11).

14b. Phacelia crenulata var. crenulata

*Phacelia crenulata* Torr. in Wats., Bot. King
Exped. 251. 1871. Holotype: Nevada: Per-
shing Co.: Trinity Mountains, May 1868,
S. Watson 873 (ny!); duplicates (gh, us).

*Phacelia crenulata* Torr in Wats. var. vul-
garis Brand, Das Pflanzenreich IV. 251:78.
1913.

*Phacelia crenulata* Torr. in Wats. var.
409, 600. 1935. Holotype: California: Mono
Co.: Black Canyon, White Mountains, 12
May 1930, V. Duran 561 (pom!); Isotypes
(b, cas, gh, ny, uc, us).

Plants annual. 0.25-8.3 dm tall; stems
1-several, simple or branched, puberulent,
pilose, setose and stipitate-glandular, red-
dish purple to green; leaves 0.4-1.2 dm
long, 0.5-4 cm wide, strigose to setose and
stipitate-glandular, sessile to petiolate; in-
florescence of compound scorpioid cymes,
puberulent to setose and stipitate-glandu-
lar, the pedicels 0.5-2 mm long; sepals
elliptic to oblong, 3.5-3.3 mm long,
1.4-4 mm wide, setose and stipitate-glandu-
lar; corolla campanulate to rotate-cam-
panulate, blue, pale purple, or violet, pub-
escent, 4.5-7 mm long and broad; stamens
and style exserted 5.5-11 mm; style bifid
3/4 its length, glandular pubescent below;
capsule globose to subglobose, 2.6-4.1 mm
long, 2.3-3.2 mm wide, puberulent and
glandular; seeds 4, elliptic to oblong, 2.8-
3.6 mm long, 1.2-2 mm wide, the dorsal
surface with a dark center and light mar-
gins, the ventral surface corrugated (Fig.
29). Collections: 124 (13): representa-
tive: Lemmon s.n. (us); C. Purpus 5976
(uc); J. Howell 26588 (Cas); C. Purpus
s.n. (uc); D. Atwood 2597, 2600, 2623

Map 11. Utah, Nevada. Arizona, and Cali-
ifornia. Distribution of *P. crenulata* var.
*crenulata* •; var. *augustifolia* *

---

Fig. 29. Dorsal and ventral view of the
seeds of *P. crenulata* Torr. in Wats. var. *crenu-
*lat*a. D. Atwood 2623 (bry).

---
Phacelia crenulata was described from immature specimens (lacking seeds) in the northern part of its range in northwestern Nevada. This has resulted in some confusion as to its relationship to such other closely allied species as P. corrugata A. Nels. and P. ambigua Jones. Examination of specimens from Pershing Co., Nevada, as well as surrounding counties, reveals that P. crenulata is quite distinct from both P. corrugata and P. ambigua. However, there is some overlap in morphological characters where the species grow together. For the most part P. crenulata differs from P. ambigua in its reddish, usually simple and only slightly setose stems, and its distinctive seed characters. P. corrugata is easily distinguished by its yellowish green stems, uniformly fine-glandular pubescence, and distinctive seed.

The type of var. funera Voss appears to be morphologically the same as the type of P. crenulata. The author has been unable to study this complex in the field; when field observations and greenhouse studies have been accomplished, a change in taxonomic status may be necessary. However, until such studies are carried out, the present arrangement seems the most natural.

15. Phacelia denticulata Osterhout


Annual plants, 0.5-5.4 dm tall; stems erect, simple or sometimes branched, setose and stipitate-glandular; leaves oblong to oblanceolate in outline, pinnately cleft or divided, 1.7-5 cm long, 0.5-4.5 cm wide,
strigose and stipitate-glandular; inflorescence of terminal scorpioid cymes, the longer cymes becoming 10 cm long in fruit; sepals narrowly linear to oblanceolate, 2.5 mm long in flower, 5-6 mm long in fruit, 0.8-0.9 mm wide, setose and stipitate-glandular; corolla tubular, light blue, 3.5-4.5 mm long, 2.3 mm wide, the lobes short, denticulate; stamens included; style included, bifid, glandular at base; capsule ovoid, 5 mm long, 3.5-5 mm wide, pilose and glandular; mature seeds 4, elliptical to oblong, brown, 4 mm long, 1.7 mm wide, ventral surface slightly excrated on each side of the curved ridge, alveolate, dorsal surface alveolate (Fig. 31).

Collections: 61 (7); representative: H. Ripley and R. Barneby 7525 (CAS, NY); W. Weber 5974 (CAS); C. Shear 3306 (NY); A. Nelson 1361 (RM); D. Atwood 1941, 1946, 1959, 1973 (BRY).

Habitat.—Gravelly, sandy, or clay banks, draws and flats of the prairie to higher mountain slopes from 6,800 to 9,700 feet. Commonly as understory of Quercus, Cercocarpus, Artemisia, and Pinus edulis. Frequently associated with Populus tremuloides and Pseudotsuga at the higher elevations, June to September.

Fig. 31. Dorsal and ventral view of the seeds of P. denticulata Osterhout. D. Atwood 1973 (BRY).

**Fig. 32**

**Phacelia formosula** Osterhout

Annual, 1.5-2.2 dm high, up to 3 dm broad; stems single or branched throughout (especially at base), glandular and hirsute, somewhat grayish; leaves lanceolate or elliptical, 3-7 cm long (up to 4.5), 1-3 cm wide, pinnately divided, strigose, hirsute and glandular; inflorescence of compound scorpioid cymes, cymes up to 5 cm long in fruit, and more densely glandular than the stems; sepals 3.2-3.8 mm long, 0.5-0.8 mm wide, glandular and hirsute; corolla campanulate, violet, 6 mm long, 6 mm wide, slightly glandular and pilose; stamens and style long exserted; style ca. 2 mm longer than the stamens and puberulent throughout; capsule oblong to oval, 3.5 mm long, glandular and hirsute; mature seeds 4, oblong, dark brown, 2.5-3 mm long, 1.2-1.4 mm wide, excavated ventrally on each side of the ridge, pitted, dorsal surface pitted, margins rounded and smooth. Collections: 7 (2); representative: D. Keck 889 (CAS, UC); H. Ripley and R. Barneby 9008 (CAS); D. Atwood 1977, 1977a (BRY).

HABITAT.— Loose sandy soil of sandstone bluffs at an elevation of 8,300 feet. Associated with Artemisia and Tetradymia, July to August.

DISTRIBUTION.— Apparently confined to Jackson Co., Colorado.

This species appears to be most closely related to P. glandulosa Nutt. but can be distinguished from that species by its usually much-branched, erect to spreading habit, less exserted stamens and style, darker seeds, narrower calyx lobes, and more pubescent style. P. glandulosa is a somewhat variable species, and P. formosula may, perhaps, best be treated as a variety of it; however, additional materials and field work are necessary before this suggestion can be confirmed.

17. Phacelia glandulosa Nutt.

Fig. 33


Phacelia glandulosa Nutt. subsp. eu-glandulosa Brand var. descima Brand.

Das Pflanzenreich IV, 251.82. 1913.

Plants annual or possibly biennial, 0.6-3.6 dm tall; stems simple or branched, erect, densely stipitate-glandular and hirsute; leaves lanceolate to oblong in outline, pinnatifid, 1-7 cm long, 0.5-3 mm wide, glandular and densely hirsute, the lower petiolate, the upper subsessile; inflorescence of congested terminal compound scorpioid cymes, stipitate-glandular and hirsute, 1-1.5 mm long, cymes elongating to 6.5 cm in fruit; sepals elliptical to ob lanceolate, 3-4 mm long, 1.2-1.4 mm wide; corolla campanulate, purple to bluish. 5-7 mm long and broad, the lobes pubescent and often more or less crenate; stamens and style exserted 5-9
Fig. 33. *Phacelia glandulosa* Nutt. Hitchcock 10804 (uc).

mm, the style bifid 3/4 its length, the lower 1/4 pubescent; capsule subglobose, 3.5-4 mm long, 3.2-3.3 mm wide, glandular and pubescent; mature seeds elliptic to oblong, reddish brown, 2.4-3.3 mm long, 1.1-1.4 mm wide, pitted, the ventral surface excavated on both sides of the ridge (Fig. 34). Collections: 25 (1); representative: E. Graham 9774 (cas, us); R. Davis 585 (us); H. Ripley and R. Barneby 8826 (cas, ny); S. Watson 281 (gh, us); A. Rudvalis 70 (bry); H. Fitch s.n. (cas, ny, pom); A. Williams s.n. (ny).

Habitat.—Rock slides, sandy talus slopes, and clay knolls from 5,000 to 7,050 feet. Mid-June to early August.

Distribution.—West of the Continental Divide in Rio Blanco Co., Colorado, northward to southwestern and western Wyoming, southwestern Montana, and central Idaho in Lemhi and Custer cos. (Map 13). For a discussion of this taxon see *P. formosula*.

18. *Phacelia howelliana* Atwood

Fig. 35


Plants annual, 0.9-2.3 dm tall; stems mostly branched and leafy toward the base, glandular and hirsute; leaves broadly oblong to oval, 2.0-6.0 cm long, 1.0-2.5 cm wide, irregularly crenate to lobed, strigose and slightly glandular, the petiole up to 5 cm long; inflorescence of compound scorpionid cymes; pedicels up to 2 mm long; sepals linear to narrowly oblanceolate, 3.5-4.5 mm long, 1.0-1.2 mm wide, glandular and hirsute; corolla 5-6 mm long, 6-7 mm wide, rotate to funnelform, the lobes light violet to blue, the tube white; stamens and style exserted 3-4 mm, style shorter than the stamens, bifid 3/4 its length, lower 1/4 pubescent; capsule oblong to subglobose, glandular and hirsutulous, especially toward the apex; seeds 4, brown, 3.2-4 mm
Fig. 35. *Phacelia howelliana* Atwood. D. Atwood 2454 (BRY).

long, 1.4-1.8 mm wide, elliptical, the margins corrugated, involute to flattened, ventral surface pitted, excavated, and divided by a prominent ridge, the ridge sometimes curved to one side and barely corrugated, dorsal surface reddish brown, smooth and surrounded by a lighter margin (Fig. 36). Collections: 16 (3): representative: S. Welsh, D. Atwood and G. Moore 9957 (BRY); A. Eastwood s.n. (NY); B. Harrison 11244 (BRY); C. Hansen 101 (BRY); M. Jones s.n. (POM); D. Atwood 2511 (ARIZ. ASC. B. BRY. CAS. DIXIE. GIL. JEPS. NY. POM. RM. RSA. UC. US. UT. UTC. WSC); J. Howell 24689 (CAS).

Habitat.—Red sandy, gravelly, or clay soils at ca. 4,500 to 5,000 feet.

Distribution.—Known only from San Juan and Grand cos., Utah. It probably grows in Colorado near Moab and also
Monument Valley in Arizona, although no specimens have been seen from either area (Map 14).

This entity is related to *P. corrugata* A. Nelson which grows throughout most of Utah and extends to Colorado, northern New Mexico, and northern Arizona. It is distinguished from *P. corrugata* by its low, much-branched growth form and smaller corolla with a white tube. The leaves are mostly basal, and the seeds are larger and reddish brown.


Plants annual (possibly biennial in var. *tecana*), 1.2-6 dm tall, stems stout, green to reddish brown, simple or branched, puberulent, stipitate-glandular and hirsute; leaves simple, crenate to somewhat cleft, oblong to ovate or lanceolate, strigose, finely glandular, setose, lower leaves long petiolate, the upper short petiolate to sessile; inflorescence of compound scorpioid cymes, the cymes elongating to as much as 2.1 dm in fruit, pedicels 0.5-2 mm long; sepals elliptical to ob lanceolate, 2.5-6.5 mm long, 0.9-2.8 mm wide, often reddish, puberulent, hirsute and stipitate-glandular; corolla campanulate, purplish to lavender, 4.5-6.5 mm long and broad, the lobes crenulate, pubescent; stamens and style exerted 4-6.5 mm; style bifid 2/3-3/4 its length, pubescent below, the filaments purplish, the stamens bluish green; capsule ovoid to globose, 2.6-5.3 mm long, 1.1-3.5 mm wide, glandular and puberulent; mature seeds ovate or elliptic to oblong, reddish brown or dark brown to black, 2.4-4.5 mm long, 1.3-2.2 mm wide, the dorsal surface pitted and transversely ridged, the margins more finely pitted than the...
excavated portions (these tending to have transversely elongate pits), the ventral surface excavated on both sides of the ridge, corrugated or corrugations lacking.

Key to the varieties of *P. integrifolia*

1a. Mature seeds 3 mm long or less, 1.4 mm wide or less, ventrally corrugated; capsule 3.1 mm long or less; plants of southeastern New Mexico and adjacent Texas

1b. Mature seeds 3.1 mm long or more, 1.7 mm wide or more, ventral corrugations lacking; capsule 3.2 mm long or more; plants widespread in rocky to sandy soil

19a. var. *integrifolia*

Fig. 37


Plants annual, 1.6-6 dm tall; stems puberulent, finely to densely stipitate-glandular and hirsute; leaves 1-13 cm long, 0.5-3 cm wide; cymes elongating to 2.1 cm in fruit, pedicels 1 mm long; sepals oblanceolate to elliptic, 3.5-4.5 mm long (4.4-6.5 mm in fruit), 1-1.8 mm wide (1.1-2.8 mm in fruit); corolla 5-6.5 mm long and broad; stamens and style exserted 5-6 mm; capsule ovoid to globose, 3.2-5.3 mm long, 3-3.5 mm wide; mature seeds oblong to elliptic, dark brown to black, 3.1-4.5 mm long, 1.7-2.2 mm wide, transverse ridges on the dorsal surface quite distinct, the ventral surface lacking corrugations, the ridge often curved to one side (Fig. 38). Collections: 113 (23); representative: L. Higgins 3138, 3129, 3131 (BRY); D. Atwood 2555, 2556, 2278, 2275, 2273, 2169 (B, BRY, CAS, NY, WTS); D. Atwood 2265, 2263, 2557a, 2274, 2171 (BRY).

Habitat.—Sandy hills and flats, rocky hillsides of *Lucerne, Yucca, Quercus*, *Coleogyne*, and grass communities. From 3,750 to 7,500 feet, late March to mid-September.

Distribution.—Southeastern Utah in Kane and San Juan cos., southward through northeastern Arizona, eastward through much of New Mexico to western Texas and Chihuahua, Mexico (Map 15).
and appear to be tubular. Var. integrifolia has a broad distribution and is easily distinguished by its large, broad, noncorrugated seeds. Plants from the higher elevations in western New Mexico and eastern Arizona are different morphologically. Additional field work is necessary to decide whether these differences are sufficient to warrant taxonomic recognition.

19b. var. texana (Voss) Atwood, new comb.


Plants annual or possibly biennial, 1.2-4.3 dm tall; stems puberulent, densely covered with short stipitate glands (usually 0.2 mm long or less) and sometimes with a few scattered longer, simple hairs; leaves 1-10 cm long, 0.3-2 cm wide, stipitate-glandular (0.2 mm long or less), and puberulent; cymes elongating to 1.4 dm in fruit, pedicels 0.5-1.2 mm long; sepals elliptical to oblanceolate, more or less heteromorphic (two narrow and three broad), 2.5-3 mm long (3.5-5.5 in fruit), 0.9-1.4 mm wide (1.2-2 in fruit) puberulent, stipitate-glandular, and setose; corolla 4.5-6 mm long and broad; stamens and style exserted 4-6.5 mm; capsule globose, 2.6-3.2 mm long, 1.1-2.6 mm wide; mature seeds ovate, reddish brown, 2.4-3 mm long, 1.1-1.4 mm wide, transverse ridges on the dorsal surface only fairly distinct, the ventral surface corrugated on the ridge and part of the margin. Collections: 38 (0); representative: C. Cory 37574 (UC); H. Wilkens 2209 (UC); L. Higgins 3157 (BRY, WTS); T. Collins 1182 (UC); U. Waterfall +558 (GH, CAS, NY); R. McVaugh 8163 (UC).

HABITAT.—Gypsum, limestone, and calcareous soils in mixed shrub communities. Commonly associated with Larrea, Fouquieria, and Acacia. 2,550 to 6,850 feet elevation. Late April to early October.

DISTRIBUTION.—Southeastern New Mexico and adjacent Texas (Map 15). Var. texana differs morphologically from var. integrifolia in seeds and size of capsule. The corollas of var. texana appear to be lavender in contrast to the pur-
plish corollas of the latter. Jones (1931) indicated that he had collected the type at Findlay, correctly spelled Finlay. The correct collection number is 28500 rather than 285ae as cited by Voss (1937).

20. Phacelia intermedia Wooton

*Fig. 39*


Plants annual, 0.6-3.6 dm tall, stems simple or branched, often reddish, puberulent with short stipitate glands; leaves narrowly oblong, elliptic to ovate-lanceolate, sinuate to deeply lobed or pinnatifid, 0.5-8 mm long, strigose and stipitate-glandular or glandular, petiolate to sessile above; inflorescence of compound scorpioid cymes, terminal on the main stem and lateral branches, the cymes up to 1.5 dm long in fruit, pedicels subsessile to 1 mm long in flower, slightly longer in fruit; sepals linear to oblanceolate, 2.5-3.7 mm long, 1.3-1.5 mm wide, setose and glandular; corolla bluish violet, 6 mm long or less, campanulate, pubescent, the lobes crenate to entire; stamens and style exserted 3 mm or less, filaments violet, anthers yellow, style violet, bifid 2/3 its length, the lower 1/3 glandular and puberulent; capsule oval, 3 mm long and broad, glandular and puberulent; mature seeds ovate, 2.7-2.9 mm long, 1.5-1.6 mm wide, dark brown, pitted, ventral surface corrugated on one side of the ridge, both margins and partly to completely across the excavations (Fig. 40).

Collections: 34 (7); representative: E. Wooton s.n. (us!); D. Atwood 2554, 2560, 2570, 2565, 2572, 2557, 2170. (BRY); I. Higgins 3118, 3114 (BRY, wts); H. Bobish 149 (NM).

**Habitat.**— Sandy to gravelly or clay soils of foothills and higher mesas from 3,750 to 5,000 feet. Often associated with *Laurea* and *Prosopis*, March to May.

**Distribution.**— Central New Mexico, southward to western Texas and northern Mexico (Map 16).

This taxon is related to *P. corrugata* but is distinguished from it by the smaller, darker, and more distinctly corrugated seeds, smaller, lighter corolla, and shortly exserted stamens. It has been confused to some degree with *P. bombycina* W. & S., but is easily separated from it by seed, pubescence, and vegetative features.

21. Phacelia mamillarcus Atwood

*Phytologia* 26 (6): 437. 1973

**Fig. 41**

Holotype: Utah: Kane Co.: Tropic Shale formation ca. 6 mi east of Glen Canyon City, along road to Warm Creek, S. Welsh and D. Atwood 9809. (BRY); Isotypes (ARIZ, ASU, BRY, GIL, RM, UC, UT, UTC).
Fig. 40. Dorsal and ventral view of the seeds of *P. intermedia* Wooton. D. Atwood 2557 (BRY).

Plants annual, 0.9-5 dm tall; stems erect or sometimes branched below, yellowish or green, densely stipitate-glandular; leaves simple, oblong to lanceolate, irregularly crenate to dentate, 1-7 cm long, 0.5-3 cm wide, stipitate-glandular, setose to strigulous, with sessile leaves or nearly so; inflorescence of terminal or lateral compound scorpionoid cymes, stipitate-

Map 16. New Mexico and western Texas. Distribution of *P. intermedia* Wooton.

Fig. 41. *Phacelia mammillarensis* Atwood. Atwood 2632 (BRY).

with glandular, puberulent, hirsute to setose; sepals elliptic to oblanceolate, 4-6 mm long, 1-2 mm wide, stipitate-glandular, and hirsute to setose; corolla tubular to funnelform, the lobes pale blue to white, 5-8 mm long; stamens and style exerted 5-10 mm, the anthers lavender, the style bifid ca. 1/2 its length, the lower 1/4 pubescent; capsule subglobose, 4-5 mm long, pubescent; seeds 4, 3 mm long, 1.5 mm wide, brown, pitted dorsally, ventral surface pitted, excavated, and divided by a prominent ridge, one side of
the ridge corrugated, margins corrugated. Collections: 20 (15); representative: D. Atwood 2628, 2632, 1874, 1878, 4553, 3743, 3835 (Bry); B. Olsen 3† (Bry).

HABITAT.— Endemic to the Tropic Shale-Kaiparowits formations.

DISTRIBUTION.— Kane and Garfield cos., Utah, May-June.

Phacelia mammillarcensis is related to P. corrugata Nelson but differs in its larger stature, sessile leaves (at least above), light blue to whitish corolla, and larger, more densely stipitate-glandular pubescence. The leaves are not deeply lobed or pinnate as is typical in many plants of P. corrugata.


Plants annual, 0.8-6.8 dm tall; stems erect to sparsely branched, setose and with small stipitate-glandular hairs, often reddish, leafy; leaves pinnate, the secondary pinnae irregularly incised, 3-8.5 cm long, 1.4-5 cm wide, strigose and stipitate-glandular, petiolate, the petiole 1.5 cm long or less; inflorescence terminal on the main stem and lateral branches (sometimes arising from the axils of the uppermost leaves), more glandular than the stem, the individual inflorescence branches with 1-3 cymes, the cymes up to 1 dm long in fruit, flowers congested and short pedicellate (0.5 mm long); sepals linear to narrowly obovate, 2.7 mm long in flower to 4.5 mm long in fruit, setose and heavily glandular; corolla campanulate, blue, ca. 4 mm long, ca. 3-3.5 mm wide, the lobes pubescent and erose; stamens exerted 1 mm, 4.5 mm long bifid 3/4 its length, glandular on the lower 1/4; capsule oval to elliptic, 4.5-4.7 mm long, 3 mm wide, setose and heavily glandular, the raphe obovate, mature seeds 4, oblong, brown (immature seeds mottled with dark areas), 3.2-3.3 mm long, 1.1-1.5 mm wide, alveolate, ventral surface excavated on both sides of the ridge, alveolate. Collections: 20 (0); representative: H. Ripley and R. Barneby 5096 (RSA); W. Chapman s.n. (US); E. Greene s.n. (NY); O. Metcalfe 1506 (CAS, GH, NY); E. Wooton s.n. (US); E. Castettes 4852 (US); B. Dunn 6208 (NY).

HABITAT.— Pine and oak woods in canyons and on mountain slopes, in rocky to sandy soils, from 6,800 to 9,000 feet, late July to mid-October.

DISTRIBUTION.— Apache Co., Arizona, eastward to New Mexico in Grand, Otero, Socorro, Lincoln, Torrance, Bernarillo, and Taos cos. (Map 17).

P. neomexicana is apparently most closely related to P. denticulata but differs from that species in its exerted stamens and style, smaller and more deeply excavated seeds. The style is also longer (4.5 mm) and the corolla is campanulate.

23. Phacelia pallida Johnston

Perennial plants. 1.3-3.5 dm tall; stems branched, especially at the base, erect to decumbent, puberulent, hirsute to setose with flattened multicellular stipitate glands; leaves simple, some of the lower with several small lobes borne on the petiole below the oblong, lanceolate to broadly elliptic blade, 1-7 cm long, 1-3 mm wide, long petiole below to short petiole above, strigose, glandular and setose, the margins irregularly crenate to sinuate; inflorescence terminal, racemose, puberulent to hispid (when old) and stipitate-glandular, cymes densely flowered, up to 15 cm long in fruit, pedicels 0.5-1 mm long; sepals oblanceolate to spatulate, 4-5 mm long, 1.4-1.7 mm wide, glandular, hirsute; corolla tubular to salverform, pale lilac, lavender, or white, 4.6 mm long, ca 4 mm wide; stamens and style exerted 5-7 mm, style bifid 3/4 its length, the lower 1/2 pubescent; capsule subglobose, 3.5-5.5 mm long, 2.4-2.6 mm wide, puberulent; mature seeds oblong to elliptic, brown to blackish, pitted, 2.6-3 mm long, 1.5-1.5 mm wide, the ventral surface excavated on both sides of the corrugated ridge, margins corrugated, dorsal surface transversely ridged. Collections: 6 (0); representative: C. Purpus 5084 (UC); O. Sperry 1694 (US); I. Johnston 8040, 8036 (GH).

Habitat.—Apparently *Phacelia pallida* is confined to gypsum and limestone soil.

Distribution.—Brewster Co., Texas, southward into Coahuila and Chihuahua, Mexico (Map 18).

*P. pallida* and *P. petiolarata* are known only from the type collections and appear to be the same entity. Therefore the author has placed *P. petiolarata* as a synonym of the former. Additional collections are needed.


![Map 18. Brewster County, Texas, Coahuila and Chihuahua, Mexico. Distribution of *Phacelia pallida* Johnston.](image)

types (GH, US).


Robust biennial. 2.9 dm tall; stems stout, usually solitary (sometimes with few to several branches at the base), densely glandular, hirsute and pilose, becoming hispid with age; leaves oblong to lanceolate, irregularly sinuate, crenate, dentate, or serrate, 2-13 cm long, 0.5-3 cm wide, lower densely tufted, petiole and larger than the sessile, gradually reduced cauline leaves, stipitate-glandular and strigose; inflorescence a dense spicate thyrsus, 0.4-4.2 dm long, individual scorpioid cymes up to 14 cm long in fruit, pedicels
about 1 mm long in fruit; sepals oblong to spatulate, 1.5 mm long, 1-1.8 mm wide, glandular to hirsute; corolla pale (white, lavender, or violet), tubular, 5-7 mm long, pubescent; stamens and style exerted 3-7 mm, style bifid, the unbranched portion pubescent; capsule globose, 3.2 mm long, glandular to hirsute;
mature seeds 4, elliptic, black, 2.5 mm long, 1.5 mm wide, excavated on both sides of the ridge, the ridge corrugated on one side, pitted, margins corrugated, furrows or grooves partly corrugated, dorsal surface longitudinally pitted and transversely ridged (Fig. 43). Collections: 5 (+ 16); representative: D. Atwood 1530, 1390, 1720, 1409 (bry); L. Higgins 817, 1244 (bry); D. Atwood and L. Higgins 1682 (bry, US); D. Atwood 1723, 1712 (bry, CAS, GH, NY, RM, US).

Habitat.— Mostly on barren to sparsely vegetated gypsum flats, washes, and hillsides but not uncommon on rocky to sandy soil. In Diamond Valley (north of St. George) it grows on volcanic cinder cones, at 2,700 to 5,000 feet elevation, late March to August. Commonly associated with Larrea, Juniperus, Cowania, Fallugia, and Atriplex.


P. palmeri is related to P. constancei Atwood but differs in having taller stems, larger and less revolute leaves, and coarser and longer hair. The lateral branches are fewer and less leafy, and the stems lack the reddish color characteristic of the latter. Both species occur on the Moenkopi formation but have different ranges. A form from Lake Mead, Arizona (E. U. Clover 6470 & 6230), has seeds that are not corrugated and are smaller and narrower (2.0 mm long and 1.2 mm wide), dark dorsally but brown ventrally with darker glands. However, in the material from Glendale, Nevada, the seeds are dark dorsally and lighter ventrally and are less corrugated than in typical material.

25. Phacelia pedicellata Gray

Phacelia pedicellata Gray, Syn. Fl II. 1:160. 1878. Holotype: Mexico: Baja California: Lower California, 1875, Dr. Streets s.n. (GHI!); Isotype (us).

Plants annual, 1-6 dm tall; stems branching or sometimes simple, brittle, villous to setose with multicellular stalked glands; leaves suborbicular to oblong, pinnately compound with 3-9 pinnae, 0.3-1.3 cm long, 1.5-11.5 cm wide, villous to setose and glandular; inflorescence of compound cymes, somewhat dichotomously branched; pedicels filiform, 2.6 mm long, densely setose to hisrate; sepals linear to oblanceolate, 2.8-7.9 mm long, 0.6-2 mm wide, setose to hisrate and glandular; corolla lobes lavender, violet, or white, the tube white, ca. 5 mm long and broad; stamens and style exserted, style pubescent, upper
Habitat.— Dry gravel and sandy washes, often in the shade of large boulders, limestone cliffs, and as understory of larger plants, below sea level in Death Valley to 5,000 feet elevation. It has been collected in the middle of February in Mexico but usually flowers from March to the middle of June.

Distribution.— Southern Nevada in Nye and Clark cos., southward through San Bernardino to central Baja California, eastward to Coconino, Graham, Gila, Pinal, and Pima cos., Arizona (Map 20).

Phacelia pedicellata is most closely related to P. scariosa but differs in having narrower, longer, and more pubescent calyx lobes, a more compound and congested inflorescence, and a heavier, glandular, villous, and setose pubescence. The leaves have 3-9 pinnae, whereas those of P. scariosa have only 3-5 lobes, and the style is more pubescent. That they are related is indicated by the similar seeds, corolla, pedicels, and brittle stems.

26. Phacelia popei Torr. & Gray


Phacelia popei Torr. & Gray var. similis

1/3 bifid; capsule globular, 3.3-3.4 mm long, 2.3-2.5 mm wide, pilose to glandular; mature seeds 4 elliptical, 3 mm long, 1.1-1.8 mm wide, ventral surface excavated, pitted to tuberculate, the ridge corrugated on one side, dorsal surface tuberculate and pitted, margins corrugated (Fig. 45). Collections: 155 (3); representative: A. Eastwood 17400 (CAS, NY, US); M. Jones s.n. (POM, UTC); W. Cottam 13125 (UTC); T. Brandegee s.n. (NY); H. Ripley and R. Barneby 2952 (RSA); J. Howell 3952 (UTC); D. Atwood 2339 (BRY); S. Welsh, D. Atwood and E. Matthews 9633 (BRY).

Fig. 44. Phacelia pedicellata Gray. W. Jesson 12482 (CAS).

Fig. 45. Dorsal and ventral view of the seeds of P. pedicellata Gray. M. Beal (JEPS).
branched from the base, 0.5-3.6 dm tall, with simple spreading or bent hirsute and somewhat glandular hairs intermixed with a finer pubescence; leaves narrowly oblong, pinnate to bipinnate, with linear or lanceolate divisions, 2-15 cm long, 1-3 cm wide, petiolate, strigose to glandular, except on the petioles and then like that on the stems; inflorescence of compound scorpoid cymes, the cymes crowded, terminal, up to 10 cm long in fruit, glandular and hirsute, flowers nearly sessile (pedicels ca. 0.5 mm long); corolla campanulate, blue to purplish, 3.5-7 mm long and broad, pubescent; sepals oblanceolate to spatulate, somewhat keeled (at least at the base), 2.3-3.9 mm long, 1-1.8 mm wide, glandular, hirsute; stamens and style exerted, style exerted ca 2 mm longer than the stamens, bifid 2/3 its length, lower 1/3 pubescent; capsule globose, 2.3-2.5 mm long, 2.4-3.1 mm wide, glandular and pilose; mature seeds 4, cymbiform, ovate, brown, 1.8 mm long, 1.4 mm wide, favose to reticulate, ventral surface deeply excavated on both sides of the ridge, dorsal surface reticulate and transversely ridged (Fig. 47). Collections: 150 (11); representative: D. Atwood 2096a, 2095, 2268, 2266, 2153, 2159, 2131, 2133, 2134 (BRY); L. Higgins 3083, 3025 (BRY, WTS); R. Barneby 12593 (CAS, NY); M. Jones 25750 (POM); A. Hershey s.n. (CAS).

Habitat.— Commonly in sandy or sandy clay soil of roadides. Less commonly in limestone or rocky soil and associated with *Larrea, Prosopis, Yucca* or short grass prairie. Mid-February to late May.
Fig. 47. Dorsal and ventral view of the seeds of P. popei Torrey & Gray. V. Cory 13616 (GH).

**DISTRIBUTION.**—West central Texas from Dickens and Lubbock cos. southward to southwestern Texas, westward to New Mexico from Roosevelt Co., westward to Sierra and Luna cos., Nuevo León, Mexico (Map 21).

Wooton and Standley (1909), in their original description, indicated that *P. silis* was most closely related to *P. arizonica* but failed to mention *P. popei*. Comparison of the type material of the two entities leaves little doubt that they are identical. Also, *P. arizonica* is very distinct from *P. popei*. Torrey and Gray (1885), in their original description of *P. popei*, indicated that the corolla was "apparently white." I have seen this taxon in the field in Texas and New Mexico and find that the corolla is not white or only seldom so. The flowers of some specimens turn white upon drying, and this may have been the case with the type material.

27. *Phacelia rafaelensis* Atwood


Map 21. New Mexico, Texas, and Nuevo León, Mexico. Distribution of *P. popei* Torrey & Gray.

Fig. 48. *Phacelia rafaelensis* Atwood. D. Atwood and L. Higgins 1834 (BRY).
Erect biennial herb, 0.8-5.4 dm tall; stems stout, simple or sometimes branched at the base, olive green to brownish glandular, and hirsute; basal leaves petiolate, dentate, crenate to pinnatifid, 2-7 cm long; 0.5-1.5 cm wide, strigose to hirsute, cauline leaves sessile, undulate to crenate or dentate, oblong-lanceolate, 1-10 cm long, 0.5-3.5 cm wide, strigose to hirsute and sparsely stipitate-glandular; inflorescence mainly terminal, paniculate, some axillary, flowers nearly sessile; sepals oblanceolate to spatulate, 3-4 mm long in flower, 5-6 mm long in fruit, 1-1.7 mm wide, glandular and hirsute; corolla tubular, pale and grooved with the lobes somewhat spreading, 5-6 mm long; stamens and style exerted only 3-5 mm, anthers dull in color, style bifid 3/4 its length, the lower half pubescent; capsule globose, 4-5 mm long, stipitate-glandular and hirsute; mature seeds 4, elliptic to oblong, 3.5-4 mm long, 1.5-2 mm wide, ventral surface alveolate, lighter than the dorsal surface, excavated and divided by a prominent ridge, the ridge sometimes corrugated along one side, the margins usually entire, dorsal surface brown and less deeply pitted, the surface often smoothish (Fig. 49). Collections: 33 (19); representative: M. Jones s.n. (POM); H. Ripley and R. Barneby 4362 (RSA); W. Cottam 13313 (UT); D. Atwood 1530, 1853, 1843, 1855, 1847, 1703, 1417, 1698, 1860 (BRY); S. Welsh, D. Atwood, and G. Moore 9846, 9844, 9903 (BRY); D. Atwood 1390 (BRY).

Habitat.—Clay hills of the Moenkopi formation, May to June.


Phacelia rafaelensis is related to P. utahensis but differs in having a slightly tubular and grooved corolla, with the lobes somewhat spreading and the stamens and style exerted only 3-5 mm. The filaments and stamens are dull in color, and the ridge is sometimes corrugated.

28. Phacelia robusta (Macbr.) Johnst.

Fig. 50


Fig. 49. Dorsal and ventral view of the seeds of P. rafaelensis Atwood. S. Welsh et al. 9903 (BRY).

1917. Holotype: Texas; Presidio Co.: Chinati Mountains, no date, Harvard 250 (GH).

Robust. viscid annual or biennial, 4.5-12 dm tall; stems branched at the base or simple, brownish, puberulent, pilose and densely glandular, the glandular hairs flattened, stipitate, unicellular to multicellular; leaves broadly ovate to orbicular, irregularly crenate to sinuate, sometimes with a single lobe below the leaf blade, 2-11.5 cm long, 1.5-9 cm wide, gradually

Map 22. Southern Utah and northwestern Arizona. Distribution of P. rafaelensis Atwood.
reduced upwards, puberulent, stipitate-glandular, setose to hirsute, the lower long-petiolate to subsessile above; inflorescence of compound scorpioid cymes, the cymes up to 1.3 dm long in fruit, pubescence the same as that of the stem, pedicels 1-1.7 mm long; sepals spatulate, 4.5-5.8 mm long, 1.5-2.5 mm wide; corolla salverform, pale lavender, 5-6 mm long, ca. 4 mm wide, pubescent; stamens and style exserted 4-6 mm, style bifid 3/4 its length, lower 1/2 pubescent; capsule subglobose, 3.9-4.1 mm long, 2.8-3 mm wide, puberulent to strigose; mature seeds oblong to ovate, reddish brown, 2.9-3.7 mm long, 1.1-1.7 mm wide, ventral surface excavated on both sides of the corrugated ridge, pitted, the margins at least partly corrugated (Fig. 51). Collections: 36 (0); representative: C. Pringle 255 (UC, RSA); E. Palmer 34077 (NY); L. Hinckley 829 (GH, NY); U. Waterfall 7316, 8255, 8283 (UC); C. Smith 289 (UC); G. Stevens 1636 (GH, NY); L. Higgins 3256, 3182 (BRY, WTS).

HABITAT.— Gravelly sand bars, clay slopes, and rocky hills from ca. 3,500 to 6,000 feet elevation, March to August.

DISTRIBUTION.— Barber Co., Kansas, southward through Woods, Blaine, Custer, Washita, and Howard cos., Oklahoma, to north central and southwestern Texas and Chihuahua, Mexico (Map 23).

This taxon has been confused with P. intergrifolia, but it is easily recognized by the white, tubular corollas, robust habit, and larger, less glandular leaves. In seed characters, P. robusta is similar to P. intergrifolia var. texana. There appear to be several distinct entities included within this taxon. The material in north central Texas is disjunct in distribution from that in Presidio and Brewster cos., but additional material is needed to determine if there are sufficient morphological characters to delineate the populations. Also, specimens from southern Colorado and adjacent New Mexico appear to be different and need to be investigated further.

29. Phacelia rupestris Greene


Fig. 51. Dorsal and ventral view of the seeds of P. robusta (Macbride) Johnston. L. Hinckley 829 (NY).
Perennial plants (sometimes flowering the first year), 1-6 dm tall; stems 1-many, usually from a woody caudex, pubescence of whitish hairs, these hispid to setose and finer, sometimes glandular (these not multicellular glands); leaves pinnately compound, the terminal part incompletely 3-5 lobed and larger than the lower pinnae, 1.5-10 cm long, 1.5 cm wide, setose to densely pilose; inflorescence of terminal compound scorpoid cymes, individual cymes 1.5-4.5 cm long, pedicels 1.5-2.5 mm long; sepals linear to oblanceolate, 3-4.8 mm long, 0.5-0.8 mm wide, setose to hirsute; corolla campanulate, white, 2-4 mm long and broad, lobes pubescent; stamens and style exserted up to ca. 2 mm, anthers dull blue; style 3-6 mm long, bifid over 1/2 its length, the lower unbranched portion pubescent; capsule oval to ovate, 2.6-3 mm long, 2.1-2.5 mm wide, finely pubescent with a few long hairs near the apex; mature seeds 4, brown, 2.1-2.7 mm long, 1.1 mm wide, elliptical to oblong, reticulate scabrous, ventral surface excavated on both sides of the ridge (Fig. 52). Collections: 78 (1); representative: L. Goodding 2330 (GH, BM, UC); H. Rusby s.n. (CAS, US); B. Maguire 11204 (BR); A. Nelson 1248 (NY); C. Pringle 162 (MEXU, NY, US); E. Wooten s.n. (NY); D. Dunn 8525 (UC).

Habitat.— Growing on coarse, sandy soil and gravel bars, moist shady crevices of limestone cliffs, and ledges in canyons and arroyos, at 2,100 to 6,500 feet elevation. Flowering commonly occurs from late June to late August but sometimes as early as mid-March and as late as the last of October. Usually associated with Larrea, Acacia, Lippia, Fallugia, Chilopsis, and Opuntia at lower elevations and with Quercus, Cercocarpus, Juniperus, Pinus, and Fraxinus at higher elevations.

Distribution.— Southern New Mexico from Socorro Co. westward to Pinal, Pima, and Cochise cos., Arizona, and southward to south-western Texas and adjacent Mexico (Map 24).

This entity is closely related to P. congesta but differs in having smaller, white corollas, shorter and fewer flowered cymes, a perennial habit, and the absence of multicellular glands. At times it apparently flowers in the first year, at least in the more southern parts of its range.

30. Phacelia scariosa T. S. Brandegee


Fig. 53

Fig. 52. Dorsal and ventral view of the seeds of P. rupestris Greene. W. Eggleston 16341 (US).
GREAT BASIN NATURALIST

Vol. 35, No. 2

Plants annual, 0.5-4 dm tall; stems branching from the base (sometimes dichotomously), finely glandular and pilose; leaves ovate to oblong, deeply cleft to more often pinnately divided with 3-5 pinnae, terminal leaflet usually trifoliate and larger than the other leaflets, 1.5-8 cm long, 1.5-5.5 cm wide, strigose and somewhat glandular; inflorescence paniculate to racemose, glandular to villous, cymes elongate, open, up to 11 cm long, pedicels filiform, 3 mm long in flower, up to 8 mm long in fruit; corolla broadly campanulate, bluish to lavender, with white throat and tube, 4 mm long, 4-5 mm wide, pubescent; sepals obovate, 2-3 mm long in flower, becoming broadly obovate and conspicuously enlarged and scarious in fruit, 4.5-7.6 mm long, 2.3-3.7 mm wide, glandular to villous; stamens and style exserted 1-2 mm, style cleft 1.3 its length, lower 1.3 pubescent; capsule globular, 3.3-3.7 mm long, 2.6-3.5 mm wide, glandular to pilose; mature seeds 4, brown, elliptical, 2.5-3 mm long, 1.2-1.3 mm wide, ventral surface divided by a prominent ridge, pitted, margins corrugated, the ridge corrugated on one side, dorsal surface curved, pitted (Fig. 54). Collections: 42 (0); representative: C. Orcutt 13 (CAS, NY, US); M. Jones 24069 (POM, RM); T. Brandegee s.n. (UC); R. Moran 3890 (UC); D. Porter 236 (CAS, MEXU); F. Shreve 7023 (US).

Habitat.— Sandy, gravelly washes, rocky hillsides, and lava flows from 200 to 5,000 feet elevation. Apparently a winter annual, flowering from late October to mid-June.

Distribution.— Lower California and adjacent Sonora, Mexico (Map 25).

Phacelia scariosa is apparently related to P. pedicellata and is discussed under that species.


Fig. 53. Phacelia scariosa T. S. Brandegee. I. Wiggins 7887 (US).
ATWOOD: PHACELIA CRENLATAE GROUP

184, Lemmon and wife (uc, uc, us); Sunset Mountain, Flagstaff, 21 August 1915, H. Rusby s.n. (NY).

Phacelia macdougallii Heller in Brand. Das Pflanzenreich IV. 251:80. 1913, as synonym.

Annual plants, 1-3.4 dm tall; stems erect, simple or branched at the base, with simple setose, hirsute and multicellular

Fig. 54. Dorsal and ventral view of the seeds of P. scariosa Brandegee. J. Johnston 3884 (CAS).

Map 25. Baja California and Sonora, Mexico. Distribution of P. scariosa Brandegee.

31. Phacelia serrata Voss

Fig. 55


Fig. 55. Phacelia serrata Voss. J. T. Howell and G. True 45184 (CAS).
glandular hairs; leaves lanceolate, serrate, dentate to shallowly lobed, 1.4 cm long, 0.5-2 cm wide, with a basal leaf cluster, especially when young, gradually reduced upward, the upper sessile or nearly so, the lower with a petiole up to 1.5 cm long, setose, hisurate and glandular; inflorescence of compound scorpionoid cymes, setose, puberulent with multicellular stipitate glands, pedicels up to 1 mm long; sepals elliptical to oblanceolate, more or less keeled at the base, 3.5-6.5 mm long, 1.5-2 mm wide, setose, puberulent and stipitate-glandular; corolla rotate (appearing tubular in some pressed specimens), blue to light violet, 3-4 mm long and broad, pubescent; stamens and style exerted, style bifid 3/4 its length, lower 1/4 pubescent; capsule subglobose, 2.8-3.5 mm long, 2-2.5 mm wide, glandular and puberulent; mature seeds 4, elliptical to oblong (sometimes unequally so when one of the margins is involute), dark brown, 3-3.2 mm long, 1-1.3 mm wide, excavated and divided by a prominent ridge, the ridge corrugated on one side, the margins corrugated, pitted and often one or both involute, dorsal surface smooth and shiny to somewhat dull, sometimes faintly pitted, the tip and margins darker for part of their length (or at least different in appearance from the rest of the dorsal surface). Fig. 56. Collections: 15 (2); representative: J. Hill s.n. (US); L. Goodding 1526 (UC); D. Atwood 2586 (BRY); D. Dunn 1264+ (RSA); H. Hansen 615 (RIL); J. Howell and G. True (BRY, CAS).

Habitat.— Confined to volcanic scoria slopes of open yellow pine forest and juniper flats and hills. Flowering from late June to mid-September, 5,900 to 7,150 feet.

Distribution.— In and around Sunset Crater National Monument and San Francisco Mountains north of Flagstaff, Coconino Co., Arizona.

The relationships of this entity to other taxa in this group are questionable at the present time. Part of the paratype material cited by Voss (1937) belongs to P. palmeri. The specimen in question is Palmer 335 (GH, NY) and was probably collected in southern Utah or the extreme northern part of Arizona in Mohave Co. The label bears the data southern Utah-northern Arizona. Brand (1913) mad-

vertently listed P. macdougalii as a synonym of P. integrifolia Torr. even though it was only a manuscript name and had never been published. I have seen the specimens in question and conclude that they are referable to P. serrata Voss. Voss (1937) described P. serrata but failed to mention P. macdougalii.

32. Phacelia splendens Eastwood

Fig. 57


Plants annual, 0.5-2.7 dm tall; stems erect, simple or branched leafy, puberulent, with scattered stipitate-glandular hairs; leaves pinnatifid, 2.7-5.5 cm long, 0.7-4 cm wide, petiolate, leaf blade essentially glabrous (pubescent only on the petiole and rachis or lower portion of the pinnae); inflorescence terminal on each branch and the main stem, cymes compact and densely flowered, pedicels short but lengthening to as much as 1.7 mm in fruit, slightly more pubescent than the stem; sepals linear to narrowly oblanceolate, 2.5-3 mm long in flower, 4-4.4 mm long in fruit, 0.6-1 mm wide, hisurate and with a few scattered glandular hairs; corolla campanulate, the lobes bright blue, the tube yellowish, 4-8 mm long and broad, glabrous to sparsely pubescent; stamens and style exerted 7-11 mm, the filaments blue, anthers yellow, style bifid ca. 2/3

Fig. 56. Dorsal and ventral view of the seeds of P. serrata Voss. J. T. Howell and G. True 45184 (BRY).
Phacelia splendens Eastwood

Fig. 57. Phacelia splendens Eastwood R. Barneby 12797 (CAS).

Fig. 58. Dorsal and ventral view of the seeds of P. splendens Eastwood. D. Atwood and L. Higgins 12743 (CAS, NY, RSA); E. Payson 671 (GH).

33. Phacelia utahensis Voss

Fig. 59


Plants stout, erect annuals, 0.8-5.8 dm tall; stems usually simple, sometimes branched at the base, brownish to yellowish, densely glandular and finely pubescent; leaves linear to narrowly lanceolate, strigose to ciliate on the margins, with scattered glands (especially the upper), 1.5-12 cm long, 0.5-1.5 cm wide, the mar-

feet elevation. Commonly associated with Atriplex, but in Mesa Verde National Monument it was collected in pinyon-juniper. Mid-May to mid-July.

**DISTRIBUTION.**—Known only from western and southwestern Colorado and northwestern New Mexico (Map 26).

This species is related to *P. corrugata* and *P. utahensis* and may be a link between the two complexes. It can be distinguished from the former by its nearly glabrous and more-divided leaves, yellowish corolla tube, and different-textured and less-corrugated seeds. From the latter, it differs in having a shorter and less-glandular indument, a less-robust and less-branched habit, and different seeds. The seeds were reported by both Eastwood (1893) and Voss (1937) as lacking corrugations. Observations of mature seeds of *P. splendens* demonstrate that there definitely are evident corrugations on one side of the ridge and sometimes on one of the incurved margins.

33. **Phacelia utahensis** Voss

Fig. 59


Plants stout, erect annuals, 0.8-5.8 dm tall; stems usually simple, sometimes branched at the base, brownish to yellowish, densely glandular and finely pubescent; leaves linear to narrowly lanceolate, strigose to ciliate on the margins, with scattered glands (especially the upper), 1.5-12 cm long, 0.5-1.5 cm wide, the mar-

feet elevation. Commonly associated with Atriplex, but in Mesa Verde National Monument it was collected in pinyon-juniper. Mid-May to mid-July.

**DISTRIBUTION.**—Known only from western and southwestern Colorado and northwestern New Mexico (Map 26).

This species is related to *P. corrugata* and *P. utahensis* and may be a link between the two complexes. It can be distinguished from the former by its nearly glabrous and more-divided leaves, yellowish corolla tube, and different-textured and less-corrugated seeds. From the latter, it differs in having a shorter and less-glandular indument, a less-robust and less-branched habit, and different seeds. The seeds were reported by both Eastwood (1893) and Voss (1937) as lacking corrugations. Observations of mature seeds of *P. splendens* demonstrate that there definitely are evident corrugations on one side of the ridge and sometimes on one of the incurved margins.
gins often revolute, crenate, undulate to irregularly dentate, basal ones petiolate and dense, the upper sessile, auriculate to cordate; inflorescence thyrsoid, up to 3.4 dm long, often with a few lateral, leafy inflorescence branches below, stipitate-glandular and finely pubescent, cymes mostly in pairs, (or 1-3), up to 4 dm long in fruit, densely flowered, the pedicels, 1-1.5 mm long; sepals oblanceolate, 3-4 mm long, 0.8-1.1 mm wide, glandular and hirsute; corolla rotate to campanulate, the lobes bluish to violet, the tube yellowish, ca. 3-4 mm long, ca. 6 mm broad, glabrous; stamens exerted 9-10 mm, filaments violet, anthers yellow; style exerted ca. 10 mm, bifid 3/4 its length, the lower 1/4 setose and glandular; capsule globose to subglobose, 3.5-4.1 mm long, 2.6-3.5 mm wide, glandular and setose; mature seeds 4, elliptical, dark (reddish), the dorsal surface faintly pitted. The ventral surface excavated on both sides of the ridge, often lighter than the dorsal surface, pitted with the markings in the excavations longer (transversely) than those of the ridge or margins, the ridge sometimes faintly corrugated on one side. Collections: 22 (13); representative: J. Howell and G. True 44640 (BRY, G); L. Higgins 1624 (BRY); D. Atwood 1520, 1893, 1895, 1684, 1892, 1894, 1895, 1526, 1519, 1518, 1525, 1528, 1527 (BRY).

Habitat.—Endemic to the Arapian Shale formation.

Distribution.—Sevier and Sanpete cos., Utah, from 5,500 to 5,700 feet, April to June (Map 27).

Fig. 60. Phacelia vossii Atwood


Perennial plants, 2.1-7.3 dm high; stems erect from a woody caudex, with hirsute to setose and stipitate-glandular hairs; leaves...
linear to lanceolate, 2-11 cm long, 0.5-2.2 cm wide, revolute, ventral surface heavily glandular, dorsal surface hirsute, with scattered stipitate-glandular hairs, margins dentate to irregularly toothed, petiolate, the petiole up to 1.5 cm long; inflorescence axillary to terminal, scattered along the stems for as much as 1/2 its length or less, consisting of simple to compound scorpionid cymes, individual cymes up to 7.5 cm long in fruit, pedicels up to 2 mm long in fruit, glandular and hirsute; corolla tubular to short campanulate, pale lavender (rarely white), 5.5 mm long; sepals oblanceolate to spatulate, 4.6 mm long, 1.5-2 mm wide, glandular and hirsute; stamens exerted, filaments purple, anthers greenish blue; style exerted ca. 2 mm longer than the stamens ca. 9 mm long, bifid for 3/4 its length, lower 1/4 pubescent; capsule ovate, 3.7 mm long, 2.5-2.7 mm wide, glandular and strigose; immature seeds 4, elliptical to oblong, brown, 2.5-3.1 mm long, 1.4 mm wide. Collections: 4 (1); representative; known only from the type collections and D. Atwood and J. Reveal 5985, 25 September 1973 (BRY).
Fig. 61. *Phacelia welshii* Atwood. D. Atwood 2605 (Bry).
Habitat.—Apparently endemic to calcite and limestone soils.

Distribution.—Known only from the type locality near Galeana in the state of Nuevo León, Mexico.

The corollas of the type specimens have faded to white, which is a common occurrence in several species of this group.

This taxon appears to be related to *P. pinnaatIfida* Grisob., which, according to Brand (1913), occurs in the Andes of South America in Peru, Bolivia, and Argentina.

35. *Phacelia welschii* Atwood

Fig. 61


Annual, 1.5-5 dm tall; stems more or less yellowish to green, simple or branched, leafy, hirsute and densely covered with multicular stipitate glands; leaves oblong to lanceolate, 1.5-8 cm long, 0.5-2.7 cm wide, hirsute and densely glandular, the margins often revolute, undulate and dentate, the basal leaves clustered, petiolate, the petiole 2 cm long or less, cauline leaves sessile or nearly so, often cordate at the base; inflorescence of compound scorpioid cymes, these terminal at the ends of the main stem and lateral branches, densely glandular and hirsute. The individual cymes congested, but loosing in fruit, up to 10 cm long, pedicels up to 1.5 mm long; sepals spatulate to oblanceolate, 3.5-4.5 mm long, 0.7-1.7 mm wide, hirsute and stipitate-glandular; corolla campanulate, purplish to blue, 5-6 mm long and broad, pubescent; stamens exerted ca. 8-10 mm, filaments the same color as the corolla, anthers yellow; style exerted ca. 8 mm, bifid 3/4 its length, the lower 1+4 stete and glandular; capsule oval, 3-3.2 mm long, 2.9-3.1 mm wide, hirsute and glandular; mature seeds 4, oblong, brown ventrally to reddish dorsally, pitted, 2.8-3.4 mm long, 1.3-1.5 mm wide, the ventral surface lighter than the dorsal surface, the ridge corrugated on one side, the margins corrugated and more or less revolute. Collections: 15 (6); representative: D. Atwood 2591 (BRY, CAS); J. Howell 24397 (CAS); D. Atwood 2598 (ARIZ, B, BRY, CAS, COLO, DIXIE, GH, NY); D. Demarce 43982 (UTC); D. Atwood 2601 (ASC, BRY, CAS, US, WSC).

Habitat.—Red shale formation.

Distribution.—Coconino Co., Arizona.

*Phacelia welschii* is probably most closely related to *P. utahensis* and *P. corrugata*. It can be distinguished from the former by its broader, dark brown seeds, long (up to 1.3 mm long), flattened, multicellular, stipitate glands, and broadly lanceolate leaves. The more open inflorescence, corrugated seeds, and broader, shorter, densely glandular leaves easily separate *P. welschii* from *P. corrugata*.

APPENDIX I

SYNONYMS

The following is a list of synonyms in the *Phacelia* Crenulatae group. The names in the left column are the synonyms, and the number to the right is the reference to the numbered taxa in the present treatment.

EUTOCA

*E. glandulosa* Hook. .......................... 17

PHACEII

*P. arenicola* Brandegee .......................... 19
*P. conferta* D. Don .......................... 10
*P. congesta* var. *disecta* Gray .......................... 10
*P. congesta* var. *rupetris* (Greene) Macbride .......................... 29
*P. congesta* var. *typica* Voss .......................... 10
*P. dissecta* (Gray) Small .......................... 10
*P. corrugata* var. *ambigua* (Jones) Macbride .......................... 3a
*P. corrugata* var. *bakeri* Brand .......................... 7
*P. corrugata* var. *corrugata* (Nels.) Brand .......................... 12
*P. corrugata* var. *funerea* Voss in Munz .......................... 14b
*P. corrugata* var. *minutiflora* (Voss) Jeps. .......................... 3b
*P. corrugata* var. *vulgaris* Brand .......................... 14b
*P. depauperata* W. & S .......................... 26
*P. desertica* Nels. .......................... 17
*P. foetida* Goodding .......................... 24
*P. glandulosa* Gray in Brand. pro syn. .......................... 26
*P. glandulosa* Hemsley .......................... 13
*P. glandulosa* ssp. *eu-glandulosa* Brand var. *australis* Brand, in part .......................... 15
*P. glandulosa* ssp. *eu-glandulosa* Brand var. *australis* Brand, in part .......................... 7
*P. glandulosa* ssp. *eu-glandulosa* Brand var. *deserta* Brand .......................... 17
*P. glandulosa* ssp. *eu-glandulosa* .......................... 1
*P. glandulosa* ssp. *splendens* (Eastwood) Brand .......................... 32
*P. glandulosa* var. *neomexicana* (Thurber ex Torr.) Gray .......................... 22
*P. integrifolia* var. *arenicola* (Brandegee) Brand .......................... 19a
*P. integrifolia* var. *palmeri* (Torr. ex Wats) Gray .......................... 24
*P. integrifolia* var. *robusta* Macbr. .......................... 28
*P. intermediæ* Wooton, in part .......................... 9
*P. invenusta* Gray .......................... 9
P. macDougalli Heller in Brand, pro. syn. .... 31
P. neomexicana var. alba (Rydb.) Brand .... 1
P. neomexicana var. coultieri (Greenman) Brand .... 13
P. neomexicana var. coultieri subvar. foliisima Brand .... 1
P. neomexicana var. cu-neomexicana Brand .... 22
P. neomexicana var. microphylla Brand .... 15
P. palmeri var. typica Voss .... 24
P. petiolarata Johnston .... 23
P. popei var. arizonica (Gray) Voss .... 6
P. popei var. similis (W. & S.) Voss .... 26
P. popei var. typica Voss .... 26
P. similis W. & W. .... 26
P. tenutipes W. & S. .... 8
P. texana Voss .... 19b

Appendix II

Glossary

Alveolate. Honeycombed; pits in the surface of the seed.
Auriculate. With earlike appendages.
Corrugated. Wrinkled or folded.
Cymbiform. Boat shaped.
Cyme. A determinate flower cluster in which the first flower is terminal on the main axis and the central flowers open first.
Denticulate. Slightly and finely toothed.
Favose. Honeycombed; pits in the surface of the seeds.
Fimbriate. Fringed with elongate, slender processes or lobes on the margins of the corolla lobes.
Geminate. In pairs, as regarding the seeds.
Glandular. A globose-secreting structure borne on the surface and estipitate.
Gypsiferous. Containing gypsum.
Hirsute. Pubescent with stiff, coarse hairs.
Hispid. Pubescent with long, very stiff hairs, these able to penetrate the skin.
Pilose. Pubescent with soft, slender hairs pointing the same direction as if combed.
Pitted. Having little depressions or pits.
Puberulent. Pubescent with very short hairs, not stiff.
Reticulate. Net-veined.
Revolute. Rolled backward from both margins, toward the inside.
Scabrous. Rough to the touch owing to the presence of short stiff hairs.
Scariosis. Thin, dry, and membranous, not green.
Scorpioid. A unilateral inflorescence circinate coiled in bud and anthesis.
Setose. Pubescent with short, rather stiff hairs, these not able to penetrate the skin.
Stipitate-glandular. A globose, stipitate, secretory structure borne on the surface of vegetative parts.
Strigose. Pubescent with short, straight appressed hairs.
Tuberculate. Having small knoblike projections.
Villous. Pubescent with long and weak, tangled, but not matted, hairs.

Bibliography


Brown, R. 1818. Observations, systematical and geographical, on Professor Christian Smith's collection of plants from the vicinity of the river Congo. Pages 420-485 in J. K. Tuckey's Narrative of an expedition to explore the river Zaire.


Gates, F. C. 1940. Annotated list of the plants of Kansas: ferns and flowering plants. Kansas State College, Department of Botany, Contribution 399.


1865. Enumeration of the species of plants collected by Dr. C. C. Parry, and Messrs. E. Hall and J. P. Harbour, during the summer and autumn of 1862, on and near the Rocky Mountains, in Colorado Territory, lat. 39°. Proc. Acad. Phila. 1863:55-80.


190 GREAT BASIN NATURALIST Vol. 35, No. 2


1860. Botanical appendix in J. C. Ives, Report upon the Colorado River of the west. C. Wendell, Printers, Washington, D.C.


