Brigham Young University

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A REVISION OF THE ERIOGONUM MICROTHECUM COMPLEX (POLYGONACEAE)

by

James L. Reveal

BIOLOGICAL SERIES—VOLUME XIII, NUMBER 1

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James L. Reveal[1]

ABSTRACT

This revision discusses seven closely related species of *Eriogonum* (Polygonaceae) found in the western United States of North America. One of the two major species, *E. microthecum*, is composed of nine varieties which range over a wide area of the Far West. The other major species, *E. effusum*, is found over a more restrictive geographical range mainly east of the Continental Divide. The remaining five species are primarily restricted to the Colorado-Green river drainage basin of Utah, Colorado, New Mexico, and northern Arizona. Together these entities form the core of a group of plants known as Section Corymbosa. The new varieties proposed are *E. microthecum* var. *corymbosoides* and var. *johnstonii* from southern California; *E. microthecum* var. *lapidicola* of eastern California, southern Nevada, and perhaps adjacent Utah; and, *E. microthecum* var. *alpinum* from the Sierra Nevada of east-central California. The following new combinations are proposed: *E. ericifolium* var. *pulchrum* and *E. microthecum* var. *foliosum*. Detailed distribution maps are provided for each taxonomic element recognized, and the variation in *E. microthecum* and *E. effusum* is illustrated.

INTRODUCTION

The *Eriogonum microthecum* complex, as here defined, includes those species of *Eriogonum* which are woody perennial shrubs or subshrubs with small linear-lanceolate to narrowly elliptic leaves with acute apices mainly restricted to the lower half of the herbaceous stems, and with glabrous, white to yellow, small flowers with rounded or more often truncate to slightly cordate outer tepals. The complex is related to *E. corymbosum* Benth. in DC. which differs in having large lanceolate to elliptic or orbicular leaves and slightly larger flowers with essentially round bases on the outer tepals. This latter complex was treated as Part V of this series of papers (Reveal, 1968). These two species groups form a distinct subsection within the larger section called Corymbosa which was named by Bentham in deCandolle's *Prodromus* (1856) and later typified with *E. microthecum* Nutt. (Reveal, 1969b).

Eriogonum microthecum and the species most closely related to it occur throughout much of the western United States. They are found in numerous habitats ranging from the high alpine reaches of the Sierra Nevada to the hot desert floors of Nevada and Arizona. The two species discussed in detail in this paper, *E. microthecum* and *E. effusum* Nutt., are not narrowly endemic in their distribution, but other entities associated with them tend to be restricted in their geographical range. Consequently, other species, now unknown and undiscovered, are likely to be found in the future.

The Section Corymbosa is not a simple group. The species referred to it are exceedingly variable in most diagnostic features, and a lack of familiarity with the plants in the field will put one at an immediate disadvantage in using keys to the species. Likewise, the extreme variation that is characteristic of some taxa does not reduce all of the problems. The polymorphic characteristics of *Eriogonum microthecum* var. *foliosum* is matched by the variation that exists in *E. corymbosum* var. *corymbosum*, and even the relatively restricted *E. microthecum* var. *lapidicola* is now defined with such broad latitude that most certainly at least two more variants will be described when additional material is available.

HISTORICAL STUDIES

The first species to be described in the complex were *Eriogonum microthecum* and *E. effusum*. Thomas Nuttall, the famous English botanist, had traveled to the western half of what is now the United States (then the Oregon Country held in joint occupation by the British and American governments) in 1834 with Nathaniel J. Wyeth and actively collected along the Oregon Trail (McKelvey, 1955; Graustein, 1967). Although he described many of his newly discovered plants from 1837 to 1842, a few

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remained to be described, and names for these were not formally proposed until 1848 (Reveal and Spevak, 1967). Among the new species proposed were these two members of *Eriogonum*. Nuttall suggested herbarium names for some additional plants which might be worthy of publication but neglected to provide them with the official endorsement of putting them in print. Consequently, he left these to be evaluated by others. In 1854, while discussing the plant collections of Karl Geyer, William J. Hooker proposed *E. microthecum* var. *laxiflorum*, citing in synonymy one of Nuttall's herbarium names. In 1856 Benthan wrote in de Candolle's famous world monographic series, *Prodromus*, and proposed the same name. At the same time Bentham added *E. simpsonii* from northern New Mexico, an area just acquired by the United States from Mexico; *E. confertiflorum* from what is now northern California, although at the time the collection was made the area was part of Mexico; and, *E. effusum* var. *rosmarinoides* which was designated as being from "California" but actually came from Kansas, an error pointed out by Torrey and Gray in 1870 but not adopted into the California literature until much later (Reveal and Munz, 1968).

In 1870 John Torrey of New York and Asa Gray of Harvard University revised the genus *Eriogonum* and discussed the *E. microthecum* complex at some length. Gray, who was the major author of the revision,[2] took an exceedingly conservative view of Bentham's Section Corymbosa which contained both *E. corymbosum* and *E. microthecum*. One new species was described *(E. ericifolium)*, and *E. corymbosum* was retained as a valid species. However, within *E. microthecum*, considerable "lumping" was done. In the revision, Torrey and Gray described the flowers of *E. microthecum* as being "... albis nunc roseis raro luteis ..." for the overall concept of the species, and from this action was introduced the misapplication of the concept of var. *microthecum* to what is now called var. *laxiflorum* Hook., an error that continued in the literature until the recent works by Hitchcock (1964) and Reveal and Munz (1968). The var. *laxiflorum* was only questionable recognized by Torrey and Gray (their var. α) and included in their discussion elements now referred to as var. *alpinum* in the present paper.

Following their linear sequence, Torrey and Gray recognized Bentham's var. *fendlerianum* (now a valid species, *viz.* Reveal, 1968), but included in this entity specimens referable to var. *laxiflorum* and var. *ambiguum* (M. E. Jones) Reveal in Munz. They proposed a new combination, reducing *Eriogonum confertiflorum* to a variety under *E. microthecum* and placing under this name elements of both var. *microthecum* and var. *laxiflorum*. They next transferred *E. effusum* var. *leptophyllum* to *E. microthecum*, commenting that Bentham's *E. confertiflorum* var. *stansburyi* was an intermediate stage between var. *confertiflorum* and var. *leptophyllum*. With only fragments of var. *stansburyi* and var. *leptophyllum* at hand in 1870, this transfer is not at all surprising. However, now it is possible to refer var. *stansburyi* to *E. brevicaule* Nutt., and var. *leptophyllum* is considered a valid species by most authors.

In their treatment of var. *leptophyllum*, Torrey and Gray put a diverse series of entities under this name. *Eriogonum leptophyllum*, elevated to the species rank by Wooton and Standley in 1913, was confused by Torrey and Gray with specimens of what is here called *E. microthecum* var. *foliosum*. Although they did correctly associate var. *foliosum* (in name only) with Bentham's *E. simpsonii*, they failed to see the distinct differences which exist between *E. leptophyllum* and *E. microthecum* var. *foliosum*.

The reduction of *Eriogonum effusum* to the varietal rank under *E. microthecum* was critical and is followed today by some (*viz.* Hitchcock, 1964; Porter, 1968). This is both unfortunate and unnecessary. Porter (personal communication of 6 February 1967) claims that the two "... seem to intergrade badly and ... have almost continuous (at least contiguous) ranges ...." From my data no such intergrades have been detected. However, even if this were to happen, the two species are distinct, both morphologically and geographically, and should not be confused. As will be seen, the zone of possible overlap is small (only in southern Colorado and northern New Mexico) and no major taxonomic change would be warranted.

The last variety Torrey and Gray discussed in their revision of *Eriogonum microthecum* was var. *leptocladon*. In 1857 they proposed this entity as a valid species, but were forced to reduce it to the varietal rank to conform with the rest of their revision. In 1966 I suggested that *E. leptocladon* be retained as a species and that Eastwood's *E. ramosissimum* be placed as a variety within it. Since then, fieldwork has shown that the var. *ramosissimum* (Eastw.) Reveal tends to come close to *E. kearneyi* Tidestr. in Kane County, Utah on the western flank of the range of var. *ramosissimum*, while on the eastern flank it is approached by the New Mexican phase of *E. effusum* var. *effusum*.

The complex remained neglected for some years after the Torrey and Gray revision. Watson (1877) did not alter their concepts to any great degree although he transferred *Eriogonumm ericifolium* to *E. fasciculatum* Benth. and placed *E. microthecum* var. *fendlerianum* in synonymy under *E. corymbosum*. Charles C. Parry described *E. mearnsii* in 1889. Marcus E. Jones described *E. bicolor* from eastern Utah in 1893, added a few varieties in 1895, and proposed *E. friscanum* in 1903, based on specimens

[2](See Gray's footnote to Torrey's delayed publication of the plants collected by the 1838-1842 Wilkes' United States Exploring Expedition which was finally released in 1874 here Gray reveals the role he played in the revision).

from southwestern Utah. Small added *E. clavellatum* in 1898 from a collection gathered by Alice Eastwood in 1895. In 1906 Michel Gandoger, Europe's famous "splitter," described several new species and varieties, all of which are now placed in synonymy!

In 1936 Susan G. Stokes published her monograph of *Eriogonum* and presented a bewildering arrangement of the various taxa associated with the *E. microthecum* complex. Her typical subspecies appears to be the same as my var. *microthecum*, but the placement of *E. effusum* var. *rosmarinoides* as a synonym under it is difficult to explain. Within ssp. *typicum*, she recognized a series of varieties that actually belong to vastly different forms. Her other subspecies are all synonyms except for var. *panamintense* (see Table 1).

Name in Stokes (1936)	Present Name or Concept
Ssp. *typicum* S. Stokes	Var. *microthecum*
Var. *macdougalii* (Gand.) S. Stokes	Var. *laxiflorum* Hook.
Var. *panamintense* S. Stokes	Var. *panamintense* S. Stokes
Var. *friscanum* (M.E. Jones) S. Stokes	Var. *foliosum* (Torr. & Gray) Reveal
Var. *spathulare* (Gand.) S. Stokes	Var. *laxiflorum* Hook.
Var. *idahoense* (Rydb.) S. Stokes	Var. *microthecum*
Ssp. *laxiflorum* (Hook.) S. Stokes	Var. *laxiflorum* Hook.
Ssp. *confertiflorum* (Benth. in DC.) S. Stokes	Var. *laxiflorum* Hook.
Ssp. *rigidum* (Eastw.) S. Stokes	Var. *foliosum* (Torr. & Gray) Reveal
Ssp. *ericifolium* (Torr. & Gray) S. Stokes	*E. ericifolium* Torr. & Gray var. *ericifolium*
Ssp. *intermedium* S. Stokes	Var. *foliosum* (Torr. & Gray) Reveal
Ssp. *mearnsii* (Parry in Britt.) S. Stokes	*E. ericifolium* Torr. & Gray var. *ericifolium*
Ssp. *bicolor* (M.E. Jones) S. Stokes	*E. bicolor* M. E. Jones
Ssp. *pulchrum* (Eastw.) S. Stokes	*E. ericifolium* Torr & Gray var. *pulchrum* (Eastw.) Reveal
Ssp. *aureum* (M. E. Jones) S. Stokes	*E. corymbosum* Benth. in DC. var. *glutinosum* (M.E. Jones) M. E. Jones
Var. *crispum* (L. Will.) S. Stokes	*E. corymbosum* Benth. in DC. var. *glutinosum* (M. E. Jones) M. E. Jones
Var. *expansum* S. Stokes	Var. *ambiguum* (M. E. Jones) Reveal in Munz

Table 1. The disposition of taxa recognized by Stokes (1936) in *Eriogonum microthecum*, unless otherwise indicated, all varieties are referable to *E. microthecum*.

As can be seen in Table 1, Stokes includes four different elements within her definition of ssp. *typicum*. Only var. *idahoense* is actually referable to var. *microthecum*, while both var. *macdougalii* and var. *spathulare* are placed in synonymy under var. *laxiflorum* in the present treatment of the group. The inclusion of var. *panamintense* is difficult to explain as is her placement of var. *friscanum* – a typical form of var. *foliosum*, or what she called ssp. *rigidum*. Her concept of var. *laxiflorum* (her ssp. *laxiflorum*) is correct, but I cannot maintain ssp. *confertiflorum* at any rank. When one compares the type of *Eriogonum confertiflorum* with Stokes' description of the entity, they do not match. From the description, I would judge that her intention was to include the tall forms of var. *foliosum*, but as no specimens were ever annotated with this name, one can only speculate.

Stokes proposed ssp. *rigidum* for what I am calling var. *foliosum*, but, as Torrey and Gray's *Eriogonum effusum* var. *foliosum* and Eastwood's *E. microthecum* var. *rigidum* represent the same kind of plant, Stokes should have adopted the earlier var. *foliosum* as the basionym of her name. The ssp. *intermedium*, according to Stokes, is an intermediate form between *E. microthecum* and *E. fasciculatum*, a point I cannot accept. If anything, the type of her new subspecies appears to be an intermediate between var. *laxiflorum* and var. *foliosum* of *E. microthecum*.

The remaining subspecies referred to *Eriogonum microthecum* should be retained as distinct species or associated with other species. None of these except her var. *expansum* should be associated with *E. microthecum*.

Name in Stokes (1936)	Present Name or Concept
Ssp. *typicum* S. Stokes	Var. *effusum*
Ssp. *helichrysoides* (Gand.) S. Stokes	Var. *rosmarinoides* Benth. in DC.
Ssp. *fendlerianum* (Benth. in DC.) S. Stokes	*E. fendlerianum* (Benth. in DC.) Small
Ssp. *ainslei* (Woot. & Standl.) S. Stokes	*E. fendlerianum* (Benth. in DC.) Small
Ssp. *salicinum* (Greene) S. Stokes	*E. lonchophyllum* Torr. & Gray
Ssp. *orbiculatum* S. Stokes	*E. corymbosum* Benth. in DC. var. *orbiculatum* (S. Stokes) Reveal and Brotherson
Ssp. *corymbosum* (Benth. in DC.) S. Stokes	*E. corymbosum* Benth. in DC. var. *corymbosum*
Ssp. *divaricatum* (Torr. & Gray) S. Stokes	*E. corymbosum* Benth. in DC. var. *corymbosum*
Ssp. *durum* S. Stokes	*E. corymbosum* Benth. in DC. var. *corymbosum*
Ssp. *salinum* (A. Nels.) S. Stokes	*E. corymbosum* Benth. in DC. var. *corymbosum*
Ssp. *pallidum* (Small) S. Stokes	*E. leptocladon* Torr. & Gray var. *ramosissimum* (Eastw.) Reveal
Var. *shandsii* S. Stokes	*E. leptocladon* Torr. & Gray var. *leptocladon*
Ssp. *leptocladon* (Torr. & Gray) S. Stokes	*E. leptocladon* Torr. & Gray var. *leptocladon*
Ssp. *simpsonii* (Benth. in DC.) S. Stokes	*E. microthecum* Nutt. var. *foliosum* (Torr. & Gray) Reveal
Ssp. *nelsonii* (L. Will.) S. Stokes	*E. microthecum* Nutt. var. *foliosum* (Torr. & Gray) Reveal
Ssp. *contortum* (Small ex Rydb.) S. Stokes	*E. contortum* Small ex Rydb.

Table 2. The disposition of taxa recognized by Stokes (1936) in *Eriogonum effusum*, unless otherwise indicated, all varieties are referable to *E. effusum*. The nomenclature of *E. corymbosum* follows Reveal (1968) while the remaining taxa are based on Reveal (1969a)

Under *Eriogonum effusum*, Stokes treated the remaining members of the *E. microthecum* complex. Her concept of typical *E. effusum* (as ssp. *typicum*) is correct, but she failed to realize that var. *rosmarinoides* (which she placed under *E. microthecum* ssp. *typicum* as a synonym) and the new combination, ssp. *helichrysoides* (Gand.) S. Stokes, were the same element. Most of the remaining subspecies under *E. effusum* belong to the *E. corymbosum* complex as summarized in Table 2.

In the list of synonyms found under some of the subspecies recognized by Stokes were some odd elements. In addition to *Eriogonum effusum* var. *rosmarinoides* which she referred to *E. microthecum* ssp. *typicum*, she also placed *E. confertiflorum* var. *stansburyi* under her ssp. *confertiflorum*; *E. aureum* M. E. Jones var. *ambiguum* M. E. Jones was put in synonymy under her ssp. *aureum*; yet, at the same time, she described the exact same plant as var. *expansum*. Under the subspecies placed with *E. effusum* she referred *E. intricatum* Gand. under ssp. *typicum* when the name should have been placed under *E. microthecum* var. *laxiflorum*. The puzzling species, *E. sarothriforme* Gand., was placed under the ssp. *corymbosum*, when in reality the name should be referred to either *E. brevicaule*, or as I have ventured to suggest (Reveal, 1969*a*), to *E. lonchophyllum* Torr. & Gray — both species quite distinct and different from *E. corymbosum*.

In her monograph, Stokes maintained *Eriogonum leptophyllum* and *E. clavellatum* as distinct species.

Work on the *Eriogonum microthecum* complex since 1936 has been minimal. Stokes described *E. effusum* var. *limbatum* in 1941, but this is identical to her *E. microthecum* var. *panamintense* named five years before. Kearney and Peebles, unaware of the nature of *E. ericifolium*, made the combination *E. mearnsii* var. *pulchrum* in 1939, and I proposed the new combination, *E. microthecum* var. *ambiguum* in 1968.

In 1968 I published a revision of the *Eriogonum corymbosum* complex. Since then, one additional species has been found, *Eriogonum revealianum* Welsh (1970), was known to me in 1968 and included in my concept of *E. corymbosum* var. *corymbosum*. I believe that this new name should be reduced to synonymy under var. *corymbosum*.

Within *Eriogonum microthecum*, a number of new entities are proposed at this time. Two of the new varieties, var. *alpinum* and var. *johnstonii*, have been suspected as being undescribed for a long time but never formally proposed until now. The var. *corymbosoides* has been collected for several years in the mountains of southern California, but its unique nature generally has gone unnoticed. The var. *lapidicola* has been known to collectors since the late 1890s, but it was not until the fine collections of Dr. Janice C. Beatley on the Nevada Test Site in southern Nevada that the distinctiveness of this entity became obvious.

The population called var. *foliosum* by me in this paper has been outlined in various manuals and floras under a variety of names, but the proper combination has not been made until now.

One undescribed species is known to me that is not included in this paper. This species is known from a single plant gathered in Delta County, Colorado, some years ago, but until it can be rediscovered and studied in detail, it seems unwise to name it now.

TAXONOMY

In my doctoral dissertation (Reveal, 1969*a*), I proposed that the Section Corymbosa be divided into three subsections. One was designed to include *Eriogonum desereticola* S. Wats. of extreme southern California, while a second (also undescribed) was outlined to include *E. leptocladon* Torr. & Gray, *E. kearneyi* Tidestr., the recently described *E. ammophilum* Reveal, and the rare western Utah endemic, *E. nummulare* M. E. Jones. A portion of the typical subsection is the subject of this paper and may be described and discussed as follows:*

Eriogonum Sect. *Corymbosa*

Eriogonum Michx. Sect. *Corymbosa* Benth. in DC., Prodr. 14:17. 1856. — Sect. *Corymbarium* Kuntze in Post & Kuntze, Lexicon Gen. Phan. 204. 1903. Species lectotypus: *E. microthecum* Nutt., selected by Reveal in Gunckel, Curr. Topics Pl. Sci. 236. 1969.

Low to high, spreading to erect, pulvinate to compact or open subshrubs to shrubs, herbaceous or woody, 0.02-1.5 m high, 0.1-2.5 m across, the lower stems reddish-brown to brown or somewhat grayish, woody at least as much as half the height of plants or less, leafless or nearly so, the upper stems herbaceous; *leaves* solitary or in fascicles at the tips of short dwarf shoots, variously scattered or even rather congested along the lower portions of the herbaceous branches, occasionally on the upper portion of the woody stems, the leaf-blades variable, linear to orbicular, densely tomentose on both surfaces, less so to glabrous above, or totally glabrous on both surfaces, the margins plane to revolute, on short to long petioles; *inflorescences* cymose, compact or congested, infrequently open and expanded, the internodes short, glabrous to densely tomentose, the involucres arranged in the forks of the branches or at the tips of the ultimate branches, not racemosely arranged at the tips; *involucres* solitary, turbinate to broadly campanulate, glabrous to tomentose with-

* Until the other subsections are proposed, the typical subsection of Section Corymbosa does not exist. Consequently, the description of the "section" given below is actually based on the subsection as I have defined it (Reveal, 1969*a*) but not called such for nomenclatural reasons.

out, mostly 5-toothed, the teeth usually not deeply dividing the tube; *flowers* white to pink or yellow, with greenish, reddish, or reddish-brown midribs and bases, essentially glabrous or (in *E. effusum*) rarely sparsely pubescent at the base and along the midribs without, the tepals similar or dissimilar, the outer whorl of tepals oblong, obovate, spathulate, or elliptic to fan-shaped, or nearly to quite orbicular, the inner whorl of tepals narrower, mostly oblanceolate to spathulate or elliptic; *stamens* slightly to long exserted, the filaments glabrous to pilose basally, the anthers variable in color, mostly oblong; *achenes* light brown to brown, glabrous, not winged.

Distribution.

In several habitat types from the low, warm desert floors to exposed mountain ridges, from (1500) 3000-10,500 feet elevation, throughout much of the western United States, from Washington to California eastward to the Great Plains, from Nebraska and South Dakota southward to central New Mexico with a predominance of species in the Green and Colorado rivers drainage basin, especially in eastern Utah.

The subsection is a difficult group. It is large and complex, containing some sixteen species and perhaps twenty varieties; yet, the taxonomy of the group is now fairly well understood and documented. The taxon is divided into two major species complexes, one centering around *Eriogonum corymbosum* and the other around *E. microthecum*. The former complex was the subject of my fifth part of this series, and the latter complex is the group discussed in this, the sixth part, of the series. Within these two groups are a great many forms. Some, like *E. lancifolium* Reveal and Brotherson, *E. saurinum* Reveal, and *E. smithii* Reveal, are narrowly endemic to a small specific site. This seems to be a characteristic of the *E. corymbosum* complex, as the taxa in this group tend to be more restrictive in their distribution than the taxa associated with *E. microthecum*. For example, both *E. microthecum* var. *laxiflorum* and *E. effusum* var. *effusum* occur in a number of contrasting ecological niches. Even the various variants within *E. microthecum* occupy a multitude of sites except the restricted var. *johnstonii*. The only species in the *E. microthecum* complex which are even somewhat restricted in their distribution are *E. clavellatum* in southern Utah, *E. ripleyi* J. T. Howell and *E. ericifolium* of northern Arizona, and the undescribed species apparently restricted to clay slopes near Hotchkiss, Delta County, Colorado. Some additional forms of *E. microthecum* (as yet undescribed) may prove to be narrowly distributed.

Some hybridization is known to occur in this part of the Section Corymbosa. *Eriogonum microthecum* var. *laxiflorum* and *E. corymbosum* vars. *corymbosum* and *erectum* Reveal and Brotherson will hybridize with *E. brevicaule*, a herbaceous species of another section in the genus. It is suggested here that the entity known as *E. nebraskense* is the probable result of hybridization between *E. effusum* var. *effusum* and *E. pauciflorum* Pursh, but until this can be demonstrated, formal recognition of this as a hybrid species will have to wait. It is likely that other hybrids will be found in the future.

Some entities show amazing variability. *Eriogonum microthecum* var. *foliosum* probably is the most variable plant in the genus over its entire range. Other species in this species complex are extremely stable, but these tend to be the endemics restricted to a small geographical range. One exception to this is *E. bicolor* which is consistent throughout its rather extensive range in eastern Utah and western Colorado. Variation is the source of new kinds within a population, and it should be expected that the more widely distributed species should be the most variable. However, *E. microthecum* var. *corymbosoides*, in its small geographical range in the mountains of southern California is exceedingly variable in its pubescent characters, much more so than most of the more widespread entities. This may result, over a long period of time, in the further evolution of new kinds within this area.

The reader is forewarned that the exact determination of some populations within this group will be difficult. This section has been studied extensively in the field, and I have called upon this field experience in arriving at the taxonomic conclusion presented herein. Consequently, mere fragments or poorly preserved herbarium material may be impossible to determine, especially at the infraspecific rank. Geographical and edaphic isolation has seemingly played a major role in the evolution of this group, and the exact location of an undetermined collection will prove helpful in arriving at its proper name. The varieties within *Eriogonum microthecum* are easily recognized in the field or on well prepared herbarium sheets once the entity is known in the field, but when only the upper branches are gathered, the determination may prove fruitless. The key to the various species in the Section Corymbosa (as discussed here) attempts to take in all exceptions and provide the user with several possible choices. As the key is based mainly on leaf features, it is to be understood that the general trend of all leaves is to be considered rather than the one leaf that differs from the rest. However, I have attempted to provide a lead for most of the commonly encountered exceptions even if these exist on only a few herbarium specimens.

Note.

The following key is to the entire Corymbosa taxon. It includes those species treated in this paper, part V of this species, and other species as suggested in my overall revision of the genus (Reveal, 1969a). It is hoped that an inclusive key will be useful to those faced with the necessity of determining a member of the group and not knowing whether it is more closely related to *Eriogonum microthecum* or *E. corymbosum*.

Key to the Species of Corymbosa

A. Leaves narrow, linear or narrowly elliptic or narrowly lanceolate, the apices sharply acute or nearly so, or if the leaves broader, then plants from the mountains of eastern and southern California or of the plains of central Washington

B. Leaves tightly revolute, narrow

C. Leaves 2-6 cm long

D. Inflorescences densely cymose, 0.2-1.2 (1.5) dm long, glabrous and bright green; plants forming round compact shrubs 2-6 (8) dm high, 3-10 (12) dm across; involucres 2-3 mm long, 1.1-1.7 (2) mm wide, glabrous; clay hills and slopes, Sandoval County, New Mexico, westward across northwestern New Mexico into Apache, Navajo, and extreme eastern Coconino counties, Arizona, northward to the Four Corners area of Utah and Colorado

1. *E. leptophyllum.*

DD. Inflorescences less dense, or if so, then the stems not glabrous; plants forming erect to spreading shrubs and subshrubs; involucres floccose to lanate without

E. Inflorescences (1.5) 2-6 cm long, white-tomentose or lanate, rarely glabrate; leaves 0.3-3.5 (4) cm long, mostly rigid, thickish in some; clay hills and slopes, sandy desert washes and rocky outcrops, San Juan County, New Mexico, and adjacent southern Colorado westward across northern Arizona, southern Utah, and southern Nevada into extreme eastern California (the var. *foliosum* phase of *E. microthecum*)

6. *E. microthecum.*

EE. Inflorescences 5-15 cm long, floccose to glabrate; leaves 3.5-6 cm long, twisted in some, thin and linear; clay hills and washes, west-central Kansas (the var. *rosmarinoides* phase of *E. effusum*)

7. *E. effusum.*

CC. Leaves 0.5-2 cm long

D. Plants subshrubs, 1-2 dm high; involucres sessile

F. Involucres (3.5) 4-4.5 mm long, glabrous; leaves 0.8-1.7 (2) mm wide, glabrous above; stems green and glabrous, sparsely branched; low round compact subshrubs; clay slopes and washes, rare, San Juan County, Utah

2. *E. clavellatum.*

FF. Involucres 2-2.5 mm long, pubescent or rarely glabrate; leaves 2-4 mm wide, sparsely pubescent above; stems white-tomentose, rarely glabrate in New Mexico and Arizona, cymosely branched; low decumbent, prostrate, or erect subshrubs; granite or limestone outcrops and slopes in the high mountains of eastern California (var. *alpinum*) and Nevada (low forms of var. *laxiflorum*), or on rolling clay hills and slopes at lower elevations in western Colorado and adjacent Utah into northern Arizona and southern and central Nevada (low forms of var. *foliosum* and var. *lapidicola*)

6. *E. microthecum.*

DD. Plants matted, woody, less than 1 dm high, or if higher, then lacking bracts immediately below the involucres; involucres sessile or on short peduncles

E. Flowers 2.5-4.5 mm long; achenes 3-3.5 mm long; west-central Colorado, eastern Utah, and northwestern Arizona

F. Tepals similar or nearly so, oblong, united at least ½ the length of the flower; leaves thinly floccose to glabrate; inflorescences cymose; involucres narrowly turbinate, 3-3.5 mm long, 1-1.5 mm wide; Delta County, Colorado.

Eriogonum species (undescribed).

FF. Tepals distinctly dissimilar, the outer whorl of tepals broadly obovate to orbicular, united about ¼ the length of the flower; inflorescences umbellate-cymose; involucres turbinate to campanulate

G. Leaves densely tomentose on both surfaces, 5-12 (15) mm long, 1-2 (3) mm wide; involucres turbinate-campanulate, 5-lobed; flowers 2.5-4 mm long, the outer whorl of tepals (2) 2.5-3 mm wide; involucres peduncled, the bracts 1.5-3 (4) mm below the base of the involucral tube; clay flats and rolling hills, Mesa County, Colorado, and adjacent eastern Utah from Grand County south to northern San Juan County and Wayne County.

3. *E. bicolor.*

GG. Leaves densely tomentose below, thinly floccose to villous and greenish above, 2-6 mm long, 0.5-1 mm wide; involucres campanulate, 3-5 mm long, 3-5 lobed; flowers 3.5-4.5 mm long, the outer whorl of tepals 3.5-4 mm wide; involucres on top of bractless peduncles; sandy clay slopes and washes in southwestern Coconino County and northern Yavapai County, Arizona

4. *E. ripleyi.*

EE. Flowers 2-2.5 mm long; achenes 2-2.5 mm long; leaf-blades 5-8 mm long, 0.8-1.5 (1.9) mm wide; involucres 2.5-3 mm long, 1.5-2 mm wide; rocky places on flats and slopes, western Mohave County, southern and central Navajo and Coconino counties, and Yavapai County, Arizona

5. *E. cryptolium.*

BB. Leaves flat, not revolute or with the margins rolled, occasionally with margins thickened

C. Leaves 0.2-4 cm long

D. Leaf-apices sharply acute, the blades mostly narrowly elliptic or narrower, 1-8 (20) mm wide; plants mostly low subshrubs

E. Inflorescences 0.5-6 (12) cm long,

compact and rather congested, the branches white-tomentose to lanate or more commonly floccose to subglabrous, rarely glabrous, green; leaves 0.3-3.5 (4) cm long, 1-8 (20) mm wide; widespread on a variety of soil types west of the Continental Divide, from Washington eastward to Montana, hence south to southern California, northern Arizona, and New Mexico

6. *E. microthecum.*

FF. Inflorescences 6-25 cm long, open, the branches floccose, white but often drying blackish; leaves linear-oblanceolate or oblanceolate to oblong or obovate, (1) 2-4 cm long, mostly 3-7 (10) mm wide, the blades plane or in the mountains of central Colorado, some plants with blades rolled; gravelly to sandy hills, slopes and flats, east of the Continental Divide from South Dakota, Wyoming, and adjacent Nebraska southward along and in the Front Range and on the western edge of the Great Plains in Colorado to central and northwestern (west of the Divide) New Mexico

7. *E. effusum.*

DD. Leaf-apices slightly acute to rounded, the blades oblanceolate to elliptic, (0.5) 1-3 cm wide; plants decidedly woody shrubs; Utah and Colorado south to New Mexico and Arizona

8. *E. corymbosum.*

CC. Leaves 3-8 cm long

D. Leaf-apices mostly rounded, the blades oblanceolate to elliptic, 1-3 (5) cm long; southern Utah and northern Arizona (the var. *glutinosum* phase of *E. corymbosum*)

8. *E. corymbosum.*

DD. Leaf-apices acute, usually sharply so, the blades mostly lanceolate, usually more than 3 cm long

E. Branches subglabrous to tomentose; involucres tomentose without

F. Involucres 2.5-3 mm long; inflorescences with several short branches; flowers white, 3-3.5 mm long, the tepals slightly dissimilar; leaves 3-5 cm long, the petioles 3-6 mm long, deciduous on the lower portion of the stem; Mancos Shale hills east and south of Wellington, Carbon County, Utah

9. *E. lancifolium.*

FF. Involucres 3-4 mm long; inflorescences open with few long branches; basal stem leaves usually persistent; Duchesne County, Utah, and adjacent areas

G. Involucres 3.5-4 mm long; flowers white, 3.5-4.5 mm long, the tepals slightly dissimilar; leaves 3.5-7 cm long, the petioles 5-10 (18) mm long; Bad Land Cliffs, Duchesne County, Utah

10. *E. hylophilum.*

GG. Involucres (2.5) 3-3.5 mm long

H. Flowers yellow, 2.5-3 mm long, the tepals essentially similar; leaves 2.5-4 cm long, the petioles 4-7 mm long; Indian Creek Canyon, Duchesne County, Utah

11. *E. duchesnense.*

HH. Flowers white, or if yellowish, then plants from southern Utah and northern Arizona, or if from Duchesne County, then flowers pale-yellow and leaf-blades less than 3 cm long; leaves mostly less than 3 cm long, but an occasional blade up to 4 cm long (various forms of *E. corymbosum*)

8. *E. corymbosum.*

EE. Branches glabrous or floccose; involucres glabrous without

F. Leaves tomentose below; stems, among the leaves, floccose to tomentose

G. Involucres 2-3 mm long; flowers 2-3 mm long, cream to pale yellowish-white; leaves 3-6 cm long; erect shrubs 3-5 dm high; Mowry Shale, Dinosaur National Monument, Uintah County, Utah

12. *E. saurinum.*

GG. Involucres 2.5-3.5 (4) mm long; flowers white, 2.5-3.5 (4) mm long; leaves 1.5-4 (5) cm long; southern Colorado and adjacent northern New Mexico eastward into northern Texas

13. *E. fendlerianum.*

FF. Leaves as well as the entire plant totally glabrous throughout (except for the cottony-tomentose leaf-buds in the axils of the leaves), bright green and shining; flowers bright yellow, 3-4 mm long; red blow sand, San Rafael Desert, Emery County, Utah

14. *E. smithii.*

AA. Leaves broad, oblanceolate to lanceolate or elliptic, cordate to nearly orbicular, the apices round or nearly so

B. Leaf-blades oblanceolate to elliptic or nearly orbicular, 1-4 (5) cm long; widespread

C. Inflorescences 6-25 cm long, highly branched, stems floccose, white but often drying blackish; leaves narrowly oblanceolate to oblanceolate, 2-4 cm long; gravelly to sandy hills, slopes and flats east of the Continental Divide, South Dakota, eastern Wyoming and western Nebraska southward through eastern Colorado to northern and central New Mexico

7. *effusum.*

CC. Inflorescences 1-5 (10) cm long, sparsely

branched, or if with several branches present, then divaricately arranged and blades nearly or quite orbicular, stems mostly white-, silvery-, brownish-, or reddish-brown tomentose; leaves oblanceolate to lanceolate or elliptic to nearly orbicular, 1-3 (5) cm long; clay or gravelly slopes, hills and flats, southwestern Wyoming and western Colorado southward into eastern and southern Utah, and into northern Arizona and New Mexico, with an isolated series of population in central New Mexico

8. *E. corymbosum.*

BB. Leaf-blades cordate, (1.5) 2-2.5 cm long, 1-2 (2.5) cm wide, densely white-tomentose below, floccose and greenish- or brownish-white above; stems brownish-white tomentose; infrequent in sandstone, limestone, or other rocky areas of northern Arizona from extreme western Navajo County westward across central Coconino County to extreme east-central Mohave County

15. *E. jonesii.*

1. Eriogonum leptophyllum (Torr. in Sitgr.) Woot. & Standl.

Eriogonum leptophyllum (Torr. in Sitgr.) Woot. & Standl., Contr. U. S. Natl. Herb. 16:118. 1913, based on *E. effusum* Nutt. var. *leptophyllum* Torr. in Sitgr., Rept. Exped. Zuñi and Colorado Riv. 168. 1854. *Eriogonum microthecum* Nutt. var. *leptophyllum* (Torr. in Sitgr.) Torr. & Gray, Proc. Amer. Acad. Arts 8:171. 1870. Near Zuñi, McKinley County, New Mexico, 24 September 1851, *Woodhouse s.n.* Holotype, NY! Isotype, GH!

Large, rounded, heavily-branched shrubs 2-6 (8) dm high, 3-10 (12) dm across, the lower stems reddish-brown to brown or more frequently gray to grayish-brown, woody, the bark often exfoliating in large platelike segments, mostly leafless, the upper branches herbaceous, slender to stout, thinly pubescent and green when young but often totally glabrous, especially at maturity; *leaves* solitary or in fascicles on short dwarf shoots, rather closely grouped along the lower 1/2 to 2/3 of the herbaceous stems, the leaf-blades thin, linear to linear-oblanceolate, (1.5) 2-6 cm long, (0.8) 1-2.5 (3) mm wide, densely to thinly white-tomentose below, the midvein obvious, thinly pubescent above when young or glabrous, glabrous and green above by anthesis in all, the margins entire, tightly revolute, the bases and apices sharply acute, the leaves persistent, but soon deciduous in post-anthesis, the petioles short, 0.4-1.1 mm long, membranaceous and light yellowish-brown, glabrous, the petiole-bases triangular to deltoid, 1-1.5 mm long, 1-2 mm wide, slightly tomentose to glabrous without, light to dark brown, tomentose within, more or less clasping the stems; *flowering stems* slender, 1-8 cm long, green and glabrous, the area below among the leaves remaining tomentose; *inflorescences* cymose, dense and broomlike, congested with numerous short-internode branches, 2-12 (15) cm long, 4-15 (30) cm wide, trichotomously branched throughout, green and glabrous; *bracts* scalelike, ternate, 1-4 mm long, 0.4-1 mm wide, linear to elongate-triangular, glabrous within and without, connate at the base; *pedicels* lacking; *involucres* solitary, narrowly turbinate, 2-3 mm long, 1.1-1.7 (2) mm wide, glabrous and green within and without, the 5 acute teeth 0.3-0.7 mm long, the bractlets linear, 1.5-3 mm long, minutely fringed with short capitate gland-tipped cells, pale yellowish, the pedicels 2.5-5 mm long, glabrous, *flowers* white with greenish-brown midribs and bases, 2.5-4 mm long, glabrous within and without except for a few microscopic glands at the base of the united tepals, the tepals essentially similar, oblong to narrowly obovate, the outer whorl of tepals 1.4-1.7 mm wide, the inner whorl of tepals 1.1-1.4 mm wide, united only at the base of the flower; *stamens* long exserted, 3-6 mm long, the filaments subglabrous to sparingly puberulent basally, the anthers reddish or light pink, 0.5-0.7 mm long, oblong; *achenes* brown, 3.5-4 mm long, the globose base tapering to a long, 3-angled beak. Representative collections: *Arsene 16610* (G), *19433* (P, US); *Barneby 12966* (CAS, NY); *Brandegee 12128* (MO, UC); *Castetter s.n.* (UNM); *Eastwood and Howell 6909* (CAS, GH, POM, UC, US); *Goodding 4672, 4685* (ARIZ); *Jones 4938* (BM, BR, POM, US); *Michaels 890* (ASU), *Reveal and Davidse 924, 929, 942* (BRY, IT, NY, UC); *Standley 7342* (GH, MO, UC, US); *Weber 5223* (CAS, COLO, GH, ISC, OKL, UC, US); *Zuck s.n.* (CAS, MO, NY, US)

Distribution.

Dry clay flats, washes and slopes in pinyon-juniper woodlands, in Bernarlillo, Santa Fe, and Taos counties, New Mexico, westward into Apache, Navajo, and eastern Coconino counties, Arizona, and northward and just entering Colorado in Montezuma County near Four Corners and thus likely in extreme southeastern San Juan County, Utah, from 4500-6000 feet elevation. Flowering from July to October. Figure 1.

The type of the Broom-head Buckwheat, *Eriogonum leptophyllum*, was collected by Dr. Samuel W. Woodhouse, the naturalist assigned to Captain Lorenzo Sitgreaves on the latter's reconnaissance west of the Indian village Zuñi across northern Arizona to the Colorado River. The collection was made on 24 September 1851, and according to Sitgreaves' Report (1853), the expedition was near Zuñi, and Woodhouse apparently obtained his collection in low mountains east of the village. In Torrey's report of the plant collections made by the naturalist, he placed this buckwheat under *E. effusum*, but the illustration accompanying the description was of *E. brevicaule* and not his var. *leptophyllum*. Torrey (1853) stated that the original specimens were found both at Zuñi and on the San Francisco Mountains in northern Arizona; however, no specimens of this species from Arizona have been found among the Woodhouse material or among the other specimens in the Torrey Herbarium collected prior to 1853. The variety was based on fragmentary material.

The var. *leptophyllum* was transferred to *Eriogonum microthecum* by Torrey and Gray in 1870, but was elevated to the species rank by Wooton and Standley (1913) while they were working on the flora of New Mexico. Subsequent floristic works have continued to maintain the specific rank for this plant.

Eriogonum leptophyllum may be looked upon as the most primitive extant member of an evolutionary line that extends through *E. clavellatum* to *E. bicolor*, *E. ripleyi*, and perhaps to *E. cicifolium*. The origin of *E. leptophyllum* is to be sought among the various forms of ancient entities associated with the development of *E. microthecum*, and most likely those forms associated with var. *foliosum*. This concept is sup-

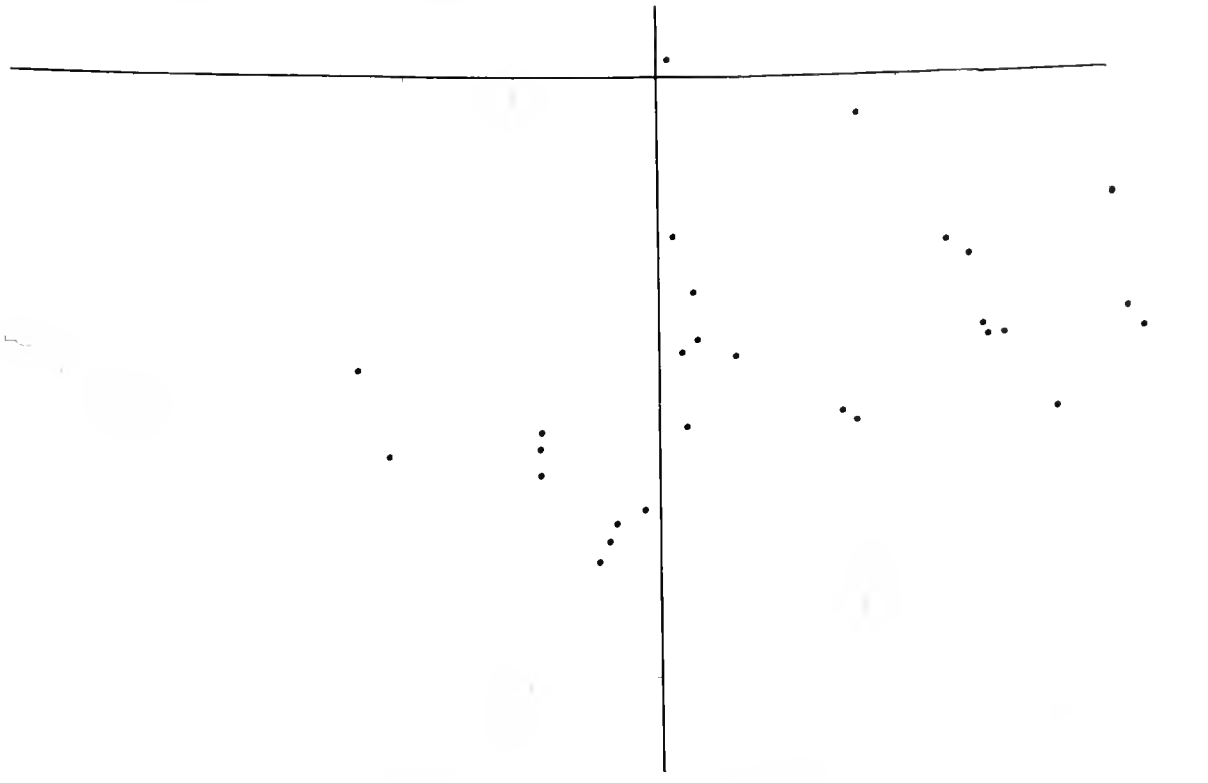

Fig. 1 Distribution map of *Eriogonum leptophyllum*.

ported in part by the appearance of the young specimens of both buckwheats which tend to resemble each other in their long leaves, narrow involucres, and rather compact inflorescences. The demarcation between *E. leptophyllum* and *E. clavellatum* is sharp, but allowing for evolutionary divergency, it is possible to speculate such an origin. The linear arrangement of the species in the Section Corymbosa could be reversed with *E. leptophyllum* following *E. microthecum*, but as those species following *E. microthecum* (i.e., *E. effusum* and the *E. corymbosum* complex) exhibit a stronger tendency for a more direct relationship, it simply proved more convenient to arrange the species as seen in this revision.

In the field, *Eriogonum leptophyllum* is distinctive and not likely to be confused with any other species. The plants are rather tall and roundish, with only the upper portions bearing herbaceous stems. The inflorescences are compact and somewhat broomlike in that they are composed of numerous erect branches bearing short, flower-bearing nodes and internodes. The result is a shrub, which in anthesis, becomes a mass of white flowers. This produces a colorful sight on the red or gray gumbo clay hills in northwestern New Mexico and adjacent Arizona as the plants stand out in brilliant contrast against the color of the soil. It would seem that the horticulturalists have overlooked a beautiful plant that might make a unique addition to the garden.

2. **Eriogonum clavellatum Small**

Eriogonum clavellatum Small, Bull. Torrey Bot. Club 25:48. 1898. – "Barton's Range," likely between Comb Wash and Lime Creek, San Juan County, Utah, 13 July 1895, *Eastwood 132*. Holotype, NY! Isotypes, CAS, GH, MO, NY, UC, US!

Low-rounded, heavily-branched polygamo-dioecious subshrubs 1-2 dm high, 3-8 dm wide, the lower stems reddish-brown, woody, the bark exfoliating in long, loose strips, often leafy, the upper branches herbaceous, slender, thinly floccose to glabrous; *leaves* solitary or in fascicles on short dwarf shoots, scattered along the lower 3/4 of the herbaceous stems, somewhat scattered and evenly-spaced but in fascicles on the woody portion of the plant, the leaf-blades oblanceolate, 5-12 (15) mm long, 0.8-1.7 (2) mm wide, densely white-tomentose below, the midveins totally obscured by the tomentum, thinly pubescent and green above when young, becoming glabrous by anthesis, the margins entire, tightly revolute and completely enclosing the lower surface, the apices rounded to obtuse, the bases acute, the leaves persistent, the petioles short, 0.5-1.5 mm long, light greenish-brown and thinly pubescent when young, becoming brown and glabrous at maturity, the petiole-bases triangular, 0.8-1.2 mm long, 1-1.3 mm wide, slightly tomentose to glabrous without, tomentose within, not clasping the stems; *flowering stems* slender, 0.6-2 cm long, slightly pubescent when young but becoming glabrous at maturity, the area among the leaves below becoming sparsely tomentose; *inflorescences* umbellate-cymose, more or less compact and congested, 0.5-1.5 cm long, 1-2 cm wide, trichotomous, the rays 2-5 mm long, green and essentially glabrous; *bracts* scalelike, ternate, linear, 1.5-2.5 (3) mm long, 0.3-0.8 mm wide, glabrous without, sparsely tomentose within, connate at the base; *pedicels* slender, 1.5-4 mm long, green and glabrous, erect; *m-*

volucres solitary, turbinate-campanulate, (3.5) 4-4.5 mm long, 2.5-4.5 mm wide, green and glabrous within and without, the 5 acute teeth 0.6-0.9 mm long, membranaceous along the margins, the bractlets linear-oblanceolate, hyaline, 2-4 mm long, fringed with short capitate gland-tipped cells, the pedicels 3.5-7 mm long, glabrous; *flowers* white with greenish-brown to reddish-brown midribs and bases, 3-3.5 mm long, glabrous within and without except for scattered microscopic glands along the midribs within, the tepals dissimilar, the outer whorl of tepals broadly obovate to nearly fan-shaped, 2-2.5 mm wide, the apices rounded to retuse, the inner whorl of tepals oblanceolate to spathulate, 0.9-1.5 mm wide, slightly shorter than the outer whorl, united about 1/4 the length of the flower; *stamens* long exserted, 3-6 mm long, the filaments sparsely pilose basally, the anthers reddish to light pink, 0.5-0.6 mm long, oblong; *achenes* light brown, 3-3.5 mm long, the globose base tapering to a long, 3-angled beak. Representative collections: *Harrison et al. 10359* (US); *Maguire 5853* (BRY, GH, NY, UC, UTC, WTU); *Reveal et al. 840* (ARIZ, BRY, CAS, GH, MO, NY, OKL, RM, RSA, UC, US, UTC, WTU).

Distribution.

Low-rolling clay hills and slopes along dry washes in and around Comb Wash west to Lime Creek, southwest of Bluff, San Juan County, Utah, from 4,500-5,200 feet elevation. Flowering from April to June. Figure 2.

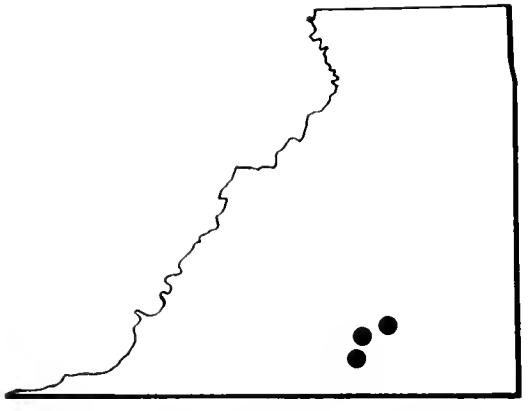

Fig. 2. Distribution map of *Eriogonum clavellatum*.

The type of the Club-leafed Buckwheat, *Eriogonum clavellatum*, was collected between Comb Wash and Lime Creek or at least it would appear that is the case. Alice Eastwood (1896) stated that her "*E. mearnsii*" (as she called the collection) was gathered "on a rocky hill on Barton's Range, between Epsom and Willow creeks," but it is difficult to determine what her Epsom and Willow creeks were. In retracing her travels, it would seem that after leaving Butler Wash she traveled up onto the mesa east of Comb Wash and then down into Comb Wash itself. From here, she traveled with Alfred Wetherill across Lime Ridge, reaching Lime Creek, which, it is thought, she called Willow Creek. As *E. clavellatum* occurs on the western rim of Comb Wash and thus on the eastern edge of Lime Ridge, it is proposed that this is the type locality. Nevertheless, the species is rather rare, both in the field and herbaria and is known only from the collections cited above.

The species is the largest and most shrubby of those taxa having elongated peduncles, tight revolute leaves, and dissimilar whorls of tepals. It is felt that *Eriogonum clavellatum* evolved from *E. leptophyllum* (or some form related to that entity), and the other members of this group which follow can be looked upon as isolated modifications of the ancestoral type which gave rise to, and evolved from, *E. clavellatum*.

In the field, this species is quickly recognized by its bright green appearance, whitish flowers, and low stature. These morphological features, plus the restricted distribution and the early flowering of this species, easily distinguishes *Eriogonum clavellatum* from all other species in the genus. The low-rounded subshrubs are easily seen on the reddish soils of Comb Wash, and in the spring of the year seem like small white boulders on the hillsides when viewed from a distance. The Comb Wash area is a pleasant place to collect, and richly rewards the more diligent botanist who cares to venture into the area at all seasons.

3. **Eriogonum bicolor** M. E. Jones

Eriogonum bicolor M. E. Jones, Zoe 4:281. 1893. – *Eriogonum microthecum* Nutt. ssp. *bicolor* (M. E. Jones) S. Stokes, Gen. Eriog. 75. 1936. Thompson Springs [now Thompson], Grand County, Utah, 7 May 1891, *M. E. Jones s.n.* Holotype, POM! Isotypes, A, MO, NY, PH, UC, US!

Low-rounded, heavily-branched pulvinate, polygamodioecious subshrubs, 2-6 cm high, 5-20 (30) cm across, the lower stems reddish-brown to light brown, woody, the bark exfoliating in long loose strips, leafy, the upper branches herbaceous, slender, tomentose; *leaves* solitary or in fascicles on short dwarf shoots, scattered along the lower 1/2 to 3/4 of the herbaceous stems, somewhat closely placed and congested, the fascicles restricted to the tips of stemless caudices or on the woody portions of the plants, the leaf-blades linear-oblanceolate to narrowly elliptic, 5-12 (15) mm long, 1-2 (3) mm wide, densely white-tomentose below, the midveins totally obscured by the tomentum, slightly less tomentose and white to whitish-green above, the margins entire, revolute and often completely enclosing the lower surface, the apices and bases acute, the leaves persistent, the petioles short, 1-1.5 mm long, light greenish- to yellowish-brown and thinly pubescent when young, becoming subglabrous at maturity, the petiole-bases triangular, 0.5-1 mm long and wide, slightly tomentose to glabrous without and light brown and densely tomentose within, not clasping the stems; *flowering stems* slender, 3-22 mm long, densely tomentose, remaining tomentose among the leaves below as well; *inflorescences* umbellate-cymose, more or less compact and congested, 5-10 mm long, 5-15 mm wide, dichotomous or trichotomous, rarely reduced to a single ray, the rays 1-5 mm long, tomentose; *bracts* scalelike, ternate, 0.7-1.3 mm long, 0.2-0.6 mm wide, linear, glabrous to sparsely pubescent without, tomentose within, connate at the base; *peduncles* slender, 1.5-3 (4) mm long, tomentose when young, becoming subglabrous at maturity; *involucres* solitary, turbinate-campanulate, 2-4 mm long, 1.5-3 mm wide, tomentose to subglabrous or glabrous without, glabrous within, the 5 acute teeth 0.4-0.7 mm long, membranous along the margins, the bractlets oblanceolate, 1.5-3.5 mm long, hirsutulous with short acute cells scattered

among gland-tipped cells, hyaline, the pedicels 3-6 mm long, glabrous; *flowers* white with greenish-brown to reddish-brown midribs and bases, 2.5-4 mm long, glabrous within and without except for scattered glands along the midribs within, the tepals dissimilar, the outer whorl of tepals broadly obovate to nearly orbicular, (2) 2.5-3 mm wide, the apices rounded to emarginate, the inner whorl oblanceolate to narrowly elliptic, 1-1.5 mm wide, slightly shorter than the outer whorl, united about 1/4 the length of the flower; *stamens* long exserted, 3-5 mm long, the filaments glabrous to pilose basally, the anthers reddish, 0.5-0.6 mm long, oblong; *achenes* light brown, 3-3.5 mm long, the narrowly globose base tapering to a long, 3-angled beak. Representative collections: *Atwood 1340* (BRY); *Barneby 13134* (CAS, NY); *Cronquist 9091* (MICH, NY, RSA, UC, UTC, WS, WTU); *Harrison 11149, 11409, 11515, 11705* (BRY, NY); *Higgins and Reveal 1282, 1295* (BRY); *Jones s.n.*, on *8 May 1914* (CAS, GH, MICH, NY, POM, US); on *28 May 1914* (CAS, MICH, POM, UC, US); *Maguire 18241* (GH, NY, UC, UTC, WTU); *Ripley and Barneby 8635* (CAS, NY, UTC); *Stokes s.n.* (NY, UC, US); *Welsh 3976, 7072* (BRY).

Distribution.

Dry sandy clay to gumbo clay flats and low rolling hills in eastern Utah and adjacent western Colorado, from Castle Valley and the San Rafael Swells of Carbon and Emery counties into the Grand River Valley of Grand County, Utah, and Mesa County, Colorado, southward into Utah to Capitol Reef National Monument and the Green River Desert of Wayne County, the Waterpocket Fold area near Bullfrog, the foothills of the Henry Mountains of Garfield County, and entering San Juan County along the Colorado River in Canyonlands National Park. Flowering from April to June. Figure 3.

The type collection of the Bicolored Buckwheat, *Eriogonum bicolor*, was possibly distributed to herbaria on two different occasions by Jones; once with the label data as "Thompson Springs" and again as "Cisco." The first is cited in the original publication (Jones, 1893), and the handwritten labels bearing Thompson Springs are found in several herbaria (such as Arnold Arboretum, Gray Herbarium, The New York Botanical Garden, and The Academy of Natural Sciences). The second label is printed and has the words "N. Sp. Type" found below the scientific name. According to Jones (1965), he was at Westwater in eastern Grand County, Utah, on 6 May 1891, and at Thompson Springs [now Thompson on road maps] on 7 May. No mention is made of Cisco, but if Jones was traveling by train or if he was going by buckboard, he had to pass through Cisco, the largest town in the area. It is considered at this time that the printed labels were prepared later and the plants distributed to other herbaria (such as The Missouri Botanical Garden, the University of California at Berkeley, and the United States National Museum) sometime after the others had been sent out. Nevertheless, they are still part of the original type collection gathered near Thompson, and Jones was simply identifying the location as being near the largest town in the area at that time.

Eriogonum bicolor is a low, pulvinate species which flowers in the spring of the year, being at the

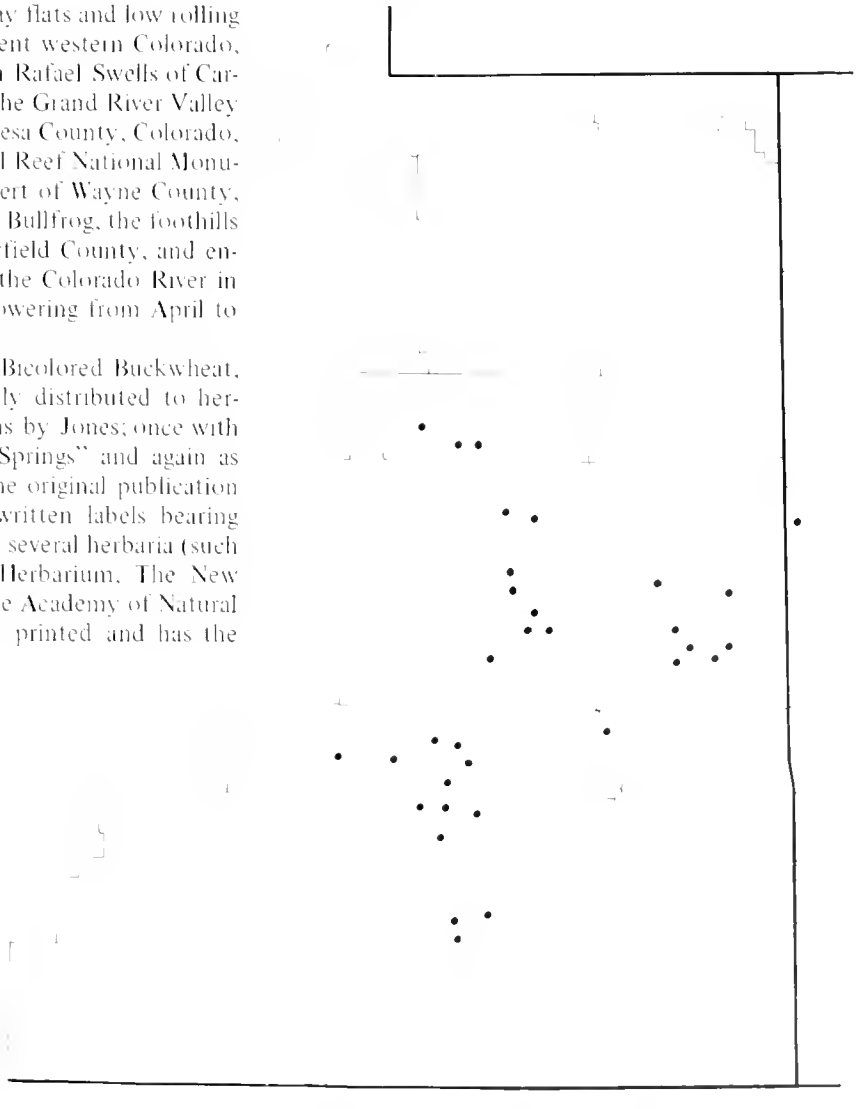

Fig. 3. Distribution map of *Eriogonum bicolor*.

peak of anthesis in May. It is rather closely related to *E. clavellatum*, differing essentially only in the degree of pubescence and stature. Both occur on clay soils, but so far as is known, their respective ranges do not overlap.

During the course of this study, a single collection was discovered which seems to represent a new species for the *Eriogonum microthecum* complex. This is a low, pulvinate subshrub also related to *E. clavellatum* as it possess the same type of leaf construction and, to a great degree, a similar type of pubescence as well. The distinctive features of this buckwheat are the narrowly turbinate involucres, the flowers with the essentially similar tepals, and the large globose flower bases. The plants are more pulvinate and not as woody as *E. clavellatum*, nor do they have the same type of inflorescence. In most of these features, this seemingly new species also differs from *E. bicolor*. At present, this new entity is known from a single collection made by Harold Gentry from near Hotchkiss, Delta County, Colorado. However, recent attempts to rediscover the population have failed. Dr. Larry C. Higgins has discovered a new species of *Cryptantha* in the area while searching for *Eriogonum* and thus this part of Colorado seems to need additional collecting. Hopefully, additional material will come to light, which may form the basis of a future publication.

Of all the species in this complex, the Bicolored Buckwheat is the only one that has been studied sufficiently to allow some comment on the polygamo-dioecious condition. The *female* plants are male sterile, that is, the anthers do not form or function and the filaments fail to elongate; however, vestigial remains of the anthers and filaments are clearly visible. The *male* plants, on the other hand, produce both function stamens and ovaries. Collections at the Brigham Young University Herbarium which are only *female* (at least in part) are *Cottam 2009; Harrison 11149, 11206, 11409; Higgins and Reveal 1295*, and *Welsh 7072*. Often the two conditions occur on plants growing together, but at least on one occasion, plants found on the San Rafael Desert were only female with no hermaphroditic plants discovered. Unfortunately it was too early in the year to determine if such plants would have viable seeds; still, it could be that some populations of *Eriogonum bicolor* are apomictic, although it is too early to make such suggestions. Nevertheless, this evolutionary condition seems to point to the fact that this species represents an end point, or at least a highly specialized condition in the genus, even if it occurs in only a few members of the population.

4. **Eriogonum ripleyi** J. T. Howell

Eriogonum ripleyi J. T. Howell, Leafl. W. Bot. 4:5. 1944. — On the edge of sandstone mesas 13 miles southwest of Fraser's Wells, Coconino County, Arizona, 13 May 1943, *Ripley & Barneby 5226*. Holotype, CAS!

Low-depressed, heavily branched, possibly polygamo-dioecious subshrubs 0.5-1.5 (2) dm high, 0.5-3 (5) dm across, the lower stems reddish-brown or grayish, woody, the bark exfoliating in long loose strips of platelike segments, leafy nearly throughout, the upper branches woody, slender to stoutish, subglabrous to glabrous, the bark grayish; *leaves* solitary or much more commonly in fascicles on short dwarf shoots, these alternately scattered along the upper 3/4 to 7/8 of the upper woody stems, closely placed and congested, the leaf-blades narrowly oblanceolate, 2-6 mm long, 0.5-1 mm wide, densely white-tomentose below, thinly floccose to villous and greenish above, the midvein totally obscured by the tomentum, the margins entire, strongly revolute and completely enclosing the lower surface, the apices and bases acute, the leaves persistent, the petioles short, (0.5) 1-1.5 mm long, light greenish- to yellowish-brown and thinly pubescent when young, becoming subglabrous at maturity, the petiole-bases triangular, 0.5-1 mm long and wide, slightly tomentose to glabrous without, light brown and membranous, densely tomentose within, not clasping the stems; *flowering stems* indistinguishable from the other branches, woody, grayish; *inflorescences* reduced cymose-umbellate, consisting almost entirely of a single involucre arising from the apex of each dwarf shoot; *bracts* lacking; *peduncles* slender, thinly floccose, 1-10 mm long, erect, terminating the dwarf shoot; *involucres* solitary, campanulate, 3-3.5 mm long and wide, thinly floccose or villous to subglabrous without, glabrous within, the 3-5 unequal acute teeth 0.7-1 mm long, more or less membranous along the margins, the bractlets linear, 2-3 mm long, hirsutulous with short acute cells scattered among the gland-tipped cells, hyaline, the pedicels 3-5 mm long, glabrous or sparsely pilose at the base; *flowers* white with reddish-brown midribs and bases, 3.5-4.5 mm long, glabrous within and without, the tepals dissimilar, the outer whorl of tepals suborbicular, 3-3.5 mm long, 3.5-4 mm wide, the apices rounded to emarginate, the inner whorl of tepals broadly obovate, 2.8-3.2 mm long, 2-2.5 mm wide, united about 1.5 the length of the flower; *stamens* exserted, the filaments villous to densely pilose basally, the anthers reddish, 0.5-0.6 mm long, oblong; *achenes* light brown to brown, 2-2.5 mm long, the narrow base tapering gradually to a short, 3-angled beak. — Representative collections: *Harris s.n.* (ASU, BRY, NY); *Ripley and Barneby 8445* (CAS).

Distribution.

Sandy clay soil on the edge of sandstone mesas associated with pinyon, about thirteen miles southwest of Fraser's Wells, at 6,000 feet elevation, Coconino County, and at the north end of the Horseshoe Dam area on calcareous soil, Yavapai County, Arizona. Flowering from April to June. Figure 4.

The most remarkable characteristic of the Ripley Buckwheat is the bractless flowering stems and the resulting inflorescence which is essentially composed of a single terminal involucre. This trend is first seen in *Eriogonum clavellatum* and carried to this extreme in *E. ripleyi*. The ebracteated condition is likely due to the shortening of a true flowering stem, leaving only the peduncle and the uppermost whorl of leaves of the fascicle may be true bracts. However, based on gross morphology, it is impossible to determine at this time whether or not the leaves are all "leaves" or the upper whorl is "foliaceous bracts." As noted by Howell (1944), this situation is similar to the condi-

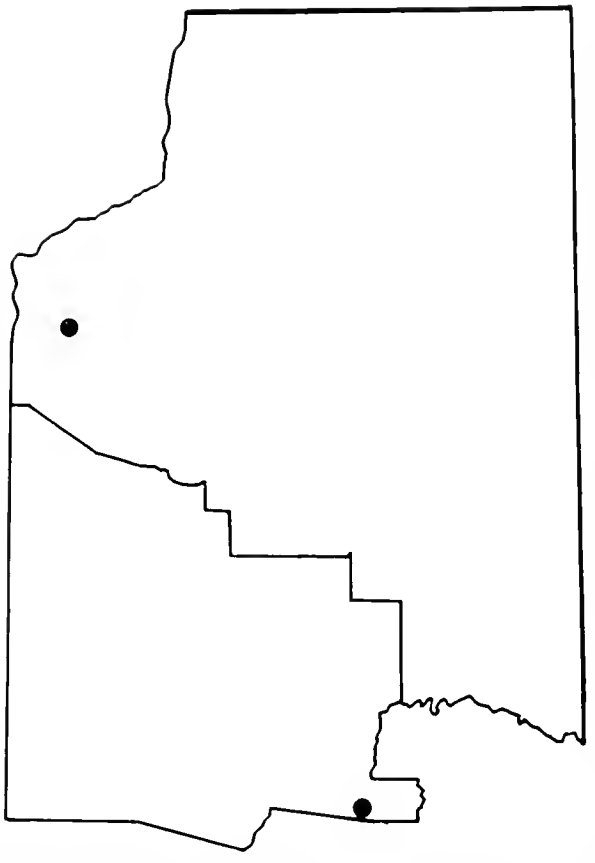

Fig. 4 Distribution map of *Eriogonum ripleyi*. Coconino and Yavapai counties, Arizona.

tion found in *E. caespitosum* Nutt., but this is only another example of parallel reduction of similar structures in unrelated species groups in the genus.

Of the remaining vegetative features, the arrangement of the leaf fascicles with the involucres extending out from these on slender peduncles represents another extreme in the reduction of the inflorescences. It is possible to imagine that at one time short branches radiated out along the main woody branches, each containing a small-branched inflorescence. However, with the reduction of the shorter branches, the leaves were reduced to mere fascicles, and the inflorescence reduced to a single involucre. This trend is not seen in other species in the *Eriogonum microthecum* complex although it is hinted at in *E. bicolor*.

In 1969 a second location of this species was discovered in Yavapai County, Arizona. Until then, *Eriogonum ripleyi* was known only from the sandstone mesas southwest of Frasier's Well. The plants from Yavapai County are larger and more robust than those from the type location, and the two differ in some minor ways as well. Whether or not the differences are important will have to remain until the necessary field work can be done and the variation studied in detail.

5. Eriogonum ericifolium Torr. & Gray

Low spreading pulvinate, probably polygamo-dioecious, subshrubs 0.5-0.9 (1.2) dm high, 0.8-2 (3.5) dm across, the lower stems reddish-brown or gray, woody, the bark exfoliating in long loose plates, essentially leafless, the upper branches herbaceous, slender, floccose; *leaves* solitary or in fascicles on short dwarf shoots, scattered along the lower 3/4 to 7/8 of the herbaceous stems, rather closely crowded, the fascicles restricted to the tips of the stemless caudices, the leaf-blades oblanceolate to narrowly elliptic, 5-8 mm long, 0.8-1.5 (1.9) mm wide, densely white-tomentose below, the midveins evident and less pubescent, glabrous and green to floccose and whitish-green above, the margins entire, revolute or at least with thickened margins, fully or only partially obscuring the undersurface of the blade, the apices and bases acute, the leaves persistent, the petioles short, 1.5-2 mm long, floccose, the petiole-bases elongate-triangular, 1-2 mm long, 0.8-1.2 mm wide, light tan to greenish-brown, glabrous or thinly pubescent, light tan and densely tomentose within, not clasping the stems; *flowering stems* slender, 0.3-2 cm long, floccose to slightly tomentose, the area below among the leaves remaining floccose to tomentose or rarely glabrate; *inflorescences* umbellate-cymose, compact and congested, 0.5-1 cm long, 0.5-1.5 cm wide, sparsely tomentose to floccose, dichotomous, the rays up to 7 mm long; *bracts* ternate, scale-like, 1-1.5 mm long, 0.4-0.6 mm wide, linear, floccose without, tomentose within, connate at the base; *peduncles* lacking; *involucres* solitary, turbinate, 2.5-3 mm long, 1.5-2 mm wide, slightly pubescent without, glabrous within, the 5 acute teeth 0.4-1 mm long, not membranous along the margin, the bractlets linear, 2-3 mm long, hyaline, minutely fringed with capitate gland-tipped cells, the pedicels 2.5-4.5 mm long, glabrous; *flowers* white with reddish-brown midribs, becoming tinged with pink or red to rose at maturity, 2-2.5 mm long, glabrous within and without except for a few scattered microscopic glands along the midribs within, the tepals dissimilar, the outer whorl to tepals broadly obovate to nearly orbicular, more or less claw-shaped in some, 2-2.5 mm wide, the apices rounded to retuse or emarginate, the bases obtuse to truncate or cordate, the inner whorl of tepals oblanceolate to oblong, 0.8-1.2 mm wide, about as long as the outer whorl, united about 1/5 the length of the flower and forming a subglobose base; *stamens* slightly exserted, 2-3 mm long, the filaments pilose basally, the anthers reddish, 0.5-0.6 mm long, oblong; *achenes* light brown, 2-2.5 mm long, the narrowly globose base tapering to a papillate, 3-angled beak.

Distribution.

Dry gravelly to rocky places mainly in pinyon-juniper woodlands from 3,000-6,600 feet elevation, extreme western Mohave County eastward across Coconino County and southern Navajo County, and in Yavapai County, Arizona. Flowering from August to October. Figure 5.

Unfortunately the Heath-leaf Buckwheat, *Eriogonum ericifolium*, has not been investigated in the field. Specimens are infrequently encountered in herbaria, and I have yet to be in northern Arizona at the right time of the year to study the species in the field. The typical phase is known only from two collections, both made in the last century. The more widespread variant, var. *pulchrum*, is not abundant, and preliminary studies have done little more than indicate its relationship to other members in this species complex. Hopefully, this plant can be fully studied in the field, but based on information now at hand, the following treatment seems correct.

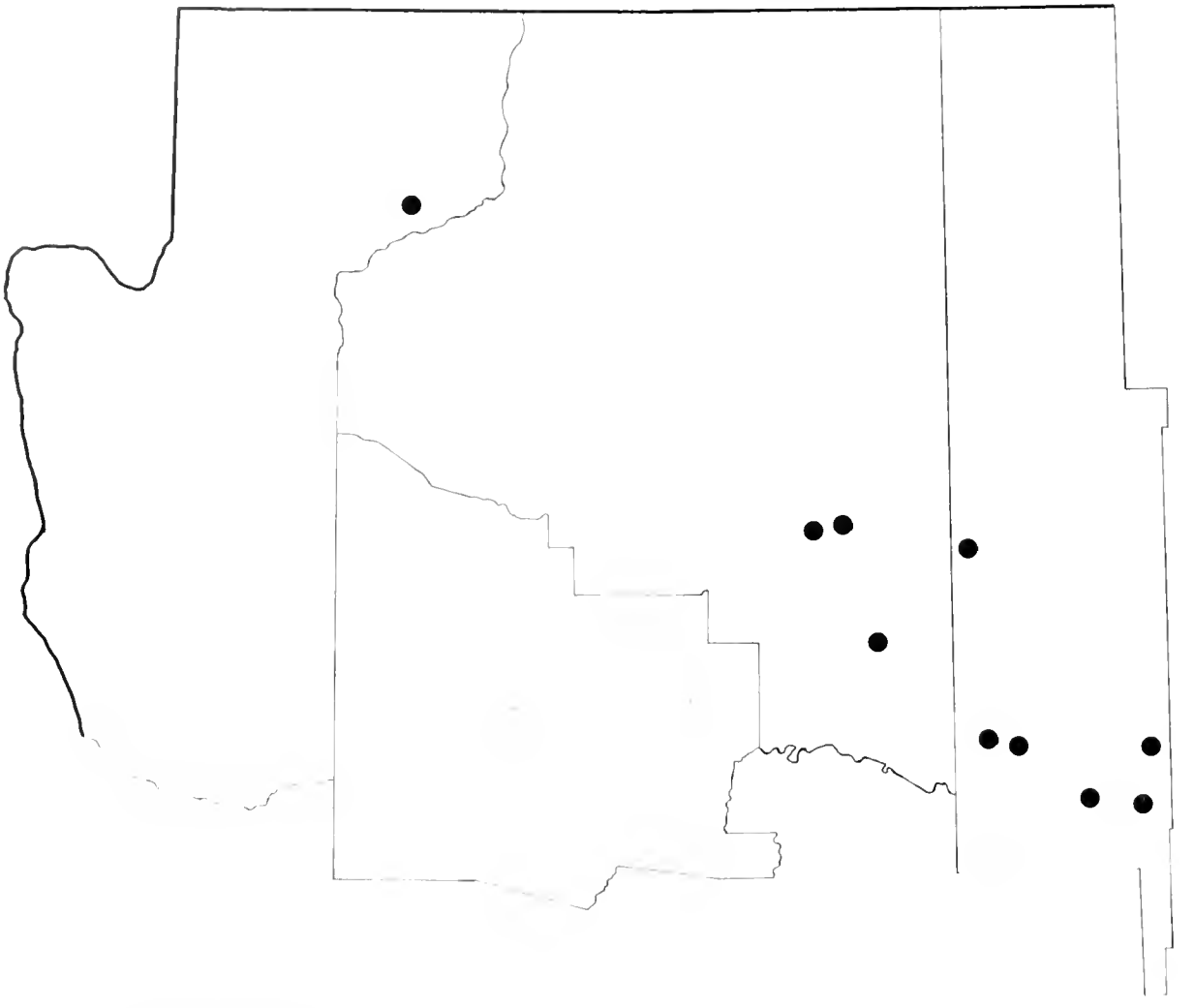

Fig. 5. Distribution map of *Eriogonum ericifolium*, with var. *pulchrum* (solid circles) and var. *ericifolium* (open circles). Northern Arizona.

Key to the Varieties of *Eriogonum ericifolium*

A. Upper surface of the leaves floccose; outer tepals nearly orbicular, claw-shaped; infrequent, extreme western Mohave County eastward to southern Navajo County, Arizona
5a. var. *pulchrum*.

AA. Upper surface of the leaves glabrous; outer tepals obovate, now claw-shaped; rare, Yavapai County, Arizona
5b. var. *ericifolium*

5a. **Eriogonum ericifolium var. pulchrum (Eastw.) Reveal**

Eriogonum ericifolium Torr. & Gray var. *pulchrum* (Eastw.) Reveal, comb. nov., based on *E. pulchrum* Eastw., Proc. Calif. Acad. Sci. IV, 20:139, 1931. *Eriogonum microthecum* Nutt. ssp. *pulchrum* (Eastw.) S. Stokes, Gen. Eriog. 76, 1936. *Eriogonum mearnsii* Parry in Britt. var. *pulchrum* (Eastw.) Kearn. & Peebl., J. Wash. Acad. Sci. 29:474, 1939. Near the Meteor Crater, near Canyon Diablo, Coconino County, Arizona, 21 October 1928, *Eastwood 15746*. Holotype, CAS! Isotypes, GH, NY, POM, US!

Low-spreading subshrubs 0.8-1.2 dm high, woody at the base; *leaves* 5-8 mm long, floccose and whitish-green above, slightly revolute or with thickened margins; *flowers* 2-2.5 mm long, the outer whorl of tepals nearly orbicular, more or less claw-shaped, 2-2.5 mm wide. Representative collections: *Barneby 12964* (CAS); *Bohrer 1097b, 1132, 1133*, (ARIZ); *Cottam 13836* (CAS); *Darrow 3292* (ARIZ, CAS); *Eastwood and Howell 6904* (CAS), *Jaeger s.n.* (MNA); *Ochto 3462* (ASU), *3498* (ASU, BYU), *Michaels 814* (CAS).

Distribution.

Dry gravelly and rocky places from Toroweap Point, Mohave County, southeastwardly into east-central Coconino County in the Painted Desert region northwest and west of Winslow, and continuing southeastward in Navajo County to near the Mogollon Rim in the vicinity of Snowflake and Heber, 5,400-6,600 feet elevation, northwestern Arizona. Flowering from August to October, Figure 5.

The var. *pulchrum* is poorly known to me and is in need of much critical field and herbarium study. It is seemingly endemic to northern Arizona but some spe-

cimens of *Eriogonum microthecum* do appear to be similar, especially some found in southern Utah. The variety seems to bridge the gap between *E. leptophyllum* and *E. microthecum* through the latter's var. *foliosum*. However, this point is highly speculative. The var. *pulchrum* also grossly resembles *E. bicolor*, but in this case, the similarities are likely due to parallel evolution and not because of any direct association.

The relationship between var. *pulchrum* and var. *ericifolium* seems clear, with the rare var. *ericifolium* being a slightly more depauperate, glabrous phase occupying an area disjunct from var. *pulchrum*. Based on existing herbarium material, the placement of var. *pulchrum* under this species seems valid, but additional studies will be needed to confirm this belief.

5b. **Eriogonum ericifolium var. ericifolium**

Eriogonum ericifolium Torr. & Gray, Proc. Amer. Acad. Arts 8:170. 1870, as *ericaefolium*. – *Eriogonum fasciculatum* Benth. var. *ericifolium* (Torr. & Gray) M. E. Jones, Contr. W. Bot. 13:14. 1903. *Eriogonum microthecum* Nutt. ssp. *ericifolium* (Torr. & Gray) S. Stokes, Gen. Eriog. 75. 1936. – Near Fort Whipple [now Whipple], Yavapai County, Arizona, 25 September 1865, *Coues & Palmer 581*. Holotype, GH! Isotype, MO!

Eriogonum mearnsii Parry in Britt., Trans. New York Acad. Sci. 8:72. 1889. – *Eriogonum microthecum* Nutt. ssp. *mearnsii* (Parry in Britt.) S. Stokes, Gen. Eriog. 75. 1936. – Near Fort Verde [now Camp Verde], Yavapai County, Arizona, 11 October 1887, *Mearns 179*. Holotype, NY! Isotypes, NY!

Low-spreading subshrubs 0.5-0.8 dm high, woody at the base; *leaves* 5-6 mm long, glabrous and green above, tightly revolute; *flowers* 2 mm long, the outer whorl of tepals obovate, not claw-shaped, 2 mm wide. – Representative collections: Known only from the two cited type collections.

Distribution.

Probably in gravelly or rocky places on slopes, known only from near Prescott and Camp Verde, Yavapai County, Arizona, from 3,000-5,200 feet elevation. Probably flowering from August to October. Figure 5.

The type of the Heath-leaf Buckwheat, *Eriogonum ericifolium*, was collected by Elliott Coues and Edward Palmer near Fort Whipple in 1865. The material is exceedingly fragmentary and consists of only the upper herbaceous branches, but based on this, Torrey and Gray (1870) described the species. A second collection was made by Mearns near Fort Verde, and this was described by Parry in Britton's (1889) paper on the Mearns collections gathered in Arizona from 1884 to 1888. In 1903 Jones proposed the varietal combination *E. fasciculatum* var. *ericifolium* perhaps following Watson's (1877) suggestion that *E. ericifolium* was a synonym of *E. fasciculatum*. I have been unable to understand this conclusion, but since Coues and Palmer did collect *E. fasciculatum* var. *polifolium* (Benth. in DC.) Torr. & Gray at Fort Whipple, Watson (and perhaps Jones) mistook this collection to represent the type of *E. ericifolium*.

In the literature on the genus, the name *Eriogonum ericifolium* has been generally ignored. The various treatments of the genus for Arizona in the past have not attempted to place the species, or, as is the more frequent case, the authors have simply not mentioned the name.

6. **Eriogonum microthecum Nutt.**

Low to tall, spreading to erect, open to compact, sparsely to diffusely branched herbaceous subshrubs to woody shrubs, 0.5-15 dm high, 0.6-1.3 (1.8) m across, the lower stems reddish-brown, light brown, yellowish-brown, to grayish, woody, the bark exfoliating in loose platelike strips or long loose strips, essentially leafless or leaves restricted to fascicles, the upper branches herbaceous, mostly slender, glabrous to floccose or densely tomentose to lanate when young, remaining so or becoming less densely pubescent as the plant matures, often greenish at maturity; *leaves* solitary or in fascicles on short dwarf shoots, scattered along the upper part of the woody stems in some, becoming alternate and variously spaced along the lower 1/3 to 3/4 (7/8) of the herbaceous branches, the leaf-blades various, linear to linear-oblanceolate or narrowly elliptic to elliptic-obovate, 0.3-3.5 (4) cm long, 1-20 mm wide, variously white-tomentose below, the midveins usually obvious and less pubescent and greenish, as pubescent to slightly less so or nearly to quite glabrous above, the tomentum white to brownish or reddish over the greenish surface, the margins entire, variously revolute or plane, usually with at least the margins thickened, the lower surface completely enclosed in some, the apices mostly acute but occasionally rounded or at least obtuse, the bases acute or infrequently rounded, the leaves persistent, the petioles short, 0.5-5 mm long, light greenish- to yellowish- or tannish-brown and thinly pubescent to nearly or quite glabrous when young, becoming usually less pubescent and more brownish in age, the petiole-bases triangular, deltoid, or elongate-triangular, 0.5-1.5 mm long and wide, slightly tomentose to glabrous without, various shades of brown but usually a less intensive hue than the petioles without, cottony tomentose within, not clasping the stem; *flowering stems* slender to more or less stout, 1-10 cm long, densely lanate to floccose when young, remaining so or becoming subglabrous or glabrous at maturity, the area among the leaves usually remaining tomentose; *inflorescences* cymose, rather congested and compact, more or less flat-topped, 0.5-6 (12) cm long, 1-10 (13) cm wide, trichotomous throughout or at the lower nodes only with the upper branches dichotomously branched, the internodes variously shortened above, tomentose to glabrous, the involucres in the forks of the branches or at the tips of the ultimate bracteated branches; *bracts* scalelike, ternate, 1-5 mm long, 0.5-2 mm wide, linear to triangular, tomentose to glabrous without, tomentose within at least at the connate base; *peduncles*, when present, slender and up to 1.5 cm long, erect, variously pubescent or glabrous; *involucres* solitary, turbinate, (1.5) 2-3.5 (4) mm long, 1.3-2.5 (3) mm wide, variously tomentose to subglabrous when young, becoming less pubescent or more frequently merely floccose between the angled ridges or even glabrous without, glabrous within, the 5 rounded to triangular teeth (0.3) 0.5-1 (1.7) mm long, often with membranous margins, the bractlets linear to oblanceolate, 1-4 mm long, variously pubescent from only sparsely fringed with scattered acute or gland-tipped cells to rather hirsutulous with long white marginal cells, the pedicels 2-4.5 mm long, glabrous; *flowers* white with green, greenish-brown, pink, red, rose, or reddish-brown midribs and bases, becom-

ing tinged with, or fully colored with, pink to rose or even orange in age in some, or yellowish to bright yellow with greenish-yellow midribs and bases, 1.5-3 (4) mm long, glabrous within and without except for scattered microscopic glands along the midribs within, the tepal similar or slightly dissimilar, the outer whorl of tepals oblong to obovate, 1.2-2 mm wide, the apices rounded to obtuse, the bases rounded to more or less cordate, the inner whorl of tepals oblanceolate, elliptic, or oblong, 0.8-1.5 mm wide, as long to slightly longer than the outer whorl, rarely shorter, united about 1/5 to 2/5 the length of the flower; *stamens* slightly to long exserted, 2.5-4 mm long, the filaments sparsely to densely pilose basally, rarely subglabrous, the anthers white, pink, rose, red, or infrequently purplish, 0.35-0.5 mm long, oblong or nearly so; *achenes* light brown to brown, 1.5-3 mm long, the narrowly globose base tapering to a long, 3-angled beak.

Distribution.

Widespread in a variety of habitats from eastern Washington southward to the mountains of southern California, hence eastward in the deserts, high mountain valleys, and mountain ranges to the Rocky Mountains from western Montana southward through Nevada, Utah, western Wyoming, and western Colorado into northern Arizona and New Mexico, from (1,500) 2,200-10,500 feet elevation. Flowering from June to October.

The Great Basin Buckwheat, *Eriogonum microthecum*, as outlined and defined in this revision, is composed of nine closely related and somewhat overlapping varieties. The species is exceedingly complex, and although it has been under intensive study for the past five years, some entities as yet unnamed may prove to be worthy of taxonomic consideration in the future.

Hybridization within *Eriogonum microthecum* is limited, and is believed to occur only between var. *laxiflorum* and var. *foliosum*. This is thought to occur in the zone of their overlapping geographical ranges across southern Nevada and in northern Arizona where var. *laxiflorum* from the north gradually merges with var. *foliosum* of the south. Hybridization between *E. microthecum* var. *laxiflorum* and *E. breviculae* var. *breviculae* is believed to occur in northeastern Utah and adjacent southwestern Wyoming where the two grow together. Supposed accounts of hybridization or introgression between *E. microthecum* and *E. effusum* are unfounded.

Almost all of the infraspecific elements in *Eriogonum microthecum* are difficult to consistently recognize, especially in all of their various phases. The vast majority of specimens can be distinguished and placed, but as some forms tend to blend into each other, these intermediates are often difficult to place. Thus, plants from central Nevada, southern Utah, and northern Arizona are often impossible to place in either var. *laxiflorum* or var. *foliosum*. Some fragmentary specimens may prove difficult to place.

Some populations from totally different habitats are morphologically somewhat similar. Plants from the high alpine reaches of the Sierra Nevada (called var. *alpinum*) will approach var. *lapidicola* which grows on volcanic mesas in southern Nevada. Forms of var. *microthecum* in the low mountains of northern Oregon approach some plants from the foothills of the Sierra Nevada in Inyo County, California, which are recognized here as var. *ambiguum*. At the other extreme, some populations which are thought to represent a single variety may vastly differ from one site to the next. In northern and eastern Utah and portions of southern Colorado, var. *foliosum* is only a few centimeters high. However, through a series of intermediate populations in southeastern Utah and northern Arizona, this variety reaches heights of a meter or more.

In summary, the varieties of *Eriogonum microthecum* are interesting. They represent an example of the kind of variability found in the genus and in plants of the western United States in general.

Key to the Varieties of *Eriogonum microthecum*

A. Flowers white, not yellow or yellowish
  B. Tomentum whitish (see also var. *alpinum* of the high Sierra Nevada); widespread and common from Washington and Montana southward to southern California, northern Arizona, southern Colorado, and northwestern New Mexico
    C. Leaves plane, infrequently revolute; stems and inflorescences floccose to glabrous; northern populations of the species, from Washington and western Montana southward to California, extreme northern Arizona, and western Colorado ..... 6a. var. *laxiflorum*.
    CC. Leaves revolute, rarely plane; stems and inflorescences densely lanate to tomentose, or if glabrous, then plants not in the range of the above variant; southern populations of the species, from southeastern California across southern and central Nevada into southern and eastern Utah, western and southern Colorado, northern Arizona, and northwestern and central New Mexico ..... 6b. var. *foliosum*.
  BB. Tomentum brownish to reddish; scattered populations in southern California, central Sierra Nevada, and from eastern California across Nevada to extreme western Utah
    C. Plants shrubby, 3-6 dm high
      D. Stems and inflorescences tomentose when young, becoming floccose at maturity; flowers 1.5-2 (2.5) mm long; achenes 1.8-2.1 mm long; Panamint Range and the Inyo Mountains, Inyo County, California ..... 6c. var. *panamintense*.
      DD. Stems and inflorescences lanate to tomentose even at maturity; flowers 2-2.5 (3) mm long; achenes 2.5-3 mm long; San Bernardino and San Gabriel mountains, San Bernardino and Los Angeles counties, California ..... 6d. var. *corymbosoides*.
    CC. Plants subshrubs, 0.5-1.5 dm high
      D. Leaves elliptic, not revolute; involucres (2) 2.5-3.5 mm long; flowers (1.5) 2-3.5 (4) mm long; southern and southeastern California eastward across central Nevada to extreme western Utah
        E. Leaves elliptic to ovate, 5-10 mm long, (2) 3-5 (6) mm wide; involucres

(2) 2.5-3 mm long; flowers (2.5) 3-3.5 (4) mm long; San Gabriel Mountains, southern California
6e. var. *johnstonii.*

EE. Leaves elliptic, 3-7 mm long, 1-4 mm wide; involucres (2.5) 3-3.5 mm long; flowers (1.5) 2-3 mm long; Inyo Mountains, Inyo County, California across southern Nevada to extreme western Utah 6f. var. *lapidicola.*

DD. Leaves linear-oblanceolate to narrowly elliptic, often revolute; involucres (1.5) 2-2.5 mm long; flowers 1.5-2.3 mm long; central Sierra Nevada of Alpine, Tuolumne, and Mono counties, California
6g. var. *alpinum.*

AA. Flowers yellowish to yellow, not white

B. Plants floccose to glabrous; leaves (3) 4-9 (12) mm wide; involucres 2.5-3 mm long; achenes 2-2.5 mm long; central Oregon eastward to the Idaho line, and southward to northern Humboldt County, Nevada, and Modoc and Lassen counties, California
6h. var. *microthecum.*

BB. Plants tomentose to floccose; leaves (2) 3-6 (8) mm wide; involucres 2-2.5 mm long; achenes 1.5-2 mm long; extreme west-central Nevada and adjacent eastern California southward to Inyo County, California, and Esmeralda County, Nevada
6i. var. *ambiguum.*

6a. **Eriogonum microthecum var. laxiflorum Hook.** *Eriogonum microthecum* Nutt. var. *laxiflorum* Hook., Hooker's J. Bot. Kew Gard. Misc. 5:264. 1853. – *Eriogonum microthecum* Nutt. ssp. *laxiflorum* (Hook.) S. Stokes, Gen. Eriog. 74. 1936. – "Rocky Mountains of the Columbia in Oregon," actually from western Idaho or perhaps northeastern Oregon, probably collected in August 1834, *Nuttall s.n.* Holotype, K! Isotypes, BM, K!

Eriogonum confertiflorum Benth. in DC., Prodr. 14:17. 1856. – *Eriogonum microthecum* Nutt. var. *confertiflorum* (Benth. in DC.) Torr. & Gray, Proc. Amer. Acad. Arts 8:171. 1870. – *Eriogonum microthecum* Nutt. ssp. *confertiflorum* (Benth. in DC.) S. Stokes, Gen. Eriog. 75. 1936. – Along the Shasta River, Siskiyou County, California, 1-4 October 1841, *Brackenridge 1570.* Holotype, NY! Isotype, GH!

Eriogonum macdougalii Gand., Bull. Soc. Roy. Bot. Belgique 42:191. 1906. – *Eriogonum microthecum* Nutt. var. *macdougalii* (Gand.) S. Stokes, Gen. Eriog. 74. 1936. – About the Grand Canyon, Coconino (probably not Mohave) County, Arizona, at 7,000 feet elevation, 28 June 1898, *MacDougal 176.* Holotype, LY! Isotype, GH, NY, UC, US!

Eriogonum spathulare Gand., Bull. Soc. Roy. Bot. Belgique 42:191. 1906. – *Eriogonum microthecum* Nutt. var. *spathulare* (Gand.) S. Stokes, Gen. Eriog. 74. 1936. – On sterile white clay hillsides, Maurey's Mountain, Crook County, Oregon, 25 July 1901, *Cusick 2698.* Holotype, LY! Isotypes, GH, K, NY, ORE, POM, UC, US!

Eriogonum intricatum Gand., Bull. Soc. Roy. Bot. Belgique 42:191. 1906, non Benth., 1844. – Near Townsend, Broadwater County, Montana, 13 August 1899, *Blankingship s.n.* Holotype, LY! Isotypes, MONT, NY!

Eriogonum tenellum Torr. var. *grandiflorum* Gand., Bull. Soc. Roy. Bot. Belgique 42:197. 1906. – From an unknown location in Rich County, Utah, August 1897, *Linford s.n.* Holotype, LY!

Eriogonum tenellum Torr. var. *sessiliflorum* Gand., Bull. Soc. Roy. Bot. Belgique 42:198. 1906. – Near Reno, Washoe County, Nevada, September 1894, *Hillman s.n.* Holotype, LY! Isotype, RENO!

Low to erect, spreading to sparsely branched subshrubs, or infrequently shrubs, (1) 2-4 (5) dm high, 2-8 dm across; *leaves* mostly elliptic, (0.5) 1-2 (2.5) cm long, (1.5) 2.5-6 (8) mm wide, densely to sparsely white-tomentose below, less so to sparsely floccose and whitish-green above, the tomentum whitish, the margins plane or with thickened edges, infrequently revolute, the apices acute; *flowering stems* slender, 2-6 (8) cm long, floccose to sparsely tomentose when young, remaining at least floccose in some in the northern part of the variant's range, otherwise frequently becoming green and glabrous or subglabrous, the tomentum whitish; *inflorescences* (1) 2-4 (8) cm long, floccose to glabrous when young, usually becoming subglabrous or glabrous at maturity; *involucres* 2-3 (3.5) mm long, subglabrous to glabrous or merely floccose between the angled ridges; *flowers* white with greenish- or reddish-brown midribs and bases, becoming tinged with pink or wholly pinkish in most especially at maturity, 2-3 mm long, the tepals slightly dissimilar, the outer whorl of tepals obovate, the bases truncate to nearly cordate, the inner whorl of tepals narrower; *achenes* 2-3 mm long. – Representative collections: *Archer 6979* (NA, RSA, WS); *Baker 8658, 8745* (WS), *9444, 9529, 9984* (WTU); *Beach 867* (ARIZ, BM, COLO, IDS, NY, OKL, SD, US, UTC, WIS, US, WTU); *Christ 5813, 5824, 6551, 8491, 8894, 8964, 9029, 9799, 11452, 12238, 15514, 15540, 16104* (NY); *Cottam 15998* (RSA, UT, WIS, WTU); *Cronquist 1961* (IDS, MO, NY), *3056* (IDS, MO, ND), *7523* (GH, NY, UC, UTC, WS, WTU), *7766* (CAS, NY, RSA, UTC, WTU); *Detling 3155* (ORE, UC); *Eastwood and Howell 7035* (CAS, GH, UC); *Ferris and Lorraine 10995* (CAS, IDS, GH, RSA, UC, WTU); *Goodding 1742* (COLO, GH, MO, NY, UC, US); *Heller 9511* (MO, NY, RENO, US), *9979* (A, GH, RENO); *C. L. Hitchcock 15587* (COLO, NY, RSA, WS, WTU), *15657, 16703* (NY, RSA, UC, WS, WTU); *Hitchcock and Martin 5579* (ISC, NY, UC, WS, WTU), *5658* (MO, NY, OKL, POM, UC, US, UTC, WS, WTU); *Leiberg 489* (BM, BR, GH, NY, OKL, UC, US); *Maguire and Holmgren 22193* (GH, MO, NY, UC, UTC, WTU), *26729* (GH, NY, UC, US, UTC); *Nelson 8116* (ARIZ, GH, MO, NY, POM, RENO, US); *Peck 9715* (GH, NY, WILLU); *Remy s.n.* (P); *Reveal and Holmgren 1905* (NTS, NY, UTC); *Roos and Roos 5931* (CAS, RSA); *Sandberg and Leiberg 383* (BM, BR, CAS, GH, MO, NY, OKL, POM, UC, US, WS); *Torrey 449* (GH, MO, NY, US); *Watson 1024* (NY, US); *Welsh and Moore 5148* (BRY); *Whited 85* (A, MO, ND, NY).

Distribution.

Widespread and common from southeastern Washington southward into north-central California, otherwise east of the Sierra Nevada as far south as extreme northeastern San Bernardino County, California, then eastward in the high valleys, foothills, and mountain ranges through central and southern Idaho, all except southernmost Nevada, Utah, and northern Arizona (mainly on the Kaibab Plateau) into western Mon-

tana, and west of the Continental Divide in western Wyoming and Colorado, found in a wide variety of habitats, from (1,500) 5,000-10,500 feet elevation. Flowering from June to October. Figures 6 and 7.

Fig. 6. Distribution map of *Eriogonum microthecum* var. *laxiflorum*

Fig. 7. Illustration of *Eriogonum microthecum* var. *laxiflorum* showing variants from throughout the taxon's range

The history of the discovery and naming of var. *laxiflorum* is long and complex. Thomas Nuttall traveled westward with Nathaniel J. Wyeth, a Boston adventurer, in 1834. Accompanying Nuttall was John K. Townsend, an ornithologist who kept an excellent journal (Townsend, 1839) which was used by McKelvey (1955), Graustein (1967) and Reveal and Hafen (1970) to trace Nuttall's round-about route from St. Louis, Missouri, to Fort Vancouver near the mouth of the Columbia River. It has been possible to essentially pin-point the type location of var. *microthecum* (which see), but the exact type locality of var. *laxiflorum* remains a mystery. The label datum on the collection at the British Museum (Natural History) is as cited above, but the exact intended meaning of the descriptive phase "Rocky Mountains of the Columbia in Oregon" is difficult to understand. Comparing Nuttall's original collections with others made along the Oregon Trail where he traveled, it would seem that the type came from Idaho or, and less likely, from adjacent eastern Oregon. The leaves are plane (that is, not revolute) and densely tomentose below; the inflorescences are open, glabrous, and the white flowers have outer tepals with cordate bases. Nuttall made several collections of this variety while in the Oregon Country, no doubt during the different years he was in the area (1834 and 1835), and assigned a series of herbarium names to each. None has exact location data and thus their exact origin can only be presumptive.

The name, var. *laxiflorum*, was first proposed by Hooker (1853) although three years later, Bentham proposed the same name, based on the same type. Both men cited *Eriogonum laxiflorum* Nutt. in synonymy, but this herbarium name actually was never published by Nuttall himself. In as much as Hooker was referring to the Nuttall name, the type is the Nuttall specimen in Hooker's Herbarium now deposited at Kew even though he mentioned a Geyer collection. The fact that Hooker was the first author of this name was not noted until recently (Reveal and Munz, 1968). However, it is difficult to explain Bentham's actions in redescribing the variety after his friend and colleague, Hooker, did so. I believe that Bentham actually suggested the name to Hooker and the latter included it in his article on Geyer's plant collection without giving Bentham credit for the name. Later, Bentham knowing he was responsible for the name, simply credited himself. However, this is speculation which is not admissible and thus, we must accept Hooker as the author of var. *laxiflorum* even though Bentham may have been the original authority.

Over the years, var. *laxiflorum* has been totally misunderstood. Stokes (1936) recognized which element represented the type of *Eriogonum microthecum* (that is, the var. *microthecum*), but she failed to apply the information to the taxonomy of the species even as she understood it, and thus her name, ssp. *typicum* and the concept of the taxon which went with it, was applied to what is here called var. *laxiflorum*. In all floras and manuals up to 1964 the concept of typical *microthecum* was associated with var. *laxiflorum*, and var. *idahoense* was considered the valid name for what is now referred to as var. *microthecum*. The first author to reverse this oversight was C. Leo Hitchcock (1964) who settled the problem at least for the Pacific Northwest flora. Thus, in most floras, the distribution and description of the species is based on a variety of the species (var. *laxiflorum*) and not on the typical form at all.

It is herein proposed that all subsequent varieties arose from this phase of the species. Four rather distinct lines evolved independently from var. *laxiflorum* and the linear arrangement is simply for convenience as one could have started with any one of the other lines and proceeded to the others. The var. *foliosum* is the closest of the extant variants and is treated next. It is difficult to separate the two varieties at times and thus they seem to be still in the process of evolving into two discrete entities. The next line is that which extends from var. *panamintense* to var. *johnstonii* via var. *corymbosoides*. This group is restricted to the mountains of southern California, and, although somewhat isolated from each other geographically, they are still very similar in some basic morphological characteristics. The vars. *lapidicola* and *alpinum* are two extremes, both highly reduced. The first is at lower elevations in the deserts from eastern California to (perhaps) western Utah, while the second is more restricted, being found on the Sierra Nevada of east-central California. The last line of evolution is that found in vars. *microthecum* and *ambignum*. Both have yellow flowers and are difficult to distinguish in the herbarium, although in the field the two are distinctive enough to merit formal recognition. The presence of the yellow flower color in otherwise white flowered species is relatively frequent in the genus, but the taxonomic significance of such a distinction can only be determined on the merits of each individual case. Here, the two yellow flowered entities have other morphological differences and seemingly occupy, at least in part, a unique geographical range, and thus, they are given formal status.

As now defined, the var. *laxiflorum* is still variable and contains many micropopulations that may or may not be worthy to taxonomic recognition in the future (see below). What is considered to have evolved from this entity and consequently described as taxonomic units at this time are those phases of the overall species that represent major lines or modes of development. Some of the additional elements within var. *laxiflorum* and most likely var. *foliosum*, may still be distinguished in time.

Certain individual populations demonstrate the taxonomic difficulties associated with var. *laxiflorum*.

In southern Washington, the plants are readily distinguished, but as one proceeds into Oregon, and especially eastern Oregon, the features of the broad, plane leaves, open inflorescences and tall stature give way to the lower, more scraggly forms so typical of the plants found in the Great Basin of Nevada and Utah. However, in north-central and central Oregon, the robust feature persists and the yellow flowered variant, var. *microthecum*, becomes common. In parts of the John Day Valley, both variants occur, but var. *laxiflorum* is very much in the minority. It is likely the two merge in various parts of their range in Oregon as they certainly do in Lassen County, California.

The Idaho plants fall well within the morphological delimitations of var. *laxiflorum*. In this area, and especially in the mountains of central Idaho, the involucres are often long peduncled and the flowering stems thinly floccose. The leaves are narrowly oblanceolate and nearly glabrous above, but on the Snake River Plains, the leaves are wider and more densely pubescent although the stature of the plants are not too greatly reduced except when the plants occur on harsh edaphic sites.

On the whole, the plants in Montana of this variety are small, being rarely more than 2.5 dm high. Correspondingly, the leaves are small, narrow and more densely pubescent (especially above) and thus similar to those individuals found in the Great Basin. In the mountainous part of the state, the plants tend to be similar to those in adjacent Idaho, as would be expected.

In the Intermountain West the var. *laxiflorum* occupies sites (as in southwestern Wyoming) that are of a similar nature. The plants tend to be reduced in stature, more spreading, woody, and less leafy. Likewise the density of the pubescence increases. However, these features are associated with two factors: one, the southward extension of the variety, and second, the upward advance of populations onto tops of mountain ranges often well above 9,000 feet elevation. The compaction of forms here is unlike that found in eastern Utah where forms of var. *laxiflorum* (and var. *foliosum*) occur on clay slopes. In the Great Basin, the plants spread outwardly from a gnarled root crown, with elongated caudex branches armed with oblanceolate leaf-blades and small but open inflorescences. Those plants at the lower elevations tend to be more pubescent than those at higher elevations. In eastern Utah and adjacent Colorado the plants are pulvinate, and *Reveal 683* from Emery County, Utah, and *Reveal and Davidse 856* from Rio Blanco County, Colorado, are so reduced they tend to resemble *Eriogonum contortum* Small ex Rydb. These plants would tend to fall into var. *foliosum* and may be better placed there along with other reduced forms of var. *foliosum* in eastern Utah and adjacent western Colorado. However, these elements do not fit within any established taxonomic group in the species as now defined, and perhaps they should be given formal recognition. The elevational gradients in Utah are not as pronounced as it is in Nevada except on the Aquarius Plateau and Henry Mountains where plants also tend to be more pulvinate than spreading as is the case on the Great Basin ranges of central and eastern Nevada.

In the field, var. *laxiflorum* occupies a multitude of habitats and comes, therefore, in a wide variety of shapes and forms. In addition to the general aspect of the plants as noted above, the variety differs in various ecological sites. For example, when the plants occur in scattered stands of *Artemisia* (sagebrush) as in southern Idaho, parts of Oregon and Nevada, the plants are often large, rounded, and rather robust at lower elevations. When plants occur on steep road banks, and especially road cuts, the plants are often extra large. Yet, as one proceeds to higher elevations, the plants become more prostrate, with their long stems spreading along the ground usually arising from root crowns situated in open places between individual plants of *Artemisia*. In protected areas at these higher elevations, the plants may be more leafy, but they are still prostrate and appear depauperate.

The ability to consistently determine var. *laxiflorum* from var. *foliosum* is impaired by a band of intermediate populations extending nearly the entire length of their contact zone in southern Nevada and Utah, and northern Arizona. For the most part the two may be readily and simply determined, but in some areas, the characteristics completely break down. For example, on the foothills of the Toquima and Monitor ranges in central Nevada, these two variants come together and cannot be distinguished; the same is true in the Grand Canyon area of northern Arizona. Variation may be seen in a single series of collections made by a single collector, no doubt to show the variation he has seen in the field. Unfortunately, these collections are broken up into herbarium sheets which are then distributed to herbaria far and wide. Once reassembled, the variation is difficult to fully understand as the growth habit of the plant is gone, the aspect of the ecological niche is not preserved, and it is impossible to know exactly what all the phases originally represented. This is especially true of the large collections of Ira W. Clokey's from the Spring (Charleston) Mountains of Clark County, Nevada. In this area both elements are present, and the entire sample seems to represent both var. *foliosum* and plants which approach (but never really reach) var. *laxiflorum*.

There is no solid line of demarcation between these two varieties, and as the taxonomic rank of "variety" is used here, this zone of morphological overlap is to be expected. If the differentiations were more consistent and rigid, one would be compelled to use a higher taxonomic rank. Likewise, as the two entities are distinct throughout much of their respec-

tive ranges, it would be equally unrealistic to reduce these to a single taxon.

6b. **Eriogonum microthecum var. foliosum (Torr. & Gray) Reveal**

Eriogonum microthecum Nutt. var. *foliosum* (Torr. & Gray) Reveal, comb. nov., based on *E. effusum* Nutt. var. *foliosum* Torr. & Gray, Rept. Explor. Surv. Ascert. Pract. Econ. Route Railroad Miss. River to Pacific Ocean 2:129. 1857. San Luis Valley, Alamosa or Saguache counties, Colorado, July 1853, *Cruetzfeldt s.n.* Holotype, NY! Isotype, GH!

Eriogonum simpsonii Benth. in DC., Prodr. 14:18. 1856. *Eriogonum effusum* Nutt. ssp. *simpsonii* (Benth. in DC.) S. Stokes, Gen. Eriog. 81. 1936. Sierra de Tunecha, northwestern New Mexico, September 1849, *Simpson s.n.* Holotype, NY!

Eriogonum mircothecum Nutt. var. *rigidum* Eastw., Zoe 4:11. 1893. *Eriogonum microthecum* Nutt. ssp. *rigidum* (Eastw.) S. Stokes, Gen. Eriog. 75. 1936. On mesas near Durango, La Plata County, Colorado, August 1892, *Eastwood s.n.* Holotype, CAS! Isotypes, GH, MO, UC, US!

Eriogonum friscanum M. E. Jones, Contr. W. Bot. 11:14. 1903. *Eriogonum microthecum* Nutt. var. *friscanum* (M. E. Jones) S. Stokes, Gen. Eriog. 74. 1936. Frisco, Beaver County, Utah, 24 June 1880, *M. E. Jones s.n.* Lectotype, POM!

Eriogonum nelsonii L. Will., Bull. Torrey Bot. Club 59:428. 1932. – *Eriogonum effusum* Nutt. ssp. *nelsonii* (L. Will.) S. Stokes, Gen. Eriog. 81. 1936. Geyser Basin, San Juan County, Utah, 30 July 1912, *Walker 368.* Holotype, RM!

Eriogonum microthecum Nutt. ssp. *intermedium* S. Stokes, Gen. Eriog. 75. 1936. Rocky slopes near Ely, White Pine County, Nevada, 24 August 1931, *J. T. Howell 7956.* Holotype, CAS! Isotypes, GH, US!

Low and spreading to tall and erect subshrubs and shrubs (1) 4-15 dm high and (1) 4-16 dm across; *leaves* mostly narrowly elliptic, 0.5-1.8 (2.5) cm long, (0.5) 1-2 (2.5) mm wide, densely white-tomentose below, floccose and whitish-green above, rarely subglabrous or glabrous and green above, the tomentum white, tightly revolute in most or at least with rolled, thickened margins, the apices acute; *flowering stems* slender to ± stout, 2-7 cm long, densely lanate to tomentose throughout, rarely floccose at maturity, or if subglabrous and greenish, then in the southeastern part of the variety's range, the tomentum whitish; *inflorescences* (1.5) 2-4 (6) cm long, tomentose to floccose, rarely subglabrous at maturity in New Mexico and northeastern Arizona; *involucres* 2-3 mm long, tomentose to floccose or subglabrous, the tomentum usually dense between the angled ridges; *flowers* white with greenish- to reddish-brown midribs and bases, becoming pinkish in fruit in some, 2-3 mm long, the tepals essentially similar to slightly dissimilar, the outer whorl of tepals narrowly obovate to obovate, the bases rounded to truncate or ± truncate-cordate to cordate, *achenes* 2-3 mm long. Representative collections – *Applequist s.n.* (MNA), *Arsene and Benedict 10610* (P, US), *Beal 562* (ARIZ, WI, WTU), *Clokey and Clokey 7071* (ARIZ, BRY, CAS, DS, GH, MO, ND, NY, OKL, RM, UC, US, UTC, WS, WTU); *Cutler 2783* (GH, MNA, NY, WIS); *Deaver 3765* (ARIZ, MNA), *Eastwood and Howell 6531, 6555, 6986* (CAS, US), *7316* (CAS, GH, POM), *7332* (CAS, GH, NY, US); *Flowers 6377* (UT); *Galway 8243* (BRY, US); *Goodman and Payson 3260* (UC, WTU); *Howell and True 44714, 44835, 44878* (CAS); *Jones 1795* (BM, BR, CAS, G, GH, NY, POM, US, UTC); *Kearney and Peebles 12820* (ARIZ, NY, US); *Maguire 17659* (GH, NY, UTC); *Munz 12855* (A, POM, UC); *Payson 613* (COLO, GH, RM, WTU); *Popenoe s.n.* (A, KSC); *Purpus 6280* (UC, US), *6296* (CAS, NY, POM); *Ramaley 14370, 15241, 15817* (COLO); *Reveal 683* (ARIZ, BRY, CAS, DS, GH, KSC, MO, NY, OKL, RM, RSA, UC, US, UT, UTC); *Reveal and Beatley 1691* (BRY, NTS, NY, UTC); *Reveal and Davidse 933* (BRY, CAS, GH, LL, NY, OKL, RSA, SMU, TEX, UC, UTC); *Reveal and Holmgren 1813* (BRY, NTS, NY, UTC); *Ripley and Barneby 4005, 8684* (CAS); *Rollins 1532* (GH, NY), *1934* (ND, NY, WTU); *Rusby 815* (CAS, NY, US); *Rydberg and Garrett 8442* (GH, NY, WIS); *Weber 3868, 7827* (COLO); *Welsh and Moore 1838* (BRY, ISC, WIS), *1993, 2221, 2348* (BRY, NY); *Wetherill s.n.* (MNA), *Wooton s.n.* (US).

Distribution.

Widespread and common from southeastern California in eastern San Bernardino and Inyo counties eastward across southern and central Nevada into northern Arizona and southern Utah, northward on the Colorado Plateau to Emery and Grand counties, and in widely scattered locations as far north as the Wyoming state line, entering western Colorado in Mesa County and proceeding southward and across southern Colorado to San Luis Valley and across northern New Mexico to the Sangre de Cristo Mountains, hence southward to central New Mexico, in a wide variety of ecological niches and communities, from 4,500-7,500 feet elevation. Flowering from June to October. Figures 8 and 9.

The type of var. *foliosum* was discovered by Frederick Creuzefeldt in San Luis Valley of south-central Colorado while with the Gunnison Expedition in 1853. The entity was described by Torrey and Gray in 1857. However, the variety was first found by Lieutenant James H. Simpson while on a Navajo raid into northwestern New Mexico lead by Lieutenant Colonel John M. Washington, the military governor of New Mexico (Goetzman, 1959). The Simpson collection, made in 1849, consisted of a small stem which was used by Bentham (1856) as the basis for his new species. As can be seen in the above list of synonyms, several specimens representing var. *foliosum* were described. Eastwood (1893) described the var. *rigidum* from material obtained only a few miles west of the type locality of var. *foliosum*, but then it was only a short distance north of the type area of *Eriogonum simpsonii*! Jones (1903) added *E. friscanum* to the list by naming this species from western Utah, but L. O. Williams (1932) brought the two "centers" of type distribution together by describing *E. nelsonii* from southeastern Utah.

The treatment by Stokes (1936) of what I have called var. *foliosum* requires close examination. She managed to recognize all of the above synonyms, except var. *foliosum*, under *Eriogonum microthecum* or

E. effusum. It has been impossible to discover the combination of characters she used to place the various forms into one or the other of these species. Under *E. microthecum* she placed var. *rigidum* (and included var. *foliosum* as a synonym, in part – but there is no indication where the other "part" should have been applied), *E. friscanum*, and described ssp. *intermedium* – one each from Colorado, Utah, and Nevada respectively. Under *E. effusum* she placed *E. simpsonii* and *E. nelsonii* – one each from New Mexico and Utah.

The var. *foliosum* is now defined to include those populations of *Eriogonum microthecum* from the southern part of the species' range. It is easily recognized by the tightly revolute leaves with densely lanate to tomentose stems and inflorescences. Still var. *foliosum* is exceedingly variable even as now defined. The largest forms of the species are found within this variety as some shrubs are over a meter high in northern New Mexico, northeastern Arizona, and southern Nevada; yet, within this same variety, I have been forced to place some highly reduced populations found on gumbo clay hills in eastern Utah and central Nevada. These latter populations are thought to represent an extreme in the variation, and except for the isolated plants in central Nevada which are provisionally placed here, all of these depauperate entities can be referred to the var. *foliosum* in the strictest sense.

Fig. 8. Distribution map of *Eriogonum microthecum* var. *foliosum*. Stars refer to populations intermediate between var. *laxiflorum* and var. *foliosum*.

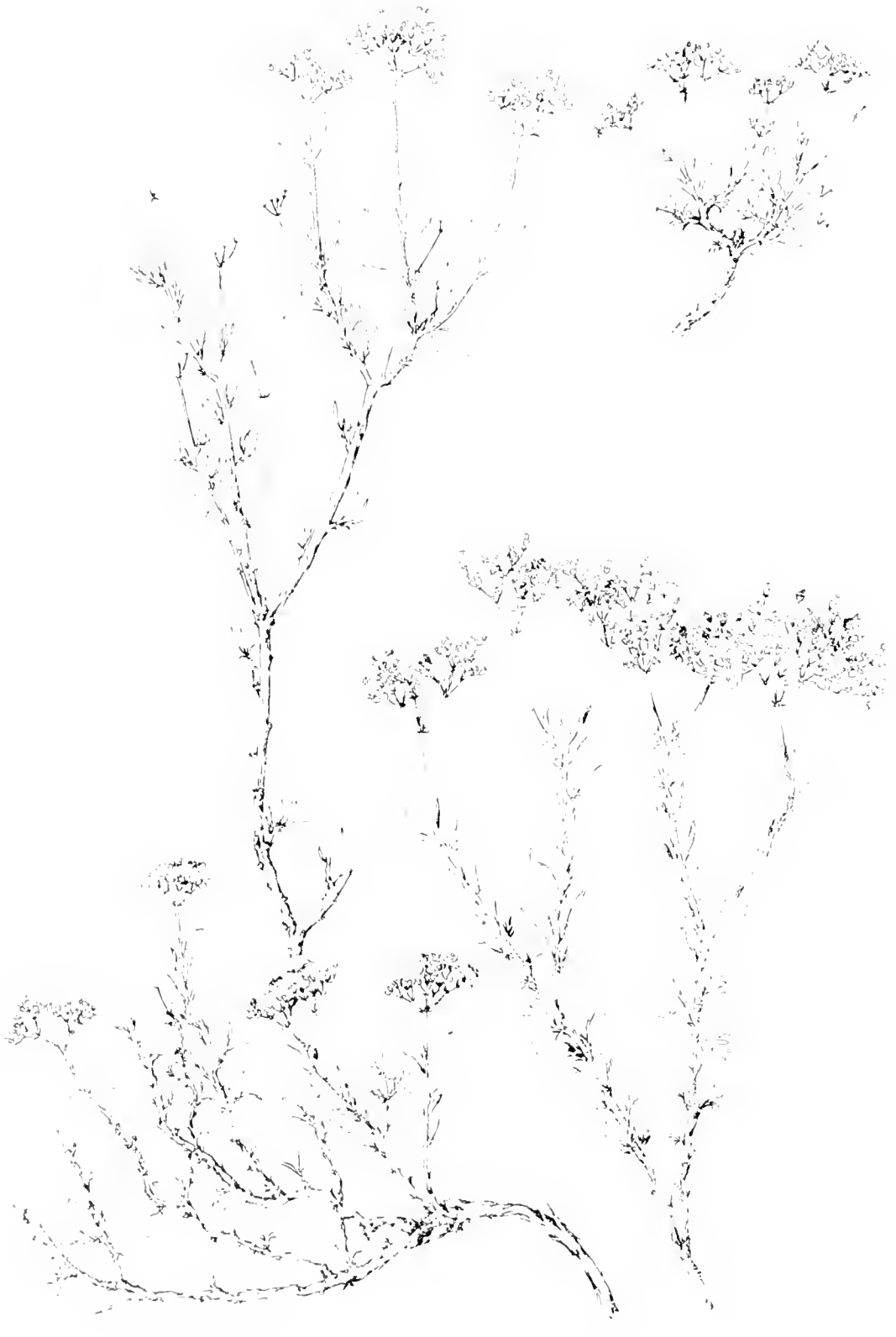

Fig. 9. Illustration of *Eriogonum microthecum* var. *toliosum* showing variants from throughout the taxon's range and both the large and small extremes in height

The variation in the amount of pubescence may be worthy of more investigation. In the tall erect plants, the stems may be very densely tomentose to lanate or glabrous. Those of the first group are common throughout the southern part of the variety's range, extending from southeastern California to New Mexico. However, the glabrous (or nearly so) plants are found in northwestern New Mexico and adjacent northeastern Arizona. Again, at the extremes, there does seem some value in attempting to distinguish between them, but as numerous intermediates are seen, the value of such a taxonomic decision becomes less obvious, and thus no new entities are proposed at this time.

As noted under var. *laxiflorum*, it and the present variety are often difficult to separate where their ranges overlap.

6c. **Eriogonum microthecum var. panamintense S. Stokes**

Eriogonum microthecum Nutt. var. *panamintense* S. Stokes, Gen. Eriog. 74. 1936. – Wild Rose Canyon, Panamint Range, Inyo County, California, at 7,800 feet elevation, 29 September 1931, *Hoffmann s.n.* Holotype, CAS.

Eriogonum effusum Nutt. var. *limbatum* S. Stokes, Leafl. W. Bot. 3:15. 1941. – Piñon Mesa, Panamint Range, Inyo County, California, at 6,200 feet elevation, 28 September 1939, *Gilman 3954.* Holotype, CAS.

Large, rounded to flat-topped shrubs 3-6 dm high and (4) 5-12 (15) dm across; *leaves* mostly broadly elliptical, 0.6-1.8 cm long, 3-8 mm wide, tomentose below, floccose to subglabrous above, the tomentum whitish-brown to brown, the margins plane, not revolute, the apices acute to obtuse; *flowering stems* slender, 5-10 (15) cm long, floccose, the tomentum reddish-brown in most; *involucres* 2-2.5 mm long, subglabrous to glabrous without; *flowers* whitish-brown with large reddish-brown midribs and bases, becoming reddish-brown in fruit, 1.5-2 (2.5) mm long, the tepals dissimilar, the outer whorl of tepals obovate, the bases truncate to cordate, the inner whorl narrower; *achenes* 1.8-2.1 mm long. – Representative collections: *Gilman 2023* (US), *2700* (CAS), *2701* (POM); *Hoffmann 431* (CAS); *Reveal and Holmgren 1779* (NTS, NY, UTC); *Roos 73* (POM).

Distribution.

Restricted to the Panamint Range and the Inyo Mountains, Inyo County, California, in gravelly to rocky soils on slopes and steep hillsides in sagebrush scrub and pinyon-juniper woodlands, from 6,000-9,000 feet elevation. Flowering from July to October. Figures 10 and 11.

The type of var. *panamintense* was collected by Ralph Hoffmann in 1931, and named by Stokes as a variety of *Eriogonum microthecum* in 1936. In 1941 she redescribed the same plant as a variety under *E. effusum*.

The affinity of vars. *panamintense* and *laxiflorum* cannot be denied. The two are very similar, differing

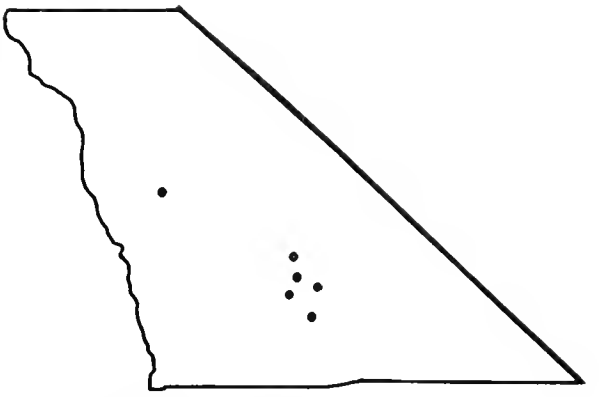

Fig. 10. Distribution map of *Eriogonum microthecum* var. *panamintense*. Inyo Co., California.

in the color of the tomentum, the broader leaves (as compared with the var. *laxiflorum* in the same area), and the brownish tinge to the flower color. As an isolated population, adaptive radiation has likely played a major role in the evolution of var. *panamintense*, but the degree of isolation is not as strong as it is in the following two variants.

In the field var. *panamintense* is easily distinguished by the large brownish shrubs which occupy the lower elevations on the west side of the Panamint Range and the Inyo Mountains. At the higher elevations, the plants tend to be shorter and more compact, but still the plants are relatively large when compared with the low scraggly forms of var. *laxiflorum* at these same higher elevations. Of all the plants in this species, this variety and the next would make fine additions to the garden.

6d. **Eriogonum microthecum var. corymbosoides Reveal**

Eriogonum microthecum Nutt. var. *corymbosoides* Reveal, var. nov. – Johnston Grade, 0.8 miles below the summit northeast of Baldwin Lake along California Highway 18, in granitic soils among pinyon and mountain mahogony, San Bernardino Mountains, San Bernardino County, California, 10 September 1968, *Reveal 2090.* Holotype, US! Isotypes, 30 duplicates to be distributed to various herbaria from the United States National Museum. – A var. *panamintensi* foliis longioribus, (0.8) 1-2 (2.5) cm longis, caulibus lanatis, involucris 2-3 mm longis, floccosis, floribus 2-2.5 (3) mm longis, acheniis 2.5-3 mm longis differt; a var. *laxiflora* tomentoso ferrugineo et a var. *johnstonii* statura maiore differt.

Large rounded to spreading shrubs 3-6 dm high and 6-12 (15) dm across; *leaves* elliptic to obovate, the leaf-blades (0.8) 1-2 (2.5) cm long, (4) 6-10 mm wide, densely tomentose below, floccose to subglabrous above, the tomentum whitish-brown, the margins plane or merely rolled, not revolute, the apices acute to obtuse; *flowering stems* slender to ± stout, 5-13 (15) cm long, lanate to tomentose, rarely thinly floccose at maturity, the tomentum tannish- to reddish-brown; *inflorescences* densely cymose, 1-4 cm long, lanate to tomentose, the tomentum tannish- to reddish-brown; *involu-*

rays 2-3 mm long, floccose when young, becoming less pubescent to subglabrous at maturity in some; *flowers* whitish-brown with large reddish-brown midribs and bases, becoming reddish-brown in fruit, 2-2.5 mm long, the tepals essentially similar to slightly dissimilar, the outer whorl of tepals merely rounded at the base in most; *achenes* 2.5-3 mm long. Representative collections *Balls 20193* (BM, CAS, RSA, UC), *Ewan 8332* (GH, NO, UC); *Johnston s.n.* (POM); *Knox s.n.* (UC), *Munz 7661* (GH, NY, UC), *10784* (POM, UC), *12706* (CA, BM, MO, POM, UC), *Pearson 4003, 5150* (RSA), *Wheeler 1288* (ND, RSA, WTU).

Distribution.

Loose gravelly to rocky granitic or limestone soils in the San Bernardino Mountains, San Bernardino County, from 5,800-9,500 feet elevation, and on the north slope of the San Gabriel Mountains, Los Angeles County, from 7,000-7,500 feet elevation, southern California. Flowering from July to September. Figures 12 and 13.

The name "corymbosoides" is derived the Greek *korymbos*, corymbose, and *oides*, likeness, alluding to the similarities between the new variety and *Eriogonum corymbosum* Benth. in DC.

Eriogonum microthecum has long been known from the mountains of southern California, but until

Fig. 11. Illustration of *Eriogonum microthecum* var. *panamintense*

Fig. 12. Distribution map of *Eriogonum microthecum* var. *corymbosoides*, San Bernadino and Los Angeles counties, California.

Fig. 13. Illustration of *Eriogonum microthecum* var. *corymbosoides*

now, the various elements restricted to this area have not been distinguished. The var. *corymbosoides* is well isolated from var. *panamintense* which is about 135 miles northward, as well as from the var. *laxiflorum* which just enters the northeastern corner of San Bernardino County in the Kingston Mountains. However, within the immediate area of var. *corymbosoides* is the var. *johnstonii*, another variety but restricted to the higher ridges in the San Gabriel Mountains.

The var. *corymbosoides* resembles many specimens of *Eriogonum corymbosum* var. *corymbosum*, an entity primarily of Utah and Colorado. The broad leaves are distinctive as is the dense, essentially lanate, tomentum on the stems and inflorescences. In its color, the tomentum approaches that found in var. *corymbosum* from eastern Utah and the southern populations of *E. corymbosum* var. *glutinosum* (M. E. Jones) M. E. Jones. In the denseness of the tomentum, the new variety is approached only by the var. *foliosum*, but the color is different, and the habit of these two forms of *E. microthecum* is most distinct. In the field, specimens of var. *corymbosoides* vary in the degree of the tomentum, much as in other phases of *E. microthecum*. The plants normally in the shade of pinyon and mountain mahogony are less densely pubescent than those plants found on flats among sagebrush. In the area around Cactus Flat, a complete trend may be seen from the sandy flat to the adjacent slopes with regards to this feature of the tomentum.

Some specimens from the Sugarloaf region of the San Bernardino Mountains approach var. *johnstonii (Balls 20193)*, but in other high elevation places, the plants clearly are var. *corymbosoides*.

Three collections require special comment. The Parish Brothers, M. E. Jones, and Anstruther Davidson collected an odd form of *Eriogonum microthecum* in Bear Valley of the San Bernardino Mountains: *Parish and Parish 1512* in August of 1882 (BM, US), *Jones s.n.* on 19 July 1900 (POM), and *Davidson 2284* in July of an unrecorded year (US). These specimens are totally glabrous except for the lower leaf surface, although the upper surface of the leaves and the stem among the leaves may be thinly floccose at times. The leaves are oblanceolate, 1-1.5 cm long and 3-5 mm wide with revolute margins. The involucres are 3-4.5 mm long and 2-2.5 mm wide. The plants are less than 2 dm tall and appear to be very distinct. Unfortunately, additional specimens of this form have not been discovered in recent years, and until this entity can be more thoroughly studied, its proper placement in the species is impossible. Dr. Philip A. Munz recently visited this popular resort area, and reports the area is so built up that it may be difficult to ever find the plants again.

6e. **Eriogonum microthecum var. johnstonii Reveal**
Eriogonum microthecum Nutt. var. *johnstonii* Reveal, var. nov. West spur of Mt. San Antonio [then, Old Baldy], San Gabriel Mountains, on the ridge in loose broken granite soil at 9,000 feet elevation, Los Angeles County, California, 16 September 1917, *Johnston 1726*. Holotype, UC! Isotypes, GH, POM! – A var. *corymbosoides* foliis minoribus, 5-10 mm longis et 3-5 mm latis, caulibus floccosis vel subglabris, involucris (2) 2.5-3 mm longis, floccosis vel glabris, floribus (2.5) 3-3.5 (4) mm longis differt.

Low decumbent spreading subshrubs 0.6-1.3 dm high and 2-5 dm across; *leaves* elliptic to ovate, the leaf-blades 5-10 mm long, (2) 3-5 (6) mm wide, densely tomentose below, floccose to subglabrous above, the tomentum whitish-brown, the margins plane or merely rolled, not revolute, the apices acute; *flowering stems* slender, 3-6 cm long, tomentose when young or more commonly floccose to subglabrous especially at maturity, the tomentum whitish- to reddish-brown; *inflorescences* cymose, 0.5-3 cm long, floccose to subglabrous, the tomentum whitish- to reddish-brown; *involucres* (2) 2.5-3 mm long, floccose when young, becoming glabrous at maturity; *flowers* whitish-brown with large reddish-brown midribs and bases, becoming reddish-brown in fruit, (2.5) 3-3.5 (4) mm long, the tepals essentially similar to slightly dissimilar, the outer whorl of tepals merely rounded at the base in most; *achenes* 2.5-3 mm long. Representative collections: *Johnston 1530* (GH, POM, UC); *Munz 1687, 6098* (POM); *Pearson 3199* (RSA).

Distribution.

Loose granitic soil in the San Gabriel Mountains near Cucamonga Peak and Mt. San Antonio (Old Baldy), San Bernardino and Los Angeles counties, California, from 8,500-9,500 feet elevation. Flowering from July to September. Figures 14 and 15.

The name is selected to honor Ivan Murray Johnston (1898-1960), professor of botany at Harvard, the authority on Boraginaceae, and a collector in southern California during a period from the late 1910s and early 1920s. He was the first to note the distinctiveness of this variety (in 1923), but never formally proposed a name for it.

The var. *johnstonii* is obviously related to var. *corymbosoides*. The two are similar in leaf shape, pubescence color, and flower color. They differ in the amount and degree of the tomentum, especially on the stems and inflorescences, and in stature and distribution. The var. *johnstonii* is similar to var. *lapidicola* in a generalized manner and points to the kind of parallel evolution that is so commonly found in this large and complex genus of flowering plants.

6f. **Eriogonum microthecum var. lapidicola Reveal**
Eriogonum microthecum Nutt. var. *lapidicola* Reveal, var. nov. North end of Rainier Mesa at the southern end of the Belted Range at the head of The Aqueduct, 0.5 mile north of Rainier Mesa Road near the junction of Old Rainier (or Back) Mesa Road on shallow soil associated with sagebrush and pinyon-juniper woodlands on flat-rock outcrops of a volcanic origin, Nevada Test Site, Nye County, Nevada, at 7,400 feet elevation, 25 August 1968, *Reveal and Holmgren*

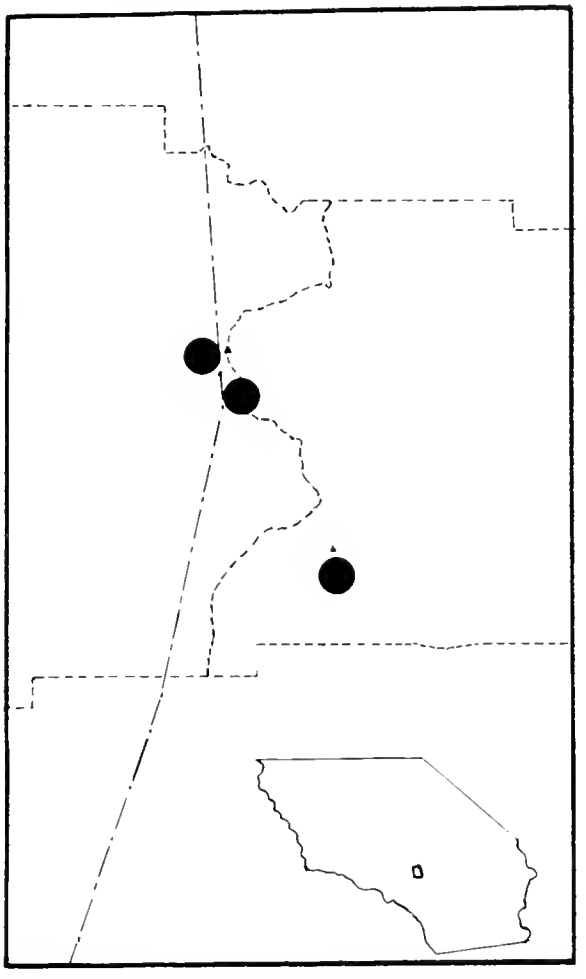

Fig. 14. Distribution map of *Eriogonum microthecum* var. *johnstonii*. San Bernadino and Los Angeles counties, California.

1926. Holotype, UTC! Isotypes, 35 duplicated will be distributed to various herbaria from the Intermountain Herbarium, Utah State University, Logan. – A var. *panamintensi* statura minore differt et similis a var. *johnstonii* sed foliis 3-7 mm longis et 1-4 mm latis, floribus (1.5) 2-3 mm longis.

Low dwarfed polygamo-dioecious (at least in some) subshrubs 0.5-1.5 dm high and 0.8-2.5 dm across; *leaves* elliptic, the leaf-blades 3-7 mm long, 1-4 mm wide, densely tomentose below, tomentose to floccose or glabrous above, the tomentum reddish-brown, the margins plane or merely rolled, not revolute, the apices acute to obtuse; *flowering stems* slender, 2-6 cm long, tomentose when young, becoming floccose at maturity, rarely glabrous, the tomentum reddish-brown; *inflorescences* cymose, 2-6 cm long, tomentose to floccose, the tomentum mostly reddish-brown; *involucres* (2.5) 3-3.5 mm long, floccose to subglabrous; *flowers* whitish-red with red midribs and bases, becoming pink to rose or even orange in fruit, (1.5) 2-3 mm long, the tepals slightly dissimilar, the outer whorl of tepals subcordate at the base; *achenes* 2.5-3 mm long. Representative collections: *Alexander and Kellogg 3060* (OKL, UC); *Beatley 599, 604, 2326, 3908, 4808* (NTS), *3103* (DS, NTS, RSA), *5012* (MARY, NTS), *Jaeger s.n.* (POM); *Reveal 1528, 1717, 1729, 1945, 2022, 2047* (BRY, NTS, NY, UTC); *Reveal and Holmgren 1819* (BRY, NTS, NY, UTC); *Wells s.n.* (CAS).

Distribution.

Rocky slopes and flats in thin shallow soils often on rocky outcrops or on sandstone ledges, from the Inyo Mountains, Inyo County, California, eastward into Esmeralda County, Nevada, on Magruder Mountain, and in the low mountains of central Nye and western Lincoln counties, Nevada, and (perhaps) westward into extreme western Utah, from 6,000-8,500 feet elevation. Flowering from July to September. Figures 16 and 17.

The name lapidicola is derived from the Latin *lapis*, rock, and *-cola*, dweller, as to the rocky habitat where this variety occurs on the Nevada Test Site, the type location.

The typical phase of var. *lapidicola* is a densely branched form, low and spreading, and generally reddish-brown in color. Of the various varieties investigated so far, this is the only polygamo-dioecious one noted although I have reasons to suspect this condition may occur sporadically elsewhere in the species. On the Nevada Test Site, where the variety has been extensively studied, the plants are confined to thin soils usually on top of flat volcanic rocks which make up the mesas. The rooting system is superficial, being less than a centimeter or two below the surface, but covering a wide area. This is similar to the rooting system of *Astragalus beatleyae* Barneby, a recently described local endemic which also grows in the same

Fig. 15. Illustration of *Eriogonum microthecum* var. *johnstonii*.

type of habitat on the Test Site. Only one collection *(Reveal 1972)* has been found on sandstone. The flower color changes from a whitish tinge to a pink or deep rose or even an orange color in fruit, giving the plants a unique color not seen elsewhere in the species.

In general the var. *lapidicola* grows with sagebrush under pinyon-juniper. In eastern California the plants grow on more exposed ridges than on the sites in Nevada, and thus the plants tend to be somewhat less spreading in the Inyo Mountains.

The variety is clearly related to var. *laxiflorum* although it is believed to have evolved from an ancestoral group similar to var. *panamintense*. It is with the latter variant that var. *lapidicola* seems to merge based on a small sample of specimens from eastern California; however, the significance of this remains to be studied in the field.

Two discordant elements related to, and likely associated with, var. *lapidicola* can be mentioned here. One phase is a highly depauperate population found on sandy calcareous clay soils in Lander and Eureka cos., Nevada *(Ripley & Barneby 9330)*. These plants are similar to var. *foliosum* populations in northeastern Utah in size and stature, but are distinct in a number of minor morphological characteristics.

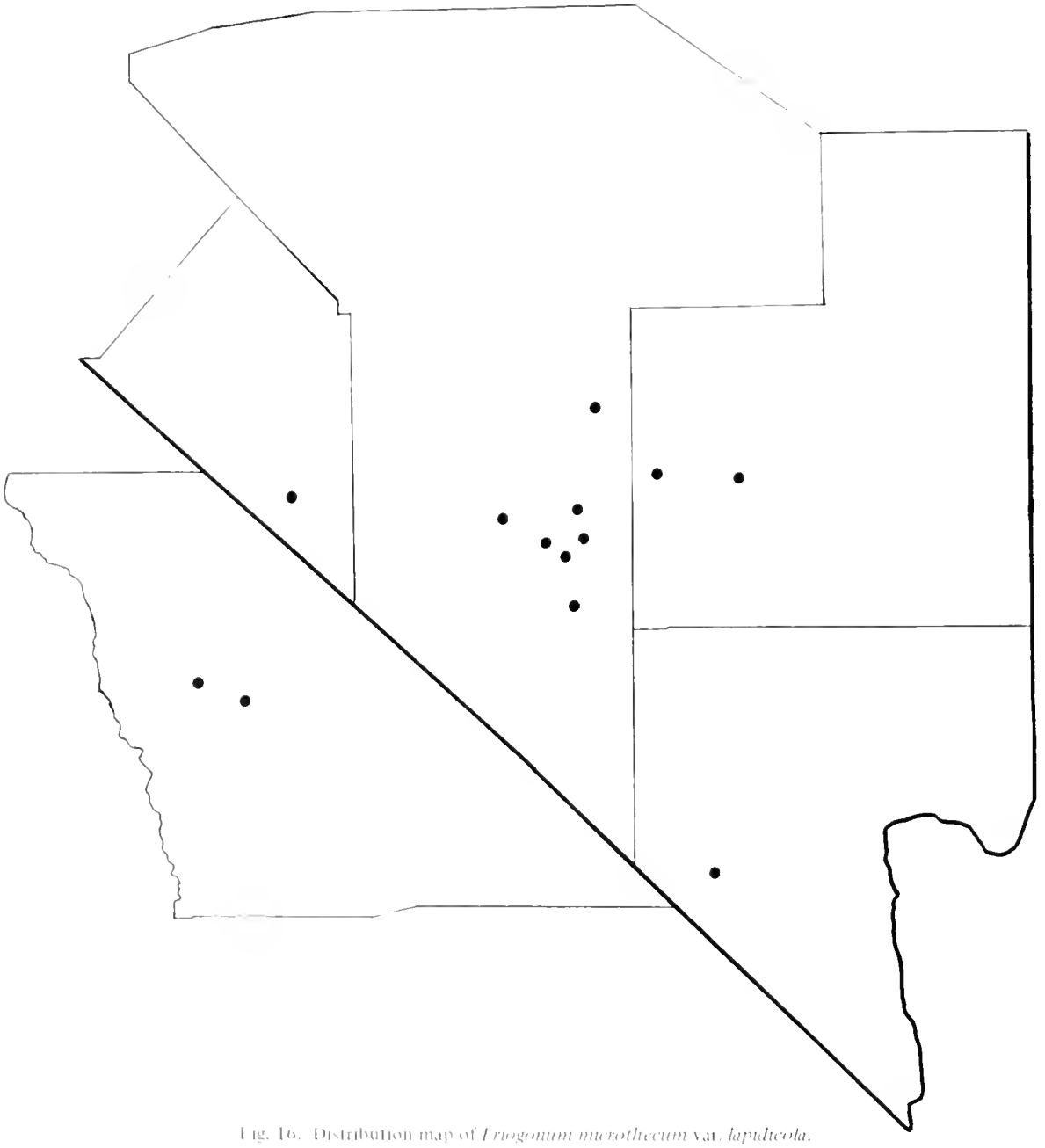

Fig. 16. Distribution map of *Eriogonum microthecum* var. *lapidicola*.

Fig. 17. Illustration of *Eriogonum microthecum* var. *lapidicola*.

Unfortunately I have not been able to study these plants in the field, and it is possible that they might represent another distinct taxon. The tomentum is whitish, and thus different from var. *lapidicola* in this respect, but whether or not this is a consistent feature of the central Nevada plants cannot be determined on the basis of a small number of collections. The second phase is represented by *Purpus 6249*. This too is a depauperate variant of *Eriogonum microthecum* and is questionably referred to var. *lapidicola*. In this very distinct phase the leaves are glabrous above, tightly revolute with thin, nearly glabrous, flowering stems and short, compact inflorescences. At first glance this population reminds one of *E. ericifolium* of northern Arizona, but that species is far to the south, and the flowers are different. One major problem with the Purpus collection is the location – it is given as Juniper Mountain, a place unknown to me. However, I suspect the site may be a part of the House Range in Beaver Co., Utah, but until this area can be visited and the population rediscovered, the fate of the population as a valid entity within var. *lapidicola* must await its time.

6g. **Eriogonum microthecum var. alpinum** Reveal

Eriogonum microthecum Nutt. var. *alpinum* Reveal, var. nov. – Loose dry soil, Sonora Pass, Tuolumne and Mono counties, California, at 9,300 feet elevation, 16 July 1863, *Brewer 1888*. Holotype, US! Isotypes, GH, MO, UC! – A var. *laxiflora* statura minore, 0.4-1 dm alta, foliis anguste ellipticis, 3-7 (9) mm longis et 1-2.5 (3) mm latis, involucris (1.5) 2-2.5 mm longis, floribus 1.5-2.3 mm longis differt; a var. *lapidicola* et var. *johnstonii* foliis anguste ellipticis et floribus 1.5-2.3 mm longis differt.

Low decumbent spreading subshrubs 0.4-1 dm high and 0.5-2.5 dm across; *leaves* linear-oblanceolate to narrowly elliptic, the leaf-blades 3-7 (9) mm long, 1-2.5 (3) mm wide, densely tomentose below, floccose to subglabrous above, the tomentum whitish- to reddish-brown, the margins rolled to revolute, infrequently plane, the apices acute; *flowering stems* thin to slender, 1.5-4 (5) cm long, floccose to subglabrous, the tomentum whitish- to reddish-brown; *inflorescences* cymose, 0.5-2 (3) cm long, floccose to subglabrous; *involucres* (1.5) 2-2.5 mm long, floccose when young, becoming thinly floccose to glabrous at maturity; *flowers* white to reddish- or brownish-white with reddish midribs and bases, becoming rose in fruit in some, 1.5-2.3 mm long, the tepals essentially similar, the outer whorl of tepals merely rounded at the base; *achenes* 1.5-2 mm long. Representative collections: *Hexander and Kellogg 4020* (WTU); *Cantelow s.n.* (CAS); *Eastwood 597* (CAS, GH, MO, US); *Hendrix 332* (OKL); *Peirson 11647* (A, CAS, COLO, RSA); *Ripley and Barneby 9909* (CAS); *Roos and Roos 5985* (CAS, RSA); *Thorne and Henrickson 33116* (RSA); *Wiggins 9268* (DS, MICH, POM, UC, UTC); *Wiggins and Rollins 565* (CAS, DS, GH, RSA, WTU).

Distribution.

Dry sandy to gravelly talus slopes and ridges in the Sierra Nevada from Alpine County south to central Mono County and southern Tuolumne County, and in the Sweetwater Mountains, Mono County, California, from 8,500-10,500 feet elevation. Flowering from July to September. Figures 18 and 19.

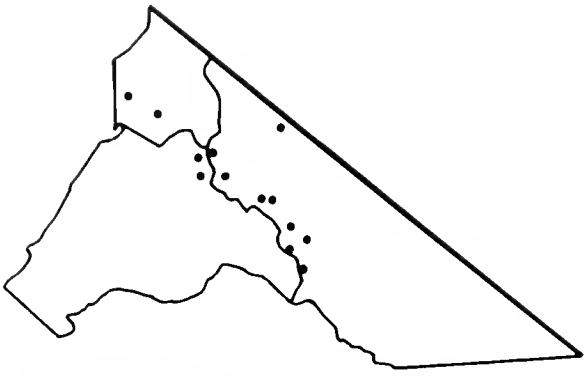

Fig. 18. Distribution map of *Eriogonum microthecum* var. *alpinum*, Alpine, Mono, and Tuolumne counties, California.

Fig. 19. Illustration of *Eriogonum microthecum* var. *alpinum*.

The name alpinum is derived from the Latin *alpinus*, alpine, alluding to the habitat of the new variety.

The var. *alpinum* was first characterized by Torrey and Gray (1870), but they did not give the entity a name. They drew up their discussion from Brewer's collection and another depauperate collection from the Ruby Mountains of northeastern Nevada (a form of var. *laxiflorum*). I am adopting their concept of the variety, excluding the Nevadan element, and restricting the entity to the Sierra Nevada and the closely associated Sweetwater Mountains of California. It is a high alpine form growing at or above timberline in the Sonora Pass region and elsewhere—on the Sweetwater Mountains and in Alpine County, the plants are often below timberline. For the most part the var. *alpinum* may be looked upon as a high altitude ecotype of var. *laxiflorum*—much as Torrey and Gray did—possessing a series of distinctive morphological features which allow it to be formally recognized at a taxonomic rank. Within the small geographical range of the variety, the morphological variation is not too extensive, but it does appear that the variety may gradually grade into var. *laxiflorum* in the Tioga Pass area where the southern limit of var. *alpinum* is encountered.

One unnamed, and seemingly related series of populations, occurs in the high mountains of central Nevada. I have been unable to place the plants from the Toiyabe Dome area of the Toiyabe Mountains; however, I strongly suspect these populations represent alpine forms of var. *laxiflorum* such as I have seen elsewhere in Nevada. The plants are depauperate, with long scraggly branches, scattered leaves, and small compact inflorescences of white flowers. Some representative collections are *Hitchcock and Martin 5616* (OKL, UC, UTC, WTU); *Linsdale and Linsdale 970* (CAS); and *Maguire and Holmgren 25996* (GH, NY, UC, UTC).

6h. **Eriogonum microthecum var. microthecum**

Eriogonum microthecum Nutt., Proc. Acad. Nat. Sci. Philadelphia 4:15. 1848. – *Eriogonum microthecum* Nutt. ssp. *typicum* S. Stokes, Gen. Eriog. 74. 1936. – "Hills in Oregon, east of Walla-walla [sic]," possibly near Huntington, Baker County, Oregon, August 1834, *Nuttall s.n.* Holotype, BM! Isotypes, BM, GH!

Eriogonum idahoense Rydb., Bull. Torrey Bot. Club 39:307. 1912. – *Eriogonum microthecum* Nutt. var. *idahoense* (Rydb.) S. Stokes, Gen. Eriog. 74. 1936. – Weiser, Washington County, Idaho, 7 July 1899, *M. E. Jones 6511*. Holotype, NY! Isotypes, BM, MO, POM, US!

Erect and spreading shrubs (2.5) 3-5 dm high and 3-7 dm across; *leaves* oblanceolate to elliptic, the leaf-blades (0.8) 1-2 (2.7) cm long, (3) 4-9 (12) mm wide, densely tomentose below, floccose to essentially glabrous above, the tomentum whitish, the margins plane or with thickened margins, not revolute, the apices acute and even apiculate in some; *flowering stems* slender to ± stout, 3-7 cm long, floccose to glabrous; *inflorescences* dense to open cymose, 3-10 cm long,

floccose to glabrous; *involucres* narrowly turbinate, 2.5-3 mm long, floccose to glabrous; *flowers* yellow, 2-2.5 mm long, the midribs and bases brownish-yellow, the tepals similar, the outer whorl of tepals tapering at the base; *achenes* 2-2.5 mm long. – Representative collections: *Cronquist 6127* (CAS, COLO, GH, MICH, NY, RSA, TEX, UC, UTC, WS, WTU), *7743* (CAS, NY, RSA, WS, WTU), *7747* (CAS, NY, UC, WS, WTU); *Dillon 935* (GH, NY, UC, WS, WTU); *Henderson 5431* (CAS, GH, MO); *Holmgren and Reveal 1346, 1697* (ARIZ, BRY, CAS, DS, GH, KSC, MO, NY, OKL, RS, RSA, UC, US, UTC, WTU); *J. T. Howell 12098* (A, CAS, GH, NY); *M. E. Jones 28859* (BM, CAS, MO, POM, UC); *Maguire and Holmgren 26730* (CAS, IDS, GH, MO, NY, POM, US, WS, WTU); *E. J. Palmer 37990* (A, NY, US, WTU); *Peck 18638* (NY, WILLU); *Thompson 11901* (A, CAS, DS, GH, NY, POM, UC, US, WTU).

Distribution.

Dry rocky slopes and hills on clay to sandy-loam soils of central Oregon from southeastern Wasco County, and southern Gillman County southeast into the John Day Valley of Wheeler and Grant counties and northern Crook County; disjunct in southeastern Baker County and adjacent northern Malheur County, Oregon and adjacent Washington County, Idaho; in isolated and very scattered populations in northern Humboldt County, Nevada; and in eastern Modoc and Lassen counties, northeastern California, from 2,200-5,500 feet elevation. Flowering from July to September. Figures 20 and 21.

The type of *Eriogonum microthecum* was collected by Thomas Nuttall in August of 1834. The exact location cannot be determined although comparison of modern specimens with that of Nuttall's is rather revealing. The route followed by Nuttall is clearly reported by Wyeth (1899) and Townsend (1839). After following the Boise River to the Snake River in western Idaho, the party crossed the Snake River on 23 August, and entered the present-day state of Oregon. Wyeth guided the party northward overland to the Malheur River which they then descended back to the Snake. On the 26th, they arrived at the Burnt River and followed it northward until the 28th. This is the only area where Nuttall could have found this species as determined from modern-day distribution. The type compares favorably with plants collected more recently from this area and is found to match almost identically with *M. E. Jones 6511*, the type of *E. idahoense*. It is suggested that the type of *E. microthecum* was collected on the rocky slopes above the Snake River below Huntington, Baker Co., Oregon, on or about the 26 August 1834.

No sooner had Nuttall named the species than authors in America and England were applying the concept of var. *microthecum* to specimens of var. *laxiflorum*–an error that has continued in floras, manual, and revisions of the genus up to 1964.

The var. *microthecum*, as here defined, consists of two rather easily distinguished groups. The one, represented by the type, has floccose flowering stems, inflorescences and involucres, oblanceolate leaves, and densely compact inflorescences. The other phase, restricted to the John Day Valley region of central Oregon, has subglabrous to glabrous stems, involucres, and a more open, glabrous inflorescence. The leaves are generally more elliptical than oblanceolate. The populations in northern Nevada and California, while similar to each other, tend to bridge the morphological gap (although not completely so) between the two Oregon types.

In the field, these two groups attributed to var. *microthecum*, differ in minor ways. For example, the plants associated with the type are usually found associated with species of *Artemisia* on open slopes or the lower foothills. If these plants are associated with *Pinus*, the species is normally pinyon. The John Day Valley phase is also associated with *Artemisia*, but less directly, and the *Eriogonum* is more often on open slopes under taller species of conifers than pinyon. The soils are different too. That of the typical phase tends to be more clayey than that found in John Day Valley which is distinctly a loam soil. The plants in northwestern Nevada are almost always on heavy clay soils, and the same is likely true of the plants in northeastern California. If further work should demonstrate the distinction between these two groups of var. *microthecum*, the definition of the variety will become even more restricted.

The var. *microthecum* clearly evolved from var. *laxiflorum*. The two variants are very similar and nonflowering plants can be difficult to place, especially when they come from northwestern Nevada or northeastern California. The presence of yellow flowers is a rather dubious feature, but when added to the other minor morphological differences and the geographical range is considered, a varietal distinction seems justified. The distinction between var. *microthecum* and var. *ambiguum* is one that is largely based on ecological and geographical differences. To be sure, morphological differences exist, but these are somewhat overlapping in nature. However, in the field, the two seem quite different and one never finds var. *microthecum* in the ecological habitats where the vast majority of specimens of var. *ambiguum* occur.

6i. **Eriogonum microthecum var. ambiguum (M. E. Jones) Reveal in Munz**

Eriogonum microthecum Nutt. var. *ambiguum* (M. E. Jones) Reveal in Munz, Suppl. A Calif. Flora 61. 1968, based on *E. aureum* M. E. Jones var. *ambiguum* M. E. Jones, Proc. Calif. Acad. Sci. II, 5:719. 1895. – *Eriogonum fruticosum* A. Nels. var. *ambiguum* (M. E. Jones) A. Nels., Bot. Gaz. 34:23. 1902. – *Eriogonum corymbosum* Benth. in DC. var. *ambiguum* (M. E. Jones) M. E. Jones, Contr. W. Bot. 11:14. 1903.

Along the Hockett Trail in the valley of Little Cottonwood Creek on the east slope of the Sierra Nevada near Lone Pine, Inyo County, California, 24 August 1891, *Coville and Funston 1688*. Holotype, US! Iso-

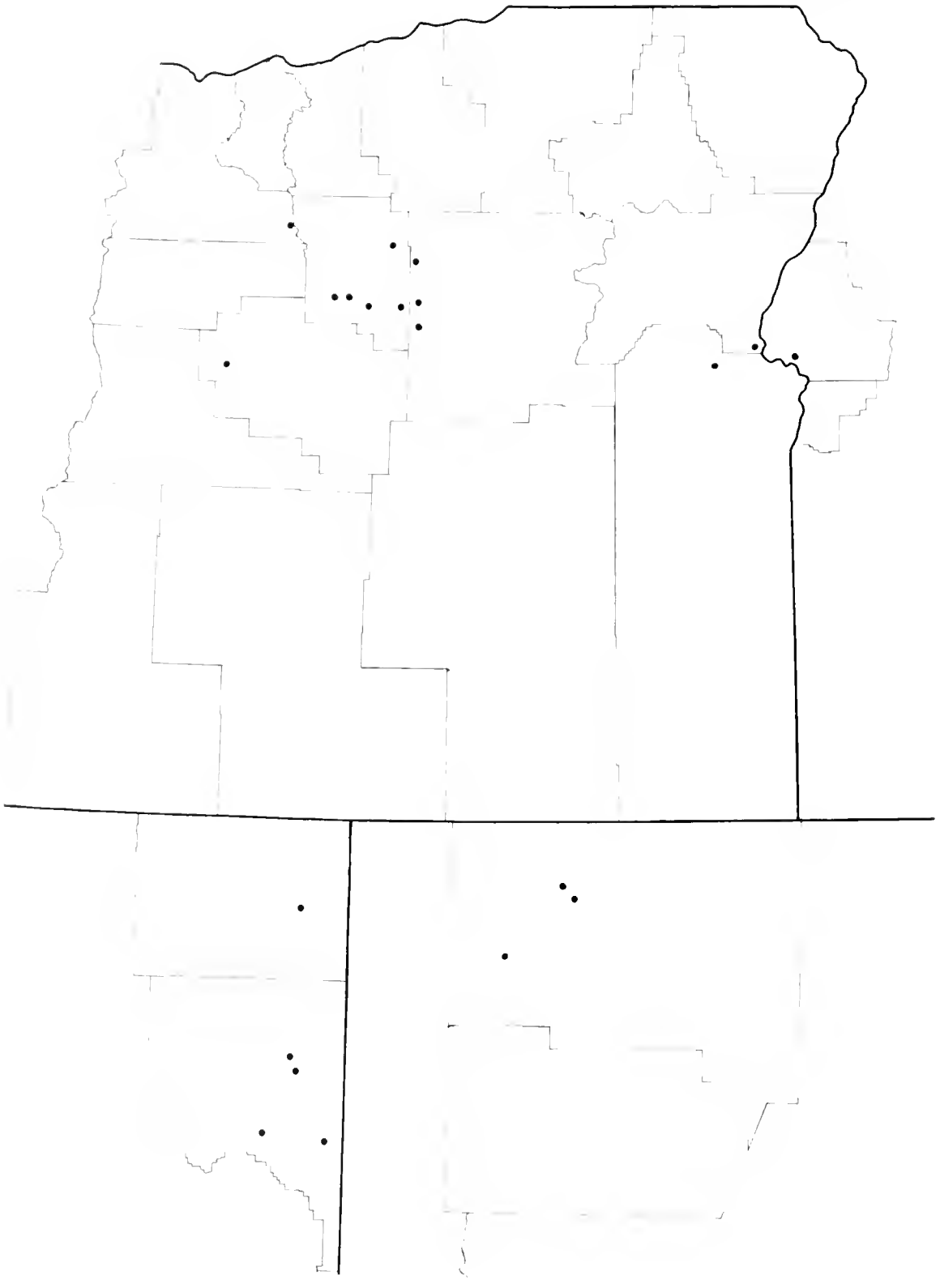

Fig. 20. Distribution map of *Eriogonum microthecum* var. *microthecum*. Portions of Oregon, Idaho, California, and Nevada.

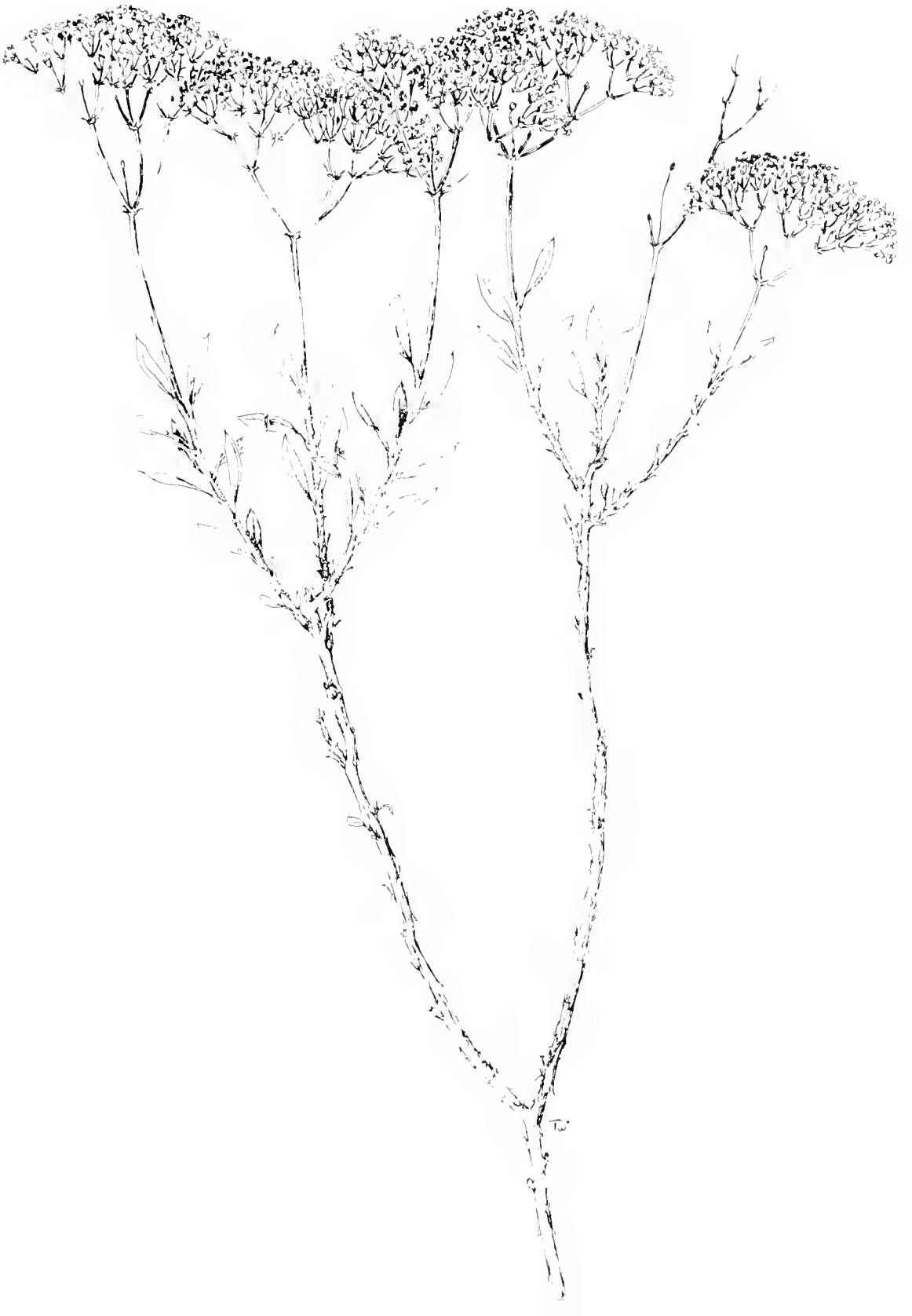

Fig. 21. Illustration of *Eriogonum microthecum* var. *microthecum*.

type, NY!

Eriogonum tenellum Torr. var. *erianthum* Gand., Bull. Soc. Roy. Bot. Belgique 42:198. 1906. Truckee Meadows, Nevada County, California, 1892, *Hillman s.n.* Holotype, LY! Isotypes, RENO, UC!

Eriogonum microthecum Nutt. var. *expansum* S. Stokes, Gen. Eriog. 76. 1936. Rocky places in the White Mountains, probably Inyo County, California, September 1898, *Purpus 6464.* Lectotype, UC! Isolectotypes, SD, US!

Erect or spreading subshrubs or shrubs, 0.5-5 dm high and 1-8 dm across; *leaves* linear-oblanceolate to elliptic, 0.8-2.5 cm long, (2) 3-6 (8) mm wide, densely tomentose below, floccose (rarely subglabrous) above, the tomentum whitish or reddish-brown, the margins plane or with thickened margins, occasionally revolute, the apices acute to rounded, rarely apiculate; *flowering stems* stoutish, 2-10 cm long, tomentose when young, becoming floccose or infrequently subglabrous at maturity; *inflorescences* open cymose, 1-5 (12) cm long, tomentose to floccose, rarely glabrous, the tomentum whitish or reddish-brown; *involucres* 2-2.5 mm long, turbinate, tomentose to floccose, glabrous along the angled ridges; *flowers* yellow, (1.5) 2-2.5 (3) mm long, the midribs and bases occasionally brownish-yellow in fruit, the tepals essentially similar, the outer whorl of tepals rounded at the base; *achenes* 1.5-2 mm long. Representative collections: *Alexander and Kellogg 2542* (GH, NY, UC, WS, WTU); *Archer 7018* (ARIZ, NA, NY, UC); *Balls and Everett 18024* (CAS, NY, RSA); *Duran 3113* (ARIZ, BM, BR, CAS, DS, GH, MICH, MO, NY, POM, RSA, SD, UC, US, UTC, WIS, WTU); *Ferris 6754, 6764* (DS, POM); *Graham 65, 75, 235* (UC); *Hall 11881* (GH, UC); *Heller 10220* (CAS, GH, MO, US); *A. E. Howell 14324, 22841, 24155, 26294, 40223, 40987* (CAS); *Munz 21165* (CAS, NY, RSA); *Reveal 392, 414* (CAS, UTC, WTU); *Roos and Roos 5931* (CAS, RSA); *Shockley 544* (ND-G, OKL, UC), *666* (ND-G, UC); *Stokes s.n.* (SD, UC); *Tram 4318* (NA, RSA, WTU); *Twisselmann 5636, 5833* (CAS).

Distribution.

Dry rocky places from southern Washoe County, Nevada and adjacent Nevada County, California, southward along the eastern flank of the Sierra Nevada and adjacent desert ranges to Mineral and Esmeralda counties, Nevada, and Mono and Inyo counties, California, from (5,000) 6,500-10,500 feet elevation. Flowering from July to September. Figures 22 and 23.

The var. *ambiguum* has suffered from numerous interpretations since it was described by Jones in 1895. First it was referred to *Eriogonum aureum*, a synonym of *E. corymbosum* var. *glutinosum*, then transferred to *E. fruticosum* by Aven Nelson as part of an error discussed under *E. corymbosum* (Reveal, 1968), and finally placed in *E. corymbosum* by Jones all of this done in a period of eight years! However, it was not put into its proper taxonomic position until some sixty years later when I called attention to this forgotten entity (Reveal & Munz, 1968). In the intervening year Gandoger (1906) and Stokes (1936) rediscovered and renamed the variety,

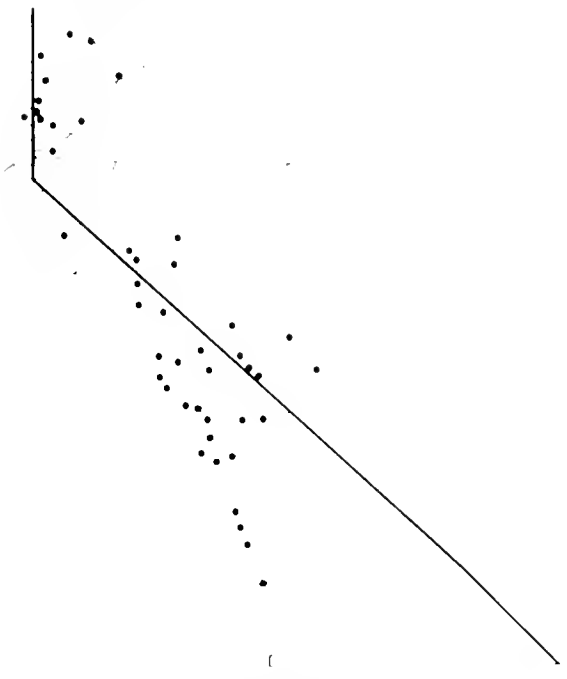

Fig. 22. Distribution map of *Eriogonum microthecum* var. *ambiguum*. Portions of California and Nevada.

first under *E. tenellum* and finally under *E. microthecum*. Even so the situation with this entity is not stable. As one may see from the key, the separation of var. *ambiguum* from var. *microthecum* is a matter of some difficulty. However, as the two differ in several minor ways which seem to be consistent, they are given formal taxonomic recognition as distinct variants.

In the field, var. *ambiguum* is a most interesting subject. In much of its range it occurs with var. *laxiflorum* and it may be easily looked upon as a yellow-flowered phase of var. *laxiflorum*. The two grow together in the lower desert foothills in Mono and Inyo counties, California, but in the higher elevations, especially on the Sierra Nevada, the var. *ambiguum* can be found separated from var. *laxiflorum*.

7. **Eriogonum effusum Nutt.**

Diffusely branched spreading shrubs 1.5-7 dm high and 3-12 (15) dm across, the lower stems grayish to reddish-brown, woody, the bark shreddy or exfoliating in platelike segments, leafless or leafy on the upper portions only, the upper branches herbaceous, slender to ± stout, scraggly and fragile, floccose to glabrous, the stems dark green; *leaves* solitary and scattered along the lower 1/4 of the herbaceous stems, ± decurrent, the leaf-blades thin, linear to linear-oblanceolate or oblanceolate to oblong, (1) 1.5-5 (6) cm long, 1-7 mm wide, densely white-tomentose below, the midvein usually distinct and not densely tomentose, white-floccose and green above, the tomentum and leaf-color drying blackish in most, the margins entire or slightly undulate in some, plane or revolute, the apices acute to subacute or obtuse, the bases cuneate, the leaves soon deciduous, the plants often leafless in late anthesis, the petioles slender, 2-7 mm long, floccose below, subglabrous to glabrate above, the petiole-bases elongated-triangular, 1.5-4.5 mm long, 1-2 mm

Fig. 23. Illustration of *Eriogonum microthecum* var. *ambiguum* showing extremes in variation.

wide, tomentose to floccose without, tomentose within, not clasping the stems; *flowering stems* slender to ± stout, few to numerous per plants, (2) 3-8 (10) cm long, floccose to glabrous, the tomentum blackish at maturity in most, often more heavily pubescent among the basal leaves and below to the woody stems; *inflorescences* densely cymose, diffuse and ± congested with numerous trichotomous and dichotomous branches, (0.5) 1-3 (4) dm long, 1-4 dm across, white-floccose to green and glabrous, the tomentum and branches often becoming blackish; *bracts* scalelike, ternate, mostly triangular, 0.5-2 (5) mm long, 0.5-1.5 mm wide, floccose to subglabrous or glabrous, usually dark brown to black without, cottony tomentose within, connate at the base; *peduncles*, when present, slender and up to 2.7 cm long, mostly floccose, restricted to the lower nodes; *involucres* solitary, turbinate, 1.5-3 mm long, 1-2 mm wide, sparsely floccose without, glabrous within, the 5 minute acute to triangular lobes 0.3-0.6 mm long, the bractlets linear to oblanceolate, 1.5-3 mm long, fringed with several short capitate gland-tipped cells, the pedicels 1.5-4.5 mm long, glabrous; *flowers* white with greenish or reddish midribs and bases, 2-4 mm long, glabrous within and without except for scattered pilose to strigose hairs without in some and for a few microscopic glands within along the midribs and lower part of the flower tube, the tepals nearly similar to slightly dissimilar, the outer whorl of tepals elliptic or more frequently obovate, 1.3-1.8 mm wide, the apices rounded to emarginated, the bases rounded to nearly cordate, the inner whorl of tepals narrowly oblong to oblong, 0.6-1 mm wide, the apices mostly acute, united about ¼ the length of the flower; *stamens* mostly exserted, 2-4.5 mm long, the filaments sparsely pubsecent to short pilose basally, the anthers reddish to purplish-red, 0.5-0.7 mm long, oblong; *achenes* brown, 2-2.5 mm long, the large globose base tapering abruptly to a long 3-angled beak.

Distribution.

Dry rocky slopes to sandy plains and flats or infrequently on heavy clay slopes, chalky bluffs, or gypsum outcrops, in the mountains and on the Great Plains from southwestern South Dakota southward to eastern Wyoming and extreme western Nebraska across eastern Colorado in the Front Ranges and on the plains into north-central, central, and northeastern New Mexico, and in west-central Kansas, from 3,000-7,500 feet elevation. Flowering from June to September.

The Great Plains Buckwheat, *Eriogonum effusum*, has been placed under *E. microthecum* as a variety by some authors. This treatment is most unrealistic as the two are well separated on morphological and geographical bases. Both species occur together in southern Colorado and northwestern New Mexico, but in this area the two are very distinct and no introgression or hybridization is seen in the field nor in the numerous herbarium specimens examined.

Within the species as now recognized, only two varieties are recognized.

Key to the varieties of *Eriogonum effusum*

A. Leaves oblanceolate to oblong or obovate, (1) 1.5-3 cm long, (2) 3-7 mm wide, not revolute; South Dakota and Wyoming southward to New Mexico
  8a. var. *effusum*

AA. Leaves linear to linear-oblanceolate, (2) 3-6 cm long, 1-2.5 (3) mm wide, usually revolute; west-central Kansas
  8b. var. *rosmarinoides*.

7a. **Eriogonum effusum var. effusum**

Eriogonum effusum Nutt., Proc. Acad. Nat. Sci. Philadelphia 4:15. 1848. – *Eriogonum microthecum* Nutt. var. *effusum* (Nutt.) Torr. & Gray, Proc. Amer. Acad. Arts 8:172. 1870. – *Eriogonum effusum* Nutt. ssp. *typicum* S. Stokes, Gen. Eriog. 78. 1936. – "Rocky Mountains of the Platte," likely along the Platte River in extreme western Nebraska or adjacent Wyoming, late May or early June 1834, *Nuttall s.n.* Holotype, BM! Isotypes, GH, PH!

Eriogonum myrianthum Gand., Bull. Soc. Roy. Bot. Belgique 42:191. 1906. – Fort Collins, Larimer County, Colorado, 1 September 1898, *Crandall s.n.* Lectotype, LY! Isolectotype, US!

Eriogonum nebraskense Rydb., Flora Rocky Mts. 1061. 1917. *Eriogonum multiceps* Nees in Wied-Neuw. ssp. *nebraskense* (Rydb.) S. Stokes, Gen. Eriog. 94. 1936. *Eriogonum pauciflorum* Pursh var. *nebraskense* (Rydb.) Reveal, Great Basin Naturalist 27:113. 1967. – Prairies in Kimball County, Kimball Co., Nebraska, 12 August 1891, *Rydberg 336*. Holotype, NY! Isotypes, KSC, NY, US!

Diffusely branched shrubs (1.5) 2-5 (7) dm high and up to 15 dm across; *leaves* oblanceolate to oblong, (1) 1.5-3 cm long, (2) 3-7 mm wide, densely tomentose below, white-floccose to glabrate or glabrous and green above, the margins plane, not revolute, or if so, then the plants from the mountains of central Colorado; *flowering stems* slender to ± stout, 3-8 cm long, floccose to glabrous; *inflorescences* 1-3 (4) dm long, floccose to glabrate or subglabrous; *involucres* 1.5-2.5 (3) mm long; *flowers* white, 2-4 mm long; *achenes* 2-3 mm long. Representative collections: *Irsene and Benedict 15418* (P, US); *Bacigalupi 662, 912* (GH, UC); *Clements and Clements 21* (ISC, NY, US); *Clokey 2948* (ARIZ, CAS, GH, NY, UC, US); *Dodds 1957, 2041, 2069* (COLO); *Eastwood 123* (CAS, COLO, GH, UC, US); *Ehlers 7827* (ARIZ, MICH, ND); *Engelmann s.n.* (GH, MO, NY); *Ewan 13691* (COLO, ND, NO, OKL). *Fendler 768* (GH, MO); *Frémont s.n.* (NY); *Goodman 2008* (ISC, MO, NY, OKL); *Hall and Harbour 502* (BM, GH, MO, NY, US); *Heller 14307, 14324* (MO, WTU); *Iltis and Iltis 18658* (WIS); *Johnston 403* (GH, MICH, MO, US); *Jones 544* (BM, BR, NY, POM, UTC); *Mulford s.n.* (GH, MO, NY, US); *Nelson 329* (MO, NY, POM, RM), *1138* (GH, RM, US, WIS), *7631* (ARIZ, COLO, GH, ISC, MO, NY, POM, RENO, RM, US). *Parry 321* (GH, ISC, MO, NY); *Ramaley 863* (CAS, COLO, RSA, UC, WTU); *Reveal and Davidse 865, 869, 870* (BRY, CAS, GH, IU, NY, OKL, RSA, SMU, TEX, UC, US, UTC); *Robbins 900* (COLO, NY, UC); *Rollins 1072* (G, GH, ND, RM, UC, US, WTU); *Rydberg 185, 335* (NY); *Sheldon 572* (LIVU, UC, US); *Standley 6941, 7107* (US); *Stokes 210* (ARIZ, BM, CAS, DS, GH, MO, NY, POM, RSA, UC, US, UTC); *Waterfall 12041* (OKL, RSA, US). *Williams 2449* (G, MO, ND, UC, US, WTU).

Distribution.

Rocky slopes of the mountains and ranges onto the sandy soils of the plains, from Pennington County, South Dakota, southward into Converse and southern Niobrara counties, Wyoming, southward in southeastern Wyoming and adjacent extreme western Nebraska to central and east-central Colorado in the Front Ranges and on the Great Plains to northern

New Mexico from eastern San Juan County eastward to Union County and with an outlying population in Socorro County, New Mexico. Flowering from June to September. Figures 24 and 25.

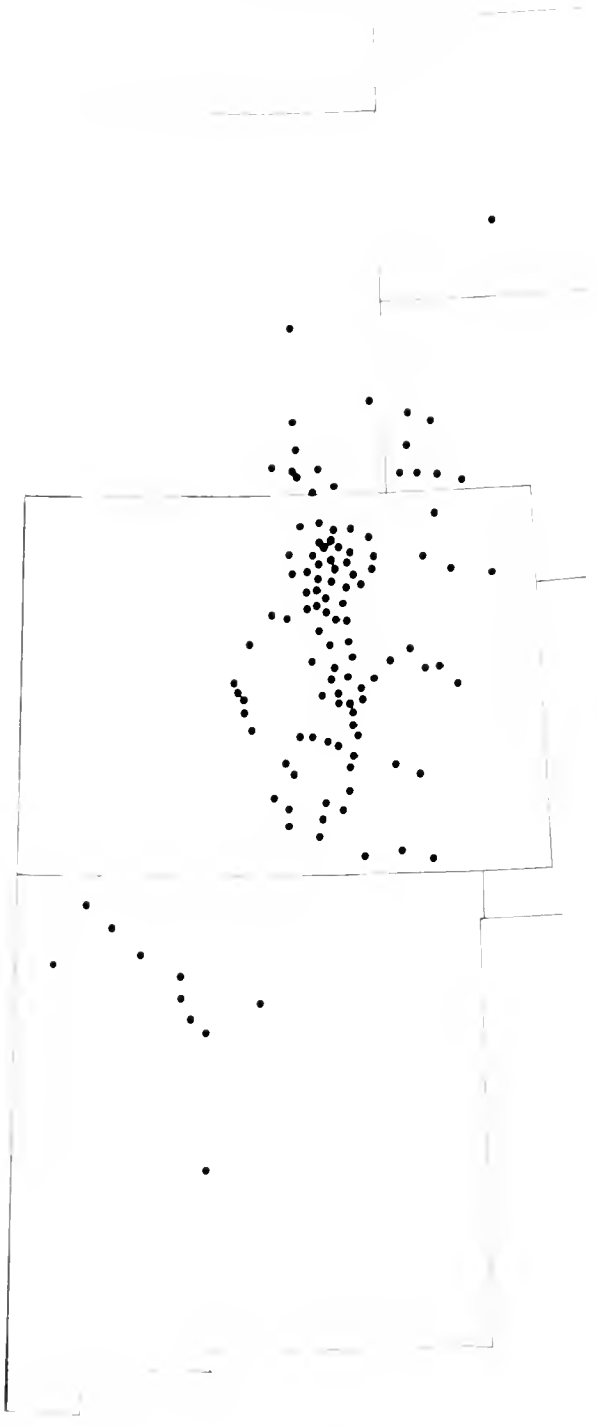

Fig. 24. Distribution map of *Eriogonum effusum* var. *effusum*.

The type of *Eriogonum effusum* was collected in a premature state by Thomas Nuttall while on his transcontinental trip with Nathaniel J. Wyeth. The exact location cannot be determined, but on the basis of known distribution of the species, and his route, the type area can be estimated fairly accurately. On 28 May, the party reached Scotts Bluff where *E. effusum* is known to occur. That Nuttall collected here is attested by Townsend (1839) who commented:

> These mounds [at Scotts Bluff] were of hard yellow clay, without a particle of rock of any kind, and along their bases, and in the narrow passages, flowers of every hue were growing. It was a most enchanting sight; even the men noticed it, and more than one of our matter-of-fact people exclaimed, *beautiful, beautiful.* Mr. N[uttall] was here in his glory. He rode on ahead of the company, and cleared the passages with a trembling and eager hand, looking anxiously back at the approaching party, as though he feared it would come ere he had finished, and tread his lovely prizes under foot.

The species is equally common on the Laramie Hills, and it is possible that Nuttall gathered his specimens on 2 June when they crossed these mountains in southeastern Wyoming.

The variety, as now defined, includes *Eriogonum nebraskense.* An understanding of this taxon has plagued botanists for years, and even its placement in synonymy here may not be a final answer. The distinguishing features are the pubescent flowers and densely tomentose leaves, both characters that may have come about as a result of introgression or hybridization with *E. pauciflorum* Pursh (Reveal, 1967). Its placement with *E. pauciflorum* was based on an over emphasis of the pubescent flowers, a point of view that is now considered to be in error. However, whether or not the species should be recognized as a hybrid species remains to be demonstrated by cytological studies.

In the field, var. *effusum* is a spectacular shrub. It forms large spreading masses of intricately branched inflorescences capped with numerous whitish to pinkish flowers. In some areas, as in central Colorado, the shrubs are massive, often being up to 1.5 m across, but in parts of northern New Mexico, they are low scraggly bushes with only a few branches. This variety might make an excellent garden shrub were it not for the fact that when it is not flowering, the dead and dried branches are rather bare and forlorn looking, and even in the field the plants look unbecoming.

The suggestion that var. *effusum* forms hybrids with *Eriogonum microthecum* appears to be unfounded. In this investigation, the distinction between these two taxa has been easily made, and not a single specimen has presented a problem. Consequently, *E. effusum* is maintained as a distinct species.

7b. **Eriogonum effusum var. rosmarinoides Benth. in DC.**

Eriogonum effusum Nutt. var. *rosmarinoides* Benth. in DC., Prodr. 14:18. 1856. – Along Smoky Hill River, Gove or Trego counties, Kansas, 21 July 1845, *Frémont 181.* Lectotype, NY! Isolectotype, GH, K, MO!

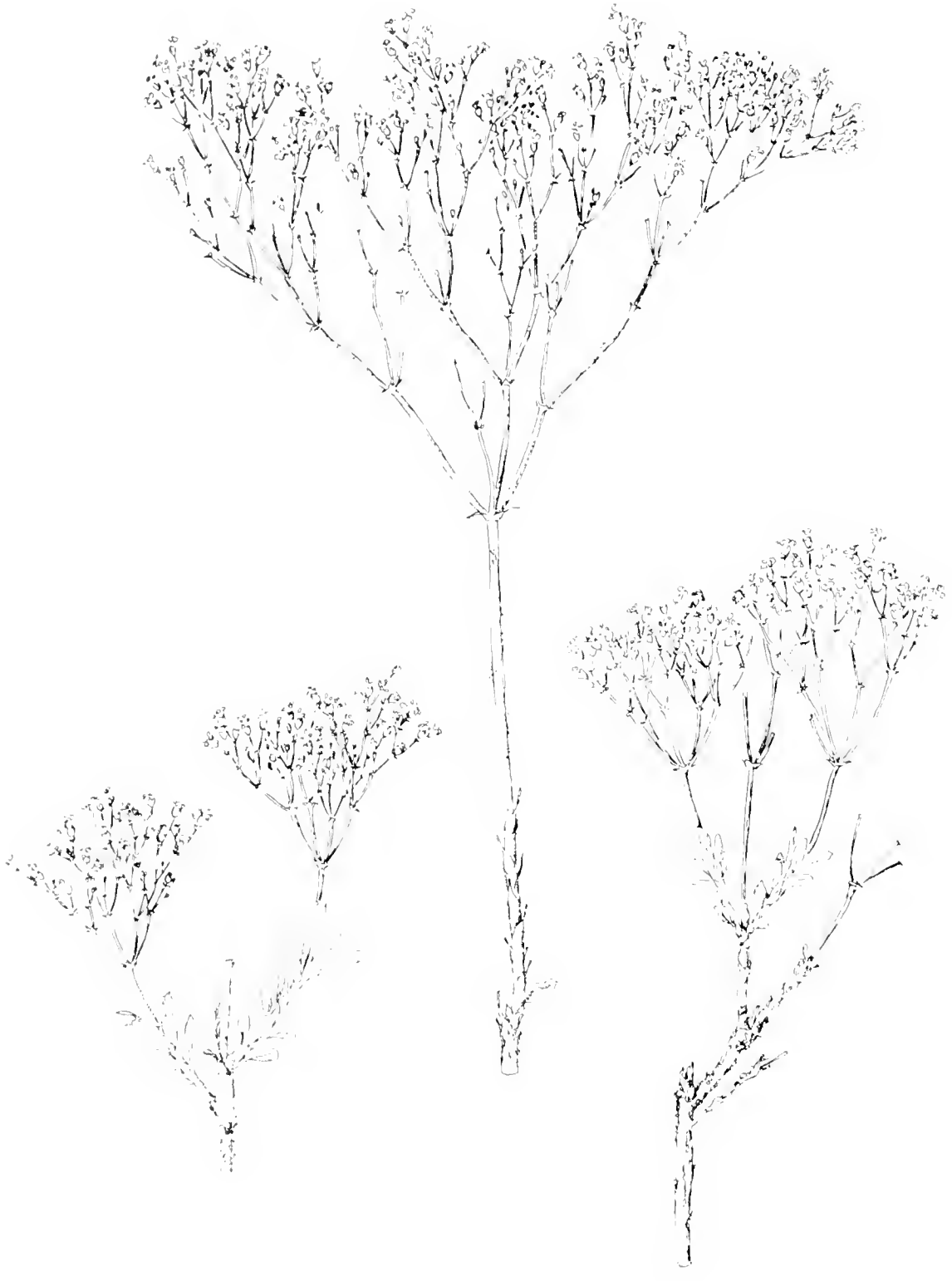

Fig. 25. Illustration of *Eriogonum effusum* var. *effusum*.

Eriogonum helichrysoides Gand., Bull. Soc. Roy. Bot. Belgique 42:192. 1906. *Eriogonum microthecum* Nutt. var. *helichrysoides* (attrib. to Gand by) Rydb., Bulletin 1:87. 1931. *Eriogonum effusum* Nutt. ssp. *helichrysoides* (Gand.) S. Stokes, Gen. Eriog. 78. 1936. In canyons of Gove County,

Kansas, 21 July 1895, *A. S. Hitchcock 448*. Holotype, LY! Isotypes, GH, KSC, MO, NY, US!

Low diffusely branched shrubs 1.5-3.5 (4) dm high and up to 8 dm across; *leaves* linear to linear-oblanceolate, (2) 3-6 cm long, 1-2.5 (3) mm wide, densely tomentose below, floccose above, often revolute; *flowering stems* slender, 2-4 cm long, floccose; *inflorescences* 0.5-1.3 (1.6) dm long, floccose to nearly glabrous; *involucres* 2.5-3 mm long; *flowers* white, 2-2.5 (3) mm long; *achenes* 2-2.5 mm long. – Representative collections: *Agrelius and Stephens s.n.* (WIS); *Gates 16676* (KSC, US); *Goodman 2206* (ISC, MO, NY, OKL); *Gordon s.n.* (MO); *Hitchcock 557* (GH); *Horr and Horr 4154* (KANU, NY); *McGregor 12471, 13652, 13644, 13666* (KANU); *Rich 1297* (KSC); *Rydberg and Imler 1034* (COLO, KANU, KSC, MO, NY), *1132* (KANU, KSC, NY); *Stephens 8996, 9770* (KANU), *19085* (KANU, UC); *Weber 142* (KSC).

Distribution

Clay slopes and chalky limestone outcrops in Logan, Gove, Trego, Scott, and Lane counties, Kansas, from 3,000-3,500 feet elevation. Flowering from July to September. Figures 26 and 27.

The type of var. *rosmarinoides* was collected by John C. Frémont on the last leg of his western trip which lasted from 1843 to 1845. However, when it was described by Bentham (1856), the location date was given as "California." In 1870, Torrey and Gray called attention to this error, but the name remained associated with the California flora until this fact was pointed out again by Reveal and Munz (1968).

The Gandoger name has been the subject of some nomenclatural confusion. Even though Gandoger specifically stated his name, *Eriogonum helichrysoides*, to be a new species, Rydberg considered the name to

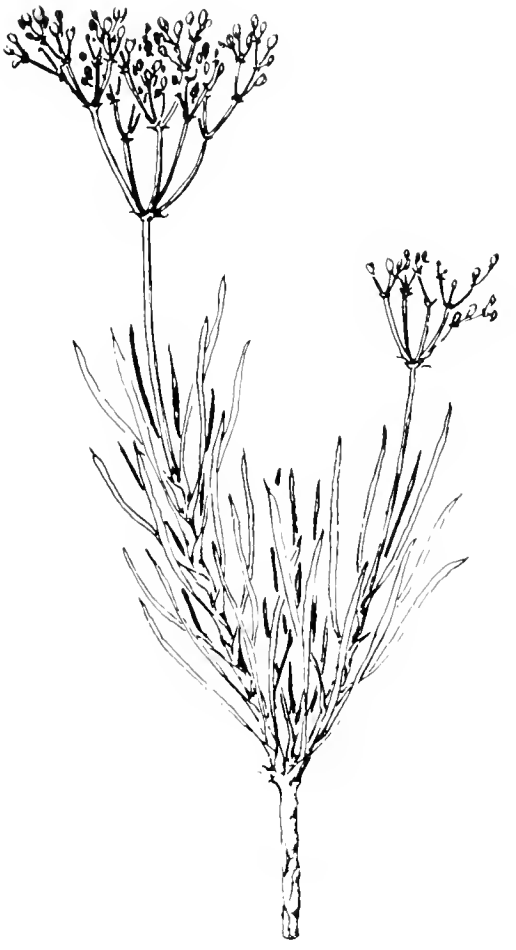

Fig. 27. Illustration of *Eriogonum effusum* var. *rosmarinoides*.

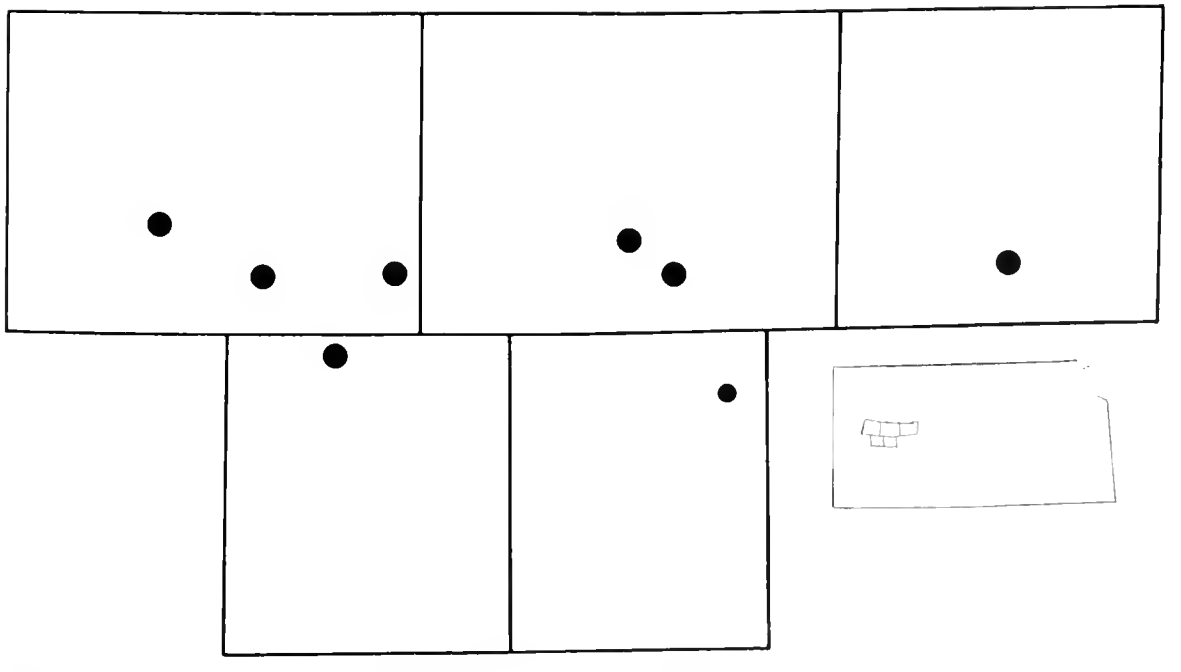

Fig. 26. Distribution map of *Eriogonum effusum* var. *rosmarinoides*. Logan, Gove, Trego, Scott, and Lane counties, Kansas.

be merely a variety of *E. microthecum* based on Gandoger's past usage of this rank in other taxonomic treatments. Nevertheless, as Gandoger was specific in his application of the rank he used in this paper, it cannot be questioned.

In the field, var. *rosmarinoides* occurs in exposed areas on steep chalky bluffs in west-central Kansas. So far as known it is endemic to this area. The low shrubs are rather woody, tend to be spreading, and have numerous branches. The differences between var. *rosmarinoides* and var. *effusum* are subtle, but their geographical ranges do not overlap.

SUMMARY

This revision discusses seven species of *Eriogonum* (Polygonaceae) found in the western United States of North America. One of the two major species, *E. microthecum* Nutt., is composed of nine varieties which range over a wide area of the Far West. The other major species, *E. effusum* Nutt., is found in a smaller geographical area mainly east of the Continental Divide. The five remaining species are primarily restricted to the Colorado-Green rivers drainage basin of Utah, Colorado, New Mexico, and Arizona. Together these entities form the core of a group of plants known as Section Corymbosa Benth. in DC. The remaining species of the section (not discussed here) are typified by *E. deserticola* S. Wats., *E. leptocladon* Torr. & Gray, and *E. corymbosum* Benth. in DC. The latter group of species was reviewed in Part V of this series, *Notes on Eriogonum*. The new entities proposed in the present paper are *E. microthecum* var. *corymbosoides* and var. *johnstonii* from southern California; *E. microthecum* var. *lapidicola* of eastern California, southern Nevada, and perhaps western Utah; and, *E. microthecum* var. *alpinum* from the Sierra Nevada of east-central California. The proper characterization of *E. ericifolium* Torr. & Gray is proposed and *E. mearnsii* Parry in Britt. is reduced to synonymy. Two new combinations are suggested: *E. microthecum* var. *foliosum* and *E. ericifolium* var. *pulchrum*. Keys and descriptions for each entity are provided as are maps showing the distribution of each taxon. Illustrations of the variation within *E. microthecum* and *E. effusum* are provided.

ACKNOWLEDGMENTS

I extend my sincere thanks to Dr. Stanley L. Welsh of Brigham Young University, Provo, Utah, for suggestions on various aspects of this study. Dr. Wallace R. Ernest and Mr. Conrad V. Morton of the Department of Botany, United States National Herbarium, Smithsonian Institution have kindly read the manuscript and made many helpful suggestions. Fieldwork since 1965 has been supported by both private financing and a National Science Foundation grant to Dr. Arthur Cronquist of the New York Botanical Garden for the Intermountain Flora Project, a cooperative program between the New York Botanical Garden and Utah State University. Summer fieldwork conducted in 1968 was aided by Contract No. AT(04-1) Gen-12 between the University of California at Los Angeles and the Division of Biology and Medicine, United States Atomic Energy Commission while collecting plants on the Nevada Test Site. Critical herbarium material has been obtained through support furnished by Brigham Young University. Visits to herbaria have been largely supported by Utah State University, New York Botanical Garden, the Smithsonian Research Foundation, the Texas Research Foundation, Brigham Young University, and the Atomic Energy Commission. The final phases were partially supported by a National Science Foundation Grant (GB-22645) for studies on *Eriogonum*. The illustrations were prepared by Mrs. Twila Davis Bird.

The several herbaria which have been consulted are noted below and abbreviated as suggested by Lanjouw and Stafleu (1964). I am grateful to the numerous curators who have so kindly provided me with material for this study.

A	Arnold Arboretum, Harvard University Herbaria, Cambridge, Massachusetts
ARIZ	University of Arizona, Tucson, Arizona
ASC	Northern Arizona University, Flagstaff, Arizona
ASU	Arizona State University, Tempe, Arizona
BM	British Museum (Natural History), London, England
BR	Jardin Botanique de l'Etat, Bruxelles, Belgium
BRY	Brigham Young University, Provo, Utah
CAS	California Academy of Sciences, San Francisco, California
COLO	Museum, University of Colorado, Boulder, Colorado
DS	Dudley Herbarium, Stanford University, Stanford, California
G	Conservatoire et Jardin botaniques, Geneve, Switzerland
GH	Gray Herbarium, Harvard University Herbaria, Cambridge, Massachusetts
IDS	Idaho State University, Pocatello, Idaho
ISC	Iowa State University, Ames, Iowa
JEPS	Jepson Herbarium, University of California,

Berkeley, California
K Royal Botanic Garden, Kew, England
KANU University of Kansas, Lawrence, Kansas
KSC Kansas State University, Manhattan, Kansas
LIVU The Harley Botanical Laboratories, Liverpool, England
LL Lundell Herbarium, Texas Research Foundation, Renner, Texas
LY Herbiers de la Faculte des Sciences de Lyon, France
MARY University of Maryland, College Park, Maryland
MICH University Herbarium, University of Michigan, Ann Arbor, Michigan
MNA Museum of Northern Arizona, Flagstaff, Arizona
MO Missouri Botanical Garden, St. Louis, Missouri
MONT Montana State University, Bozeman, Montana
NA United States National Arboretum, Washington, D.C.
ND University of Notre Dame, Notre Dame, Indiana
ND-G Greene Herbarium, University of Notre Dame, Notre Dame, Indiana
NO Tulane University, New Orleans, Louisiana
NTS Nevada Test Site Herbarium, Mercury, Nevada
NY The New York Botanical Garden, Bronx Park, Bronx, New York
OKL Bebb Herbarium, University of Oklahoma, Norman, Oklahoma
ORE University of Oregon, Eugene, Oregon
OSC Oregon State University, Corvallis, Oregon
P Museum National d'Histoire Naturelle, Laboratoire de Phanerogamie, Paris, France
PH Academy of Natural Sciences, Philadelphia, Pennsylvania
POM Pomona College Herbarium, Rancho Santa Ana Botanic Garden, Claremont, California
RENO University of Nevada, Reno, Nevada
RM Rocky Mountain Herbarium, University of Wyoming, Laramie, Wyoming
RSA Rancho Santa Botanic Garden, Claremont, California
SD San Diego Museum of Natural History, San Diego, California
SMU Southern Methodist University, Dallas, Texas
TEX University of Texas, Austin, Texas
UC University of California, Berkeley, California
UNM University of New Mexico, Albuquerque, New Mexico
US United States National Museum, Smithsonian Institution, Washington, D.C.
USFS United States Forest Service Herbarium, Boulder, Colorado
UT University of Utah, Salt Lake City, Utah
UTC Intermountain Herbarium, Utah State University, Logan, Utah
WILLU Peck Herbarium, Willamette University, Salem, Oregon
WIS University of Wisconsin, Madison, Wisconsin
WS Washington State University, Pullman, Washington
WTU University of Washington, Seattle, Washington

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A TAXONOMIC STUDY OF CROTAPHYTUS COLLARIS BETWEEN THE RIO GRANDE AND COLORADO RIVERS

by

William Ingram III[1] and Wilmer W. Tanner[2]

INTRODUCTION

The Western Collared Lizard, *Crotaphytus collaris baileyi*, Stejneger, is an attractive lizard of marked variability. Its range, as now recognized, includes the area from the Great Basin south to central Baja California and Sonora; the desert slopes of mountains in southern California, east to the Continental Divide in southwestern Colorado and western New Mexico, and south into Chihuahua, Durango, Coahuila, Nuevo Leon, and San Luis Potosi (Stebbins, 1966; Smith and Taylor, 1950).

The range of *C. c. baileyi* is divided by several natural geographic barriers which have been shown to mark boundary lines for subspecies of other saurian forms. Stebbins (1954) describes patternal differences of *C. collaris* which are both consistent and specific for certain geographic areas. Fitch and Tanner (1951) proposed that at least one geographic area within the range of *C. c. baileyi*, the Upper Colorado River Basin, contains a population of Collared Lizards that is distinguishable on the subspecific level from *C. c. baileyi*. These studies suggest that *C. c. baileyi* may in reality be a heterogeneous taxonomic unit requiring more study.

The first step in the comprehensive study of the populations presently contained in *C. c. baileyi* requires a detailed study of the population represented by the type material. An analysis of the total Western Collared Lizard problem also includes a study of the Collared Lizard populations located in the Chihuahuan Desert and the Upper Colorado River Basin. This includes the three populations' interactions with each other. The analysis of the remaining populations of Collared Lizards now presently contained within *C. c. baileyi* and occurring in areas located primarily west of the Colorado River and Baja, California is the subject of another study currently in progress.

REVIEW OF LITERATURE

In 1890, Dr. Leonhard Stejneger described as new, *Crotaphytus baileyi*. The type locality was listed as "Painted Desert, Little Colorado River, Arizona," and the type specimen designated as U.S. National Museum No. 15281. Other specimens included in the type series were USNM 15282-15287.

Stejneger (1890) distinguished *C. baileyi* from *C. collaris* on the basis of four characters: (1) two rows of interorbitals, (2) smaller supraocular scales, (3) narrower head, and (4) longer snout. At the time of the description, Stejneger indicated that further investigation probably would show *C. baileyi* to intergrade with *C. collaris*. However, he described it as a new species until conclusive evidence of intergradation was provided. The geographic range of *C. baileyi* was set forth as western New Mexico, Arizona, Nevada, and northern Mexico.

E. D. Cope (1900), in his monumental work on North American reptiles, recognized the differences listed by Stejneger. However, he stated that "transitions (of characters between geographic areas) are so numerous that a distinct subspecific name is of doubtful utility." Cope failed to support his conclusions with a clear presentation of data, but merely compared the number of specimens on hand (80) as to the condition of their interorbitals. He failed to recognize *C. baileyi* as either a species or a subspecies because his series contained a large number of specimens intermediate to *C. collaris* or *C. baileyi* with respect to interorbital scalation. However, he states that most of these intermediate specimens came from the central portion of New Mexico and western Texas, the area proposed by Stejneger as the probable region of intergradation. Thus, one wonders why Cope failed to recognize *C. baileyi* and place it as a subspecies of *C. collaris*.

Stone and Rehn (1910) was the first to recognize *C. baileyi* as a subspecies of *C. collaris*. This was based on a series of eleven specimens from Pecos, Texas, in which specimens with characteristics of both *C. baileyi* and *C. collaris* were in the series.

In 1917 Stejneger and Barbour listed *C. c. collaris* and *C. c. baileyi* in their check list using central New Mexico as the dividing line between the two sub-

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species.

Van Denburgh and Slevin (1921) described as new, *Crotaphytus insularis* from Angel de la Guardia Island, Baja California, Mexico. *Crotaphytus insularis* was separated from *C. c. baileyi* by three characters: (1) longer snout, (2) narrower head, and (3) single incomplete collar (Van Denburgh 1922). Burt (1928) showed definite relationships between the Collared Lizards of Angel de la Guardia Island and those of the mainland of Baja California and southern California. The lizards of this area are also in need of further study as a part of those populations occurring west of the Colorado River.

Crotaphytus dickersonae, was described by Schmidt (1922) from Tiburon Island, Sonora, Mexico. It was said to be distinguishable from *C. c. baileyi* by having "hindleg considerably longer than the body, a longer more distinctly compressed tail and slightly enlarged scales on the middorsal line of the tail." Burt (1928) expressed doubts as to the validity of this species, thus necessitating a further analysis of *C. dickersonae*.

Burt (1928) provided the only complete review of the species to date. He presented a detailed review of the literature and an excellent grasp of the problem of Collared Lizard taxonomy. He recognized the need for further study of the populations of Mexico and southern California and saw trends of variation within the Collared Lizards, but his investigations were not detailed.

Burt's analysis of the data was based on three assumptions, which are not substantiated by our data. He examined a large series (1,252) of lizards for the presence of ten characters, one meristic and nine proportional. His first assumption concerns the method used to assign lizards to either a western or an eastern group. He divided the Collared Lizards into two groups along state lines. The eastern group included Oklahoma, Kansas and Texas; and the western group, New Mexico, Arizona, Utah, Idaho, Oregon, California and Mexico. As was pointed out by Fitch and Tanner (1951), this completely disregards the possibility of the two subspecies' ranges not conforming to state lines. This is especially perplexing since all of the published ranges of *C. c. baileyi* and *C. c. collaris* designate the area of intergradation to be in central New Mexico and western Texas (Stejneger, 1890; Stejneger and Barbour, 1917).

Secondly, within the area Burt assigned to the Western Collared Lizard are the ranges of two forms of Collared Lizards, one form centered in the Great Basin and the other in Baja California and southern California.*

Thirdly, in the comparisons of body size and proportions, it is obvious from Burt's data (79-345 mm. total length for the eastern group) that there was no attempt to group specimens by age class. It is well known that body proportions, as well as length, change significantly from hatchling to adult (Mayr, 1969). The use of different age classes in the analysis of length and proportion characters may bias results proportionally to the percent of the total sample represented by each age class.

Fitch and Tanner (1951) separated the Yellow-headed Collared Lizard, *C. c. auriceps*, from *C. c. baileyi*. It was described as a population from the Upper Colorado River Basin, type locality: three and one-half miles north northeast of Dewey Bridge, Grand Co., Utah. *Crotaphytus c. auriceps* was separated primarily on the characters of coloration and supralabial scalation, thus introducing the factors of coloration and pattern as characters for distinguishing Collared Lizard populations.

The taxonomic history of *C. c. baileyi* and other Collared Lizards, along with their present status, is summarized in the following synonymies.

Crotaphytus collaris baileyi Stejneger

Crotaphytus baileyi Stejneger, 1890, N. Amer. Fauna, 3:103 [Type locality: Painted Desert, Desert of the Little Colorado R., Arizona; U.S. Nat. Mus.]
Crotaphytus collaris baileyi Stone and Rehn, 1903, Proc. Acad. Nat. Sci. Phila., 55:30.

Crotaphytus insularis Van Denburgh and Slevin

Crotaphytus insularis Van Denburgh and Slevin, 1921, Proc. Calif. Acad. Sci., ser. 4, vol. 11:96 [Type locality: Angel de la Guardia Island, Baja California, Mexico; Calif. Acad. Sci.].
Crotaphytus collaris baileyi Stone and Rehn, 1903, Proc. Acad. Nat. Sci. Phila., 55:30.

Crotaphytus dickersonae Schmidt

Crotaphytus dickersonae Schmidt, 1922, Bull. Amer. Mus. Nat. Hist., 46:638 [Type locality: Tiburon Island, Sonora, Mexico; U.S. Nat. Mus.].
Crotaphytus collaris dickersonae Allen, 1933, Occ. Pap. Mus. Zool. Univ. Mich., 259:7.
Crotaphytus dickersonae Smith and Taylor, 1950, Bull. U.S. Nat. Mus., 199:93
Crotaphytus collaris baileyi Stone and Rehn, 1903, Proc. Acad. Nat. Sci. Phila., 55:30.

Crotaphytus collaris auriceps Fitch and Tanner

Crotaphytus collaris auriceps Fitch and Tanner, 1951, Trans. Kans. Acad. Sci., 54(4):553 [Type locality: three and a half miles north northeast of Dewey Bridge, Grand Co., Utah; Kans. Mus. Nat. Hist.].
Crotaphytus collaris baileyi Stone and Rehn, 1903, Proc. Acad. Nat. Sci. Phila., 55:30.

* An analysis of morphological similarity of Collared Lizards demonstrated the difference between forms

MATERIALS AND METHODS

Selection and Gathering of Material

Specimens of *C. collaris* utilized in this study were from three sources: (1) specimens in the Brigham Young University Herpetological Museum, (2) specimens borrowed from several museums, and (3) live specimens collected in the field. Specimens from the first two sources were used for the measurement of meristic and proportional characters. Those collected in the field were used for pattern and coloration determination.

The museums with specimens on loan are listed below, followed by the abbreviation to be used throughout the remainder of this paper: Brigham Young University, BYU; California Academy of Science, CAS; California State College at Long Beach, CSCLB; University of Colorado Museum, CUM; University of Kansas, KU; Los Angeles County Museum, LACM; San Diego Society of Natural History, SDSNH; University of California, UC; University of Illinois Natural History Museum, UIMNH; United States National Museum, USNM; University of Texas at El Paso, UTEP; University of Utah, UU.

Four collecting trips were made to the area encompassed by this study. In May 1969, one short trip was made to southeastern Utah and a longer trip (two weeks in June) covered western New Mexico to the Nexican border and most of Arizona. During these trips specimens were collected from the Upper Colorado River Basin of Utah and Arizona, and the Chihuahuan Desert of New Mexico. Another extended trip to New Mexico and Arizona in May 1970 resulted in the collection of living specimens from the Upper Colorado River Basin of New Mexico; central New Mexico; Arizona, south of the Mogollon Rim, and additional specimens from the Upper Colorado River Basin of Utah and Arizona. During a final short trip in 1970 to southeastern Utah, we secured specimens from the northernmost extension of the range in Grand County, Utah. All living specimens examined during the course of this study will be deposited in the Brigham Young University Herpetological Museum.

Only those specimens whose snout-vent length was longer than 80 mm. were used in this study for the determination of both meristic-proportional and coloration-patternal characters. This was done to reduce the amount of bias caused by the mixing of age classes on character determination. The cutoff point was reached by determining the lower limit of a 90% confidence interval on the mean of the snout-vent length of adult *C. c. collaris*, using Fitch's data (Fitch, 1956). His data was used rather than data on adult *C. c. baileyi*, because a realistic diagnosis for *C. c. baileyi* has not been determined. Also, Fitch did the only ecological study on the Collared Lizards and is perhaps the most reliable source of adult snout-vent lengths.

The following lizards, listed by county within each state, were examined in the course of this study:

ARIZONA – Apache Co.: BYU 497; LACM 16895; UIMNH 7524; USNM 29184, 38056, 45035, 58610. Cochise Co.: CAS 35128-35135, 48615-48617 80748; USNM 8463, 8466, 8467, 14748, 19704-19706, 24462. Coconino Co.: BYU 506, 11388, 32110, 32109; UIMNH 6543, 35945, 74786-74790; USNM 15821, 15822, 60110-60113, 60115, 60117-60121. Gila Co.: UIMNH 34336, 74797, 74798. Graham Co.: UIMNH 24507, 82348-82353; USNM 5153, 51737, 51739, 54599, 54606. Maricopa Co.: CAS 80681, 80682. Mohave Co.: BYU 32116; UIMNH 74778, 74781-74784. Navajo Co.: BYU 13574; LACM 16894; UIMNH 74794-74796. Pima Co.: LACM 3983; SDSNH 15214; UIMNH 5899. Pinal Co.: UIMNH 74800; USNM 22129, 44681, 44708. Santa Cruz Co.: BYU 32106; LACM 26833; UIMNH 5900; USNM 16807, 17183. Yavapai Co.: BYU 33322; UIMNH 43208, 74767-74777, 82354; USNM 11860, 14814, 15689, 15690, 14710, 15892, 22206, 59750.

COLORADO – Baca Co.: CUM 9678-9680, 11340, 11343, 13666, 21727, 32278-32280. Bent Co.: CUM 19652, 19653. Las Animas Co.: CUM 1292, 2939, 7560-7562, 9675, 9681, 10030-10034, 11345, 32276. Mesa Co.: BYU 11342, 11344. Montezuma Co.: BYU 1577, 32108. Otero Co.: CUM 19654, 19655. Pueblo Co.: CUM 2622. San Miguel Co.: CUM 1333, 4448, 4450, 4451, 4453, 4456, 4458.

KANSAS – Anderson Co.: BYU 898. Montgomery Co.: BYU 22167. Wilson Co.: KU 41, 45, 46, 48-50, 54.

NEW MEXICO – Bernalillo Co.: USNM 58604. Chaves Co.: LACM 3974-3976. Dona Ana Co.: LACM 3971; USNM 22268, 25423; UTEP 54. Eddy Co.: LACM 3973, 16981-16983; UIMNH 8690; USNM 93034. Guadalupe Co.: LACM 16984, 16985, 16987; USNM 32862. Hildago Co.: BYU 32107; LACM 3977. Lea Co.: USNM 94360. Lincoln Co.: LACM 16990. Luna Co.: BYU 31940, 31942, 31944, 32120, 32121; USNM 44955, 80072. McKinley Co.: USNM 27738. Otero Co.: LACM 16975, 16988. Quay Co.: USNM 44940. Rio Arriba Co.: UU 3724-3732. Santa Fe Co.: CUM 7007; LACM 16907, 16908, USNM 8408, 8471. Sierra Co.: LACM 3981, 16992. Socorro Co.: LACM 3979, 3980, 16909, 16910, 16918, 16919, 16923, 16924, 16927-16929, 16931, 16932, 16934, 16935, 16940, 16942, 16944, 16945, 16947-16953, 16957-16962, 16966-16972, 16976, 16977, 16979; USNM 44573. Taos Co.: CUM 7006.

OKLAHOMA – Carter Co.: BYU 500, 1574

TEXAS – Bexar Co.: BYU 13047, 13050, 13051. Brewster Co.: USNM 32852, 103663. Clay Co.: USNM 32857. El Paso Co.: USNM 59351, 59352; UTEP 52, 55-57; UU 493. Garza Co.: CUM 32277. Llano Co.: USNM 42309. Randall Co.: CUM 13554-13556. Roberts Co.: USNM 32866. Stephans Co.: BYU 13117. Valverde Co.: USNM 32850.

UTAH – Grand Co.: BYU 1625, 1626, 10338, 12854, 12855, 31949, 31950, 31981. San Juan Co.: BYU 1461, 1464, 12619, 13006-13008, 16484, 16801, 16802, 18333-18340, 21706, 31951, 31982, 32088, 32112-32117; UU 1461, 2427.

MEXICO – Chihuahua: BYU 13383-13386, 13410, 13411, 13736, 14211, 14212, 15184, 15186-15188, 15305, 15325, 16969-16976, 17010, 17014; KU3378, 33789, 44127; UC 70704; USNM 14242. Coahuila: UC 24721. Nuevo Leon: USNM 2728. Sonora: CSCLB 2752-2755, 2757, 2759-2764; LACM 8798, 8799, 52882, 52886; UC 10163; USNM 2694.

Statistical Methods

Upon initial examination of both living and preserved specimens, three distinct populations (groups) were postulated: (1) Upper Colorado River Basin, (2) central Arizona, (3) Chihuahuan Desert. An initial analysis consisting of six steps was performed to test the null hypothesis of no difference between groups. Multivariate techniques of data analysis were used extensively in this study for reasons to be discussed later.*

Step (1).

There were 66 meristic and proportional characters chosen to represent all observable areas of phenotypic variation. These characters included scale counts, proportions of body parts, and those patternal aspects that remain even after long periods of preservation. Body parts were measured using a Golgau Vernier Caliper. All scale counts of paired structures (e.g. supralabials) were done on the right side only.

Step (2).

A random sample of ten males and ten females from each proposed group was selected from the preserved material on hand. Ostle's random number table and method for entering the table randomly were used to select the random sample (Ostle, 1963). To enable the use of multivariate analysis, only those specimens that possessed some state of each of the 66 characters were used. For example, specimens that were damaged in some aspect were omitted from this part of the study.

Step (3).

The characters were measured on the sample and correlation analysis was performed. This eliminated those characters highly correlated with each other (hence measuring the same source of variation). When two or more characters were found to be highly correlated (0.75 or greater) the character with the greatest variation between groups was selected to represent all the correlates, and the other characters were dropped from the analysis.

Step (4).

A data organizing technique developed and programmed by Wishart (1968) was used to group the lizards in clusters of highest morphological similarity. This technique, known as Ward's Minimum Variance Cluster Analysis, arranges individuals in hierarchal minimum variance clusters, thus grouping together those lizards that are most alike, as defined by the characters measured. Chosen to represent the range of geographic locations available, 80 individuals were used as input (see Fig. 1 for areas represented). The program was halted when four clusters had been formed and the members of each of the clusters were recorded as to which of the proposed groups they represented. A chi-square contingency table was formed (see Table 1). This tested the null hypothesis that the grouping originally proposed was completely independent of a grouping formed by clustering those lizards of closest morphological similarity.

Step (5).

A two-way multivariate analysis of variance following the methods of Anderson (1958) and Morrison (1967) was performed on the data. The following model was used:

$$Y_{ijk} = U + A_i + B_j + e_{ijk}$$

where:

Y_{ijk} = a vector of measurements on an individual
U = a vector of effects on Y due to the mean
A_i = a vector of effects on Y due to location
B_j = a vector of effects on Y due to sex
e_{ijk} = a vector of effects on Y due to experimental error

The U-statistic and Mahalanobis D-square (Anderson, 1958) were used to test the null hypothesis of no difference between groups.

Step (6).

Using Mayr's coefficient of difference as an indicator, 24 characters were chosen that maximized the variation between groups (Mayr, 1969). These characters are listed in a separate section (entitled Taxonomic Characters) which immediately follows this section.

This step was done for three reasons: (1) to eliminate those characters that are relatively invariant from group to group, (2) to reduce the time involved in measuring characters on each lizard, and (3) to keep the matrices used in the analysis within the limits imposed by computer storage space.

Stepwise multiple discriminant analysis was then applied to the data to select the set of functions to be used in placing additional specimens into their proper group (Dixon, 1968).

Living specimens were examined for coloration and patternal characters. All specimens so examined were warmed under 200 watt light bulbs for 15-30 minutes before being analyzed. This was done to approximate the warmth and light the animal receives in nature and to reduce the variability in coloration and pattern that is the result of internal temperature variations of these animals.

Color and pattern characters, chosen to represent all of the observable differences, were combined into

* All statistical techniques which are relatively new or unfamiliar to workers in herpetological taxonomy will be treated in the section, "Statistical Discussion." A brief nontechnical description of each method will be presented.

groups, thus expressing a lizard's color and pattern as a single variable. Aspects of color or pattern that were invariant or so variable as to present no recognizable pattern were discarded from the analysis. (The final list of color-pattern combinations follows the list of proportional and meristic characters.) The combinations were then tested for independence when compared with geographic locations. Where significant, the color-pattern combinations were used to supplement the discriminant functions in identification.

The remaining specimens were then identified to determine the extent of the ranges and intergrading areas of the groups. The probabilities for each individual to be identified as a member of each of the groups were calculated. These probabilities, using a modification of Rao (1952), were used in outlining the areas of intergradation.

Taxonomic Characters

The following is a list of the 24 characters finally selected for measurement on preserved specimens (see Figs. 1 and 2) as well as the pattern and coloration characters selected from live specimens (see Fig. 3). Terms are taken from Smith (1946).

Body measurements.

Snout-vent length, length of second collar, tail length, and hindleg length were measured to the nearest tenth of a millimeter. Hindleg length was measured from the midline to the tip of the fourth toe. The second collar was measured from the insertion, in a straight line, to either its dorsal end or to the dorsal midline if the collar was not disjunct medially. Proportions were then formed from these measurements and used as the actual characters. The proportions were tail/snout-vent, tail/hindleg, and the second collar/snout-vent.

Internasals.

These are the number of scales in a straight line between the middle of each nasal.

Enlarged internasals.

These are the number of scales in the internasal series which were noticeably larger than the rest. These scales invariably formed a median row. If the row began at the anterior or posterior end of the internasal series, it was also recorded.

Fused interorbitals.

These are the number of interorbitals belonging to both supraorbital semicircles.

Frontoparietals.

These are scales in the midline anterior to the interparietal extending anteriorly to the meeting of supraorbital semicircles.

Head dorsal scales.

These are the number of scales lying in the middorsal line between the rostral and interparietal scales.

Loreal-lorilabial series.

These are the number of scales along a straight line perpendicular to the supralabials running through the loreals and lorilabials to the junction of the canthals and suboculars.

Supralabials.

These are the number of scales between the rostral, but not including it, and the point where the scales' shape change from rectangular to pentagonal, with the apex of the pentagon pointing ventrally.

Postmentals in contact with infralabials. These are recorded as 1 or 0 to correspond with yes or no.

Gulars.

These are the number of scales along a transverse line connecting the last infralabial on each side.

Dorsal scales.

Three characters were determined within the dorsals: (1) between the interparietal and the anterior-most projection of the first collar, (2) between the anterior-most projection of the first collar and the posterior border of the second collar, and (3) total dorsals.

Scales between the collar separations.

Two characters were determined from the collar's dorsal separation and one character from the pattern of the first collar: (1) the number of scales along a line connecting the lateral boundaries of the first collar's separation, (2) the number of scales along a line connecting the lateral boundaries of the second collar's separation, and (3) the number of spots, completely isolated from the main portion of the collar, within the first collar's separation.

Ventrals.

These are the number of scales along a midventral line connecting the mental and the anterior edge of the anus.

Subdigital lamellae.

These are the number of lamellae of the second, fourth and fifth toes on the right hind foot. The lamellae were considered to begin with the first scale that was obviously a member of the subdigital lamella series.

Femoral pores.

These are the number of pores in a straight line on the right hindleg.

Color-pattern Combinations

Five combinations of color were chosen. In all cases the color refers to ground color, and variations in hue around the basic color were considered equal. The color combinations, now known as color-pattern types, are (1) body dorsum green, head yellow to second collar, gular patch green, area between infralabials and gular patch yellow, (2) body dorsum green, head yellow to second collar, gular patch green, area between infralabials and gular patch white, (3) body dorsum green, head yellow not past eyes, posterior portion head pale in color, gular patch green, area

between infralabials and gular patch white, (4) center body dorsum brown, sides body dorsum green, head less than half yellow, head posterior cream, gular patch green, area between infralabials and gular patch white, (5) body dorsum brown, head white or cream, gular patch brown, black or intermediate, area between infralabials and gular patch white.

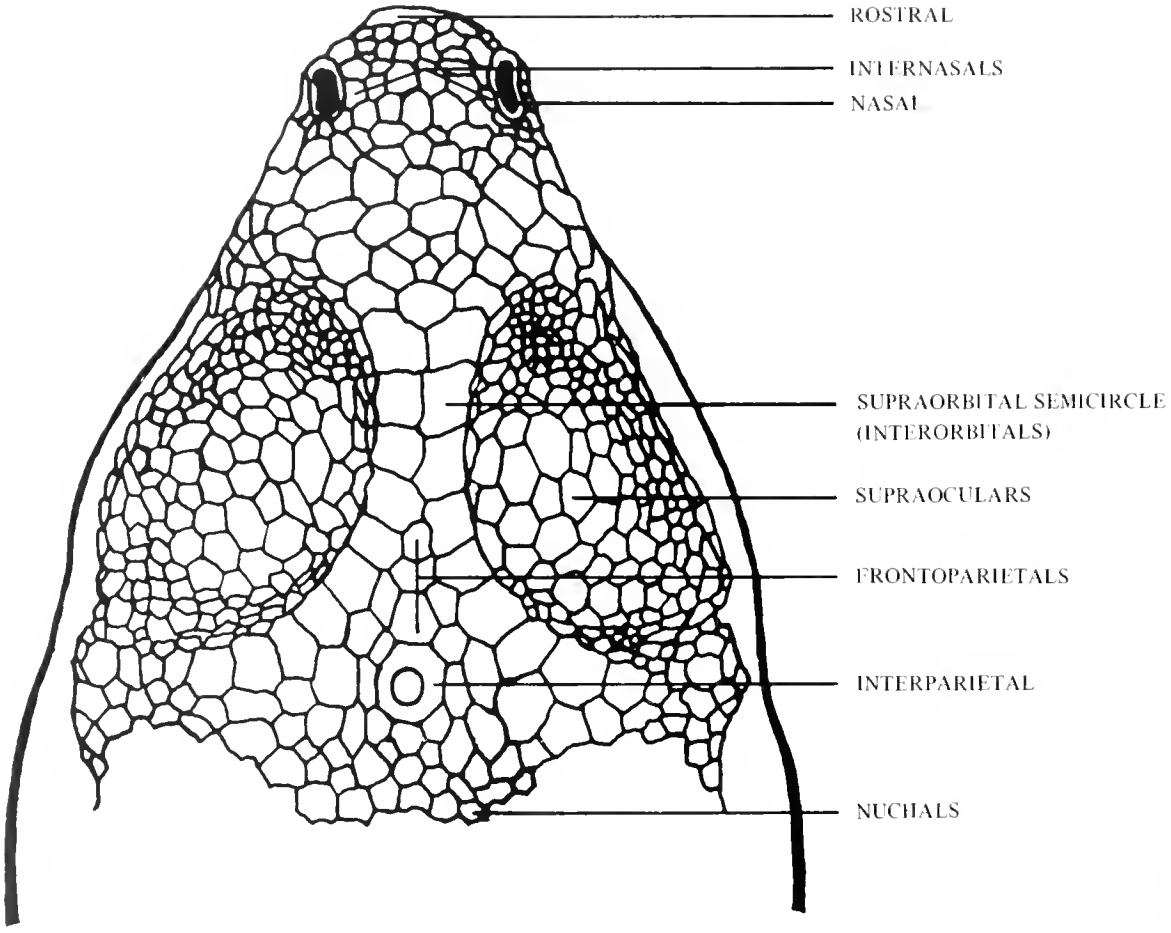


Fig. 1. A dorsal view of head scalation typical for the populations studied. (Drawn from BYU 21705)

RESULTS

Cluster Analysis

The four groupings formed by this method (see Fig. 4) were tested to see if they would support the groupings originally proposed in this study. All individuals from southeastern Utah and southwestern Colorado were considered to be *C. c. auriceps*. Arizonan specimens were labeled as *C. c. baileyi*, southern New Mexican and Mexican specimens were assigned to the Chihuahuan Desert population. Other specimens from Colorado, New Mexico, Texas, and Oklahoma were put in the *C. C. collaris* category.*

A contingency table was prepared comparing the groupings as proposed initially by the study (Upper Colorado River Basin, Central Arizona Plateau, Chihuahuan Desert, and Great Plains) with the four groupings formed by the cluster analysis (see Table 1). The null hypothesis (the two classifications, one by closest morphological resemblance and the other by geographical location, are completely independent of each other) was tested by a chi-square of nine degrees of freedom. The test statistic is significant at the 0.001 level.

* Twenty-five specimens from western Utah, Idaho, Nevada, California, and Baja California were also used in this cluster analysis. These specimens clustered together with no exceptions and remained separate until coefficient of approximately 30.0 was reached. This is taken as evidence that the Collared Lizards found west of the Colorado River are very different from those to the east.

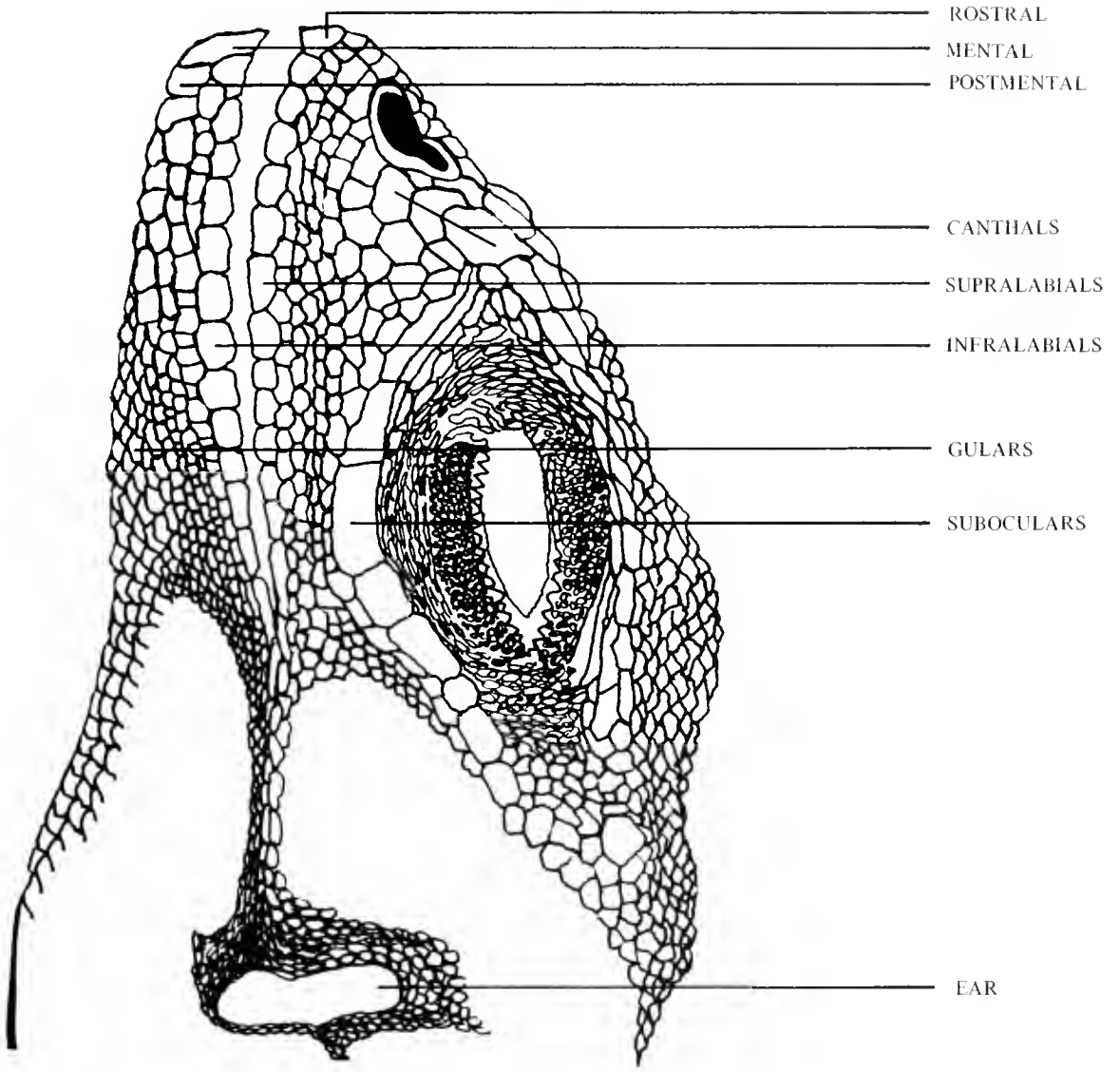


Fig. 2. A lateral view of head scalation typical for the populations studied. (Drawn from BYU 21705)

$$\chi^2_{(1-\alpha,9)} = (0_{iu} - E_{ij})^2/E_{ij}$$

$$\chi^2_{(1-\alpha,9)} = 80.768$$

$$\chi^2_{(0.999,9)} = 29.7$$

Therefore $\chi^2_{(1-\alpha,9)} \geqslant \chi^2_{(0.999,9)}$ and the null hypothesis is rejected. An analysis of the dependence pattern is as follows: The morphological relationships of the lizards examined form essentially the same groupings as those proposed at the onset of this study. (Ostle, 1963).

Analysis of Variance

One of the multivariate generalizations of the analysis of variance tests its hypothesis by means of the U-statistic (Anderson, 1958). The U-statistic was determined to be $U_{(66,3,75)} = 0.0209$. Since most U-statistic tables only go up to p=10, Paul Sampson's

Table 1. A contingency table testing the independence of Ward's clustering method and the proposed groups.

Clusters	Proposed groups			
	Upper Colorado	Central Arizona	Chihuahuan Desert	Great Plains
1	11	4	1	4
2	5	13	0	3
3	1	2	17	1
4	3	1	2	12

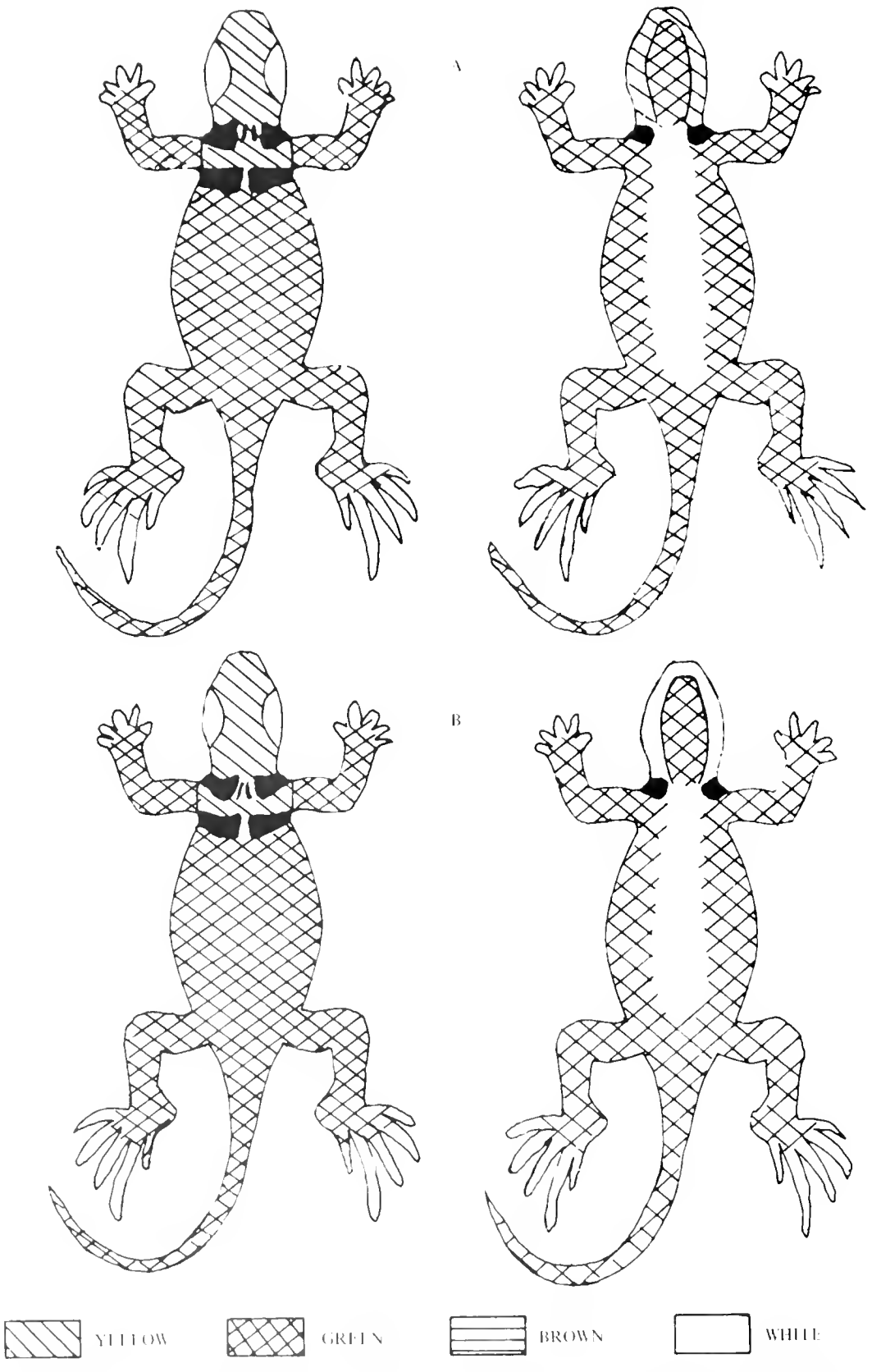
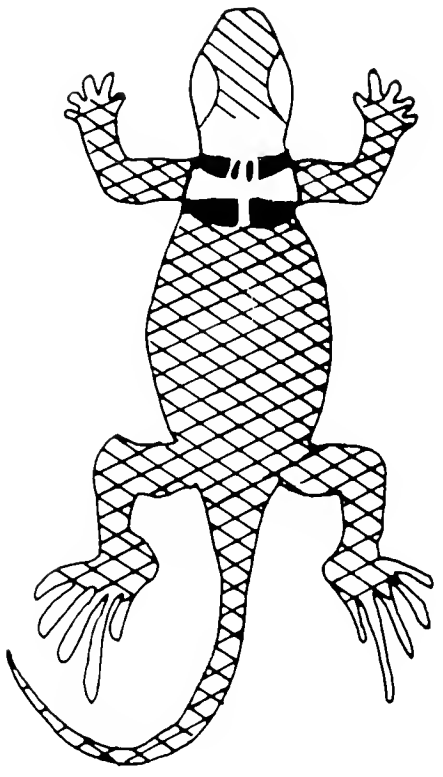
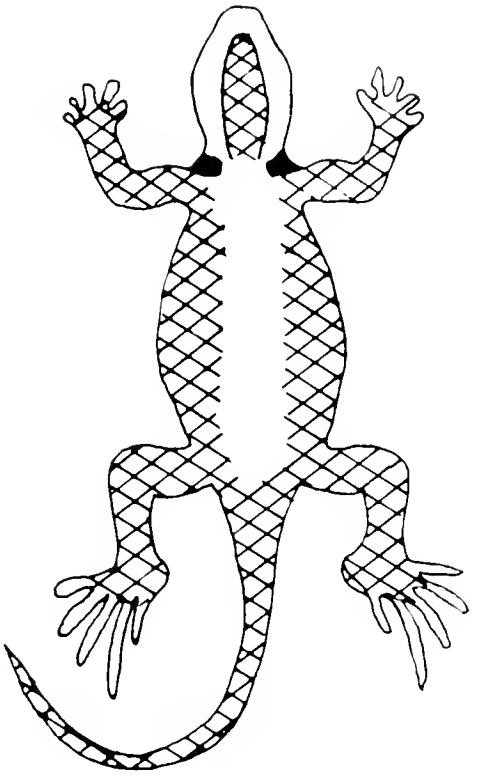


Fig. 3. Color-pattern characters: (A) type one, (B) type two, (C) type three, (D) type five, and (E) type four.



C



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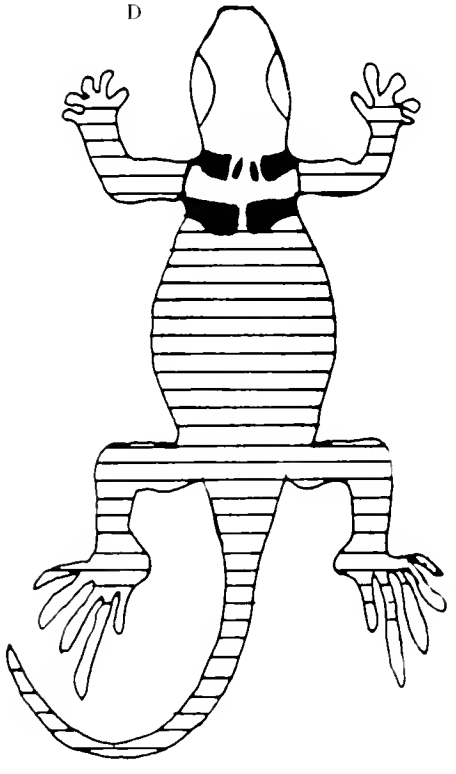

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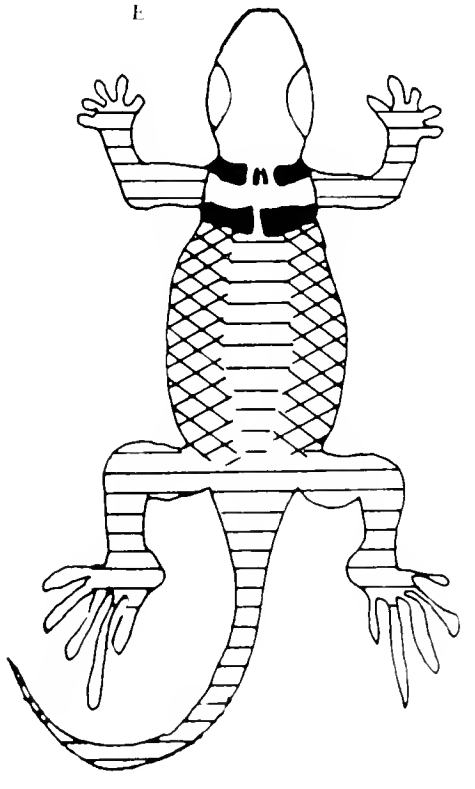


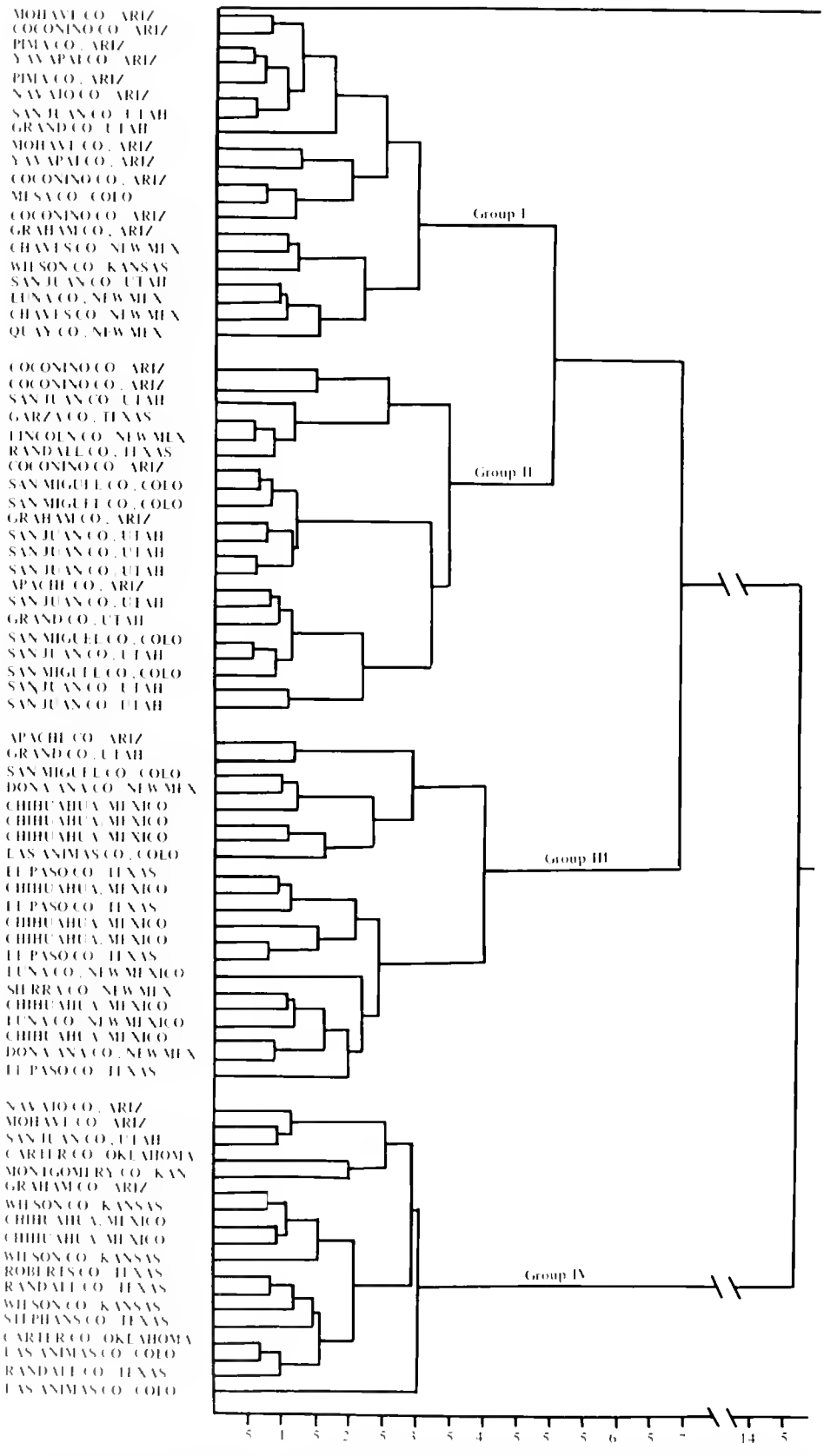


Fig. 4. Results of Ward's clustering method. (I) *auriceps*, (II) *baileyi*, (III) Chihuahua, (IV) *collaris*.

approximate F-value (Dixon, 1968) was used instead of the U-statistic. The approximate F-value is $F_{(1\alpha,72,266,84)} = 80.2955$. The tabular F-value is $F_{(0.999,60,120)} = 2.01$ (Ostle, 1963). Therefore, the approximate F-value is significant at the 0.001 level and the null hypothesis of equal group means is rejected.

The Mahalanobis D-square statistic, which is approximated by the chi-square distribution, also tests the hypothesis of equal group means. This statistic has degrees of freedom equal to the number of variables being measured times the number of groups minus one. The value of the D-square statistic is $D^2_{(1-\alpha,198)} = 571.160$. The tabular chi-square value is $\chi^2_{(0.999,100)} = 153.2$ (Ostle, 1963). The D-square statistic is also significant at the 0.001 level. These statistics give two of the appropriate multivariate methods for determining if the proposed groups are the same or different and therefore distinguishable from each other.

Coloration and Pattern

It was observed that the coloration and pattern groupings did not quite reproduce the groupings first proposed. Therefore, a contingency table, testing for independence of coloration and pattern with regard to geographic location was constructed. The test statistic was found to be significant at the 0.001 level.

$$\chi^2_{(1-\alpha,20)} = (0_{ij} - E_{ij})^2/E_{ij}$$

$$\chi^2_{(1-\alpha,20)} = 148.136$$

$$\chi^2_{(.999,20)} = 47.5 \ldots\ldots\ldots\ldots\ldots$$

Therefore $\chi^2 \geq \chi^2_{(.999,20)}$ and the null hypothesis is rejected. It was concluded that there is a definite association between the color-pattern and geographic location (see Table 2).

Discriminate Analysis

The above results were used in altering the proposed groups slightly to see if the population in question could be more closely defined. The UCLA BMOD7 stepwise discriminant analysis program (Dixon, 1968) was run using the following groups as data: (1) Upper Colorado River Basin population, *C. c. auriceps* (N = 10), consisting of those individuals found north of the union of the Colorado and Green rivers at the approximate location of Moab, Grand Co., Utah, (2) the central Arizona plateau population, *C. c. baileyi* (N = 30), containing those individuals found in Coconino and Yavapai counties, Arizona, (3) the Chihuahuan Desert population (N = 45), consisting of those individuals found in El Paso Co., Texas; Luana, Sierra and Hildago counties, New Mexico; and Chihuahua, Mexico, and (4) the Great Plains population, *C. c. collaris* (N = 12), represented by those specimens found in Kansas and Oklahoma.* Only specimens from geographic areas not thought to contain any intergrading populations were used to form the discriminant functions. All other specimens were lumped into an unclassified group to be evaluated by the functions. This is known as model 1.

The originally proposed groups were used as data to examine the effect that the change in groups would have upon the program's ability to identify the individuals correctly. The original groups were defined as follows: Upper Colorado River Basin popula-

Table 2. A contingency table testing the independence of coloration-pattern types and geographical locations.

Locations	Coloration-pattern types				
	1	2	3	4	5
Upper Colorado River Basin of Utah (north of the union of the Green and Colorado rivers)	7	0	0	0	0
Upper Colorado River Basin of Utah (south of the union of the Green and Colorado rivers)	0	2	0	0	0
Upper Colorado River Basin of New Mexico	1	4	0	0	0
Upper Colorado River Basin of Arizona (east and north of the Little Colorado River)	0	1	3	0	0
Central Arizona (west of the Little Colorado River and north of the Mogollon Rim)	0	0	17	0	0
Southern Arizona (south of the Mogollon Rim)	0	0	2	3	0
Chihuahuan Desert of New Mexico (southern Luna County)	0	0	0	0	7

*The members of Group (4) represent specimens from a close proximity of the type locality for *C. c. collaris*. They were included to demonstrate the presence of a difference between the type population of *C. c. collaris* and the populations of real concern in this study.

tion, *C. c. auriceps;* those individuals found in the Colorado River drainage of Colorado and Utah. All other groups remained the same. This is known as model II.

The classification formed by the first discriminant analysis was chosen as the one that best represented the actual populations of lizards. The determination was made by selecting the model that made fewer wrong classifications of lizards previously defined as *C. c. auriceps.* Model I identified 9 out of 10 correctly or 90%. Model II identified 24 out of 32 correctly or 75%.

The analysis of the output of the stepwise discriminant program reveals two interesting statistics, the U-statistic and the F-statistic. The U-statistic tests equality of means between groups using the variables included in the discriminant function. The U-statistic is 0.06346 with 24,3,93 degrees of freedom. The F-value approximation to the U-statistic was used because of the availability of F-tables. The approximate F-value is 4.42269 with 72,210.06 degrees of freedom. This statistical test determines whether the groups are, or are not statistically separable when given a set of taxonomic characters to be used for classificatory purposes. The tabular F-value is $F_{(.999,100,120)} = 1.82$. Therefore $F(1-\alpha,72,210.06) \geq F_{(.999,100,120)}$ and the null hypothesis is rejected.

The F-statistic is used to test the difference between each pair of groups, thus making it possible to determine if all groups are separate from each other. It is measured with 24,70 degrees of freedom, and all groups are separated at the 0.001 level. The F-statistic is summarized in Table 3, and the discriminant functions formed are listed in Table 4.

The taxonomic characters that correspond with the coefficients of the discriminant functions are listed as follows: (1) tail length/hindleg length, (2) tail length/snout-vent length, (3) snout-vent length, (4) internasal scales, (5) number of fused interorbital scales, (6) frontoparietal scales, (7) scales from the union of the posterior canthal and subocular to the supralabial, (8) infralabial contact with postmetal, (9) supralabial scales, (10) gular scale rows, (11) number of enlarged internasals, (12) scales from rostral to interparietal, (13) dorsal scales from interparietal to the anterior edge of the first collar, (14) dorsal scales from the anterior edge of the first collar to the posterior edge of the second collar, (15) total dorsal scales, (16) total ventral scales, (17) dorsal separation of the first collar, (18) dorsal separation of the second collar, (19) number of spots within the dorsal separation of the first collar, (20) second collar length/snout-vent length, (21) subdigital lamellae of the right hind foot, second toe, (22) fourth toe subdigital lamellae, (23) fifth toe subdigital lamellae, (24) femoral pores.

Table 3. A summary of the F-statistics which show differences between individual groups.

Groups	Groups	
	Chihuahua	*baileyi*
auriceps	2.99625	2.29124
baileyi	2.65349	

Table 4. A listing of the coefficients of the discriminant functions.

Variable	Groups		
	auriceps	Chihuahua	*baileyi*
1	51.39813	45.22476	47.94501
2	2.14172	8.31362	5.60604
3	1.27552	1.34056	1.21061
4	10.33790	10.90252	11.58937
5	15.42395	16.15672	15.77870
6	-13.55824	-13.54851	-13.42835
7	7.06088	4.44547	5.51994
8	9.06605	9.79720	9.35053
9	0.56730	-0.59190	0.83744[
10	1.28302	1.24001	1.18661
11	-5.04772	-3.78518	-4.35537
12	1.2393	0.81388	0.85222
13	0.85929	0.99943	0.73786
14	1.63115	1.57809	1.54830
15	0.41538	0.39279	0.56490
16	0.80368	0.81625	0.71332
17	0.70005	0.44894	0.49637
18	0.01570	-0.01466	0.04405
19	1.38450	1.95044	1.19760
20	269.06104	264.62378	294.33545
21	2.11617	2.84886	3.45656
22	1.17804	1.35396	1.12000
23	0.96154	0.98708	1.14926
24	2.53244	2.28217	2.30347
constant	-526.26660	-523.28274	-527.89990

The measurements on each lizard were put into all three functions and a numerical value for that lizard, as evaluated by each of the functions, was obtained. Identification was made by placing the lizard into the group whose function resulted in the largest numerical value. Along with placing each individual into a group, the probability that it belonged in that group as well as the probability of it belonging to each of the other groups was calculated. This probability indicated the assurance with which each individual was classified.

Two aspects of the discriminant analysis' identification were considered. First, the degree of reliability of the identification was examined. Lizards that were

from locations known to be within the ranges of one of the groups, were examined for their reaction to being identified by the discriminant functions. Areas considered definitely to belong to one of the groups are as follows: the Upper Colorado River Basin population, *C. c. auriceps*, Grand Co., Utah and Mesa Co., Colorado; the Central Arizona Plateau population, *C. c. baileyi*, Yavapai and Mohave counties, Arizona; the Chihuahuan Desert population, Hildago, Luna, and Dona Ana counties of New Mexico and Chihuahua, Mexico. In Yavapai and Mohave counties, only those Collared Lizards not resembling the Western form of Collared Lizard were considered. The percentage of individuals classified correctly was determined by dividing the number correctly classified by the total number in the geographic area considered ($N_{s,corr.}/N_{tot.}$). This was summed over all groups to get the total percentage of correctly classified individuals in the sample (see Table 5). Thus, approximately 80% of the sample was identified correctly; which is well within the bounds set by Mayr and others in the 75% rule (Mayr, 1969).

Table 5. Percentage of sample identified correctly using the discriminant analysis.

Group	Sample size	$N_{corr.}/N_{tot.}$	Percentage
auriceps	10	9/10	90.00
baileyi	42	34/42	80.95
Chihuahua	93	75/93	80.64
Total	145	118/145	81.38

Another aspect of the discriminant analysis dealt with using the discriminant functions' identification and the probability for group membership to investigate intergradation between populations. This has always been a problem that made identification of Collared Lizards difficult (Burt, 1928).

The individual, when identified by the discriminant function program as belonging to a group, is labeled with the *a posteriori* probability for its membership in all of the groups. The *a posteriori* probability is the probability of an individual belonging to a group once the group has been defined. This set of probabilities always sums to unity. The probabilities for membership in a group have three options: (1) There will be one large probability and the rest small (e.g., 0.982 and 0.044 and 0.044). In this situation, the individual is placed in the group with the largest probability of membership. Any probability that exceeds 0.70 is considered a large probability of membership. (2) There will be two approximately equal probabilities and the rest small (e.g., 0.5602 and 0.4498). This indicates that the individual is not distinct enough to fit with much assurance into either group. A specimen of this type is considered to represent an intergrade between the groups given the largest probabilities. (3) All the probabilities will be approximately equal. In this case, the individual is assumed to be unidentifiable. This aspect of discriminant analysis is an adaption of Rao's three population discriminant analysis procedure (Rao, 1952). Identification of each specimen used in the study was examined. The percentage of the total sample placed in each group was recorded. This percentage was arranged by geographic area in a north-south line. The results of this analysis are summarized in Figs. 5 and 6.

The characters themselves were examined to establish their effect on the discrimination between groups. This is summarized in Table 6. Table 7 lists the means and standard deviations for the 24 characters of each group. Figure 7 also shows the means and one standard deviation for the characters that give the best individual discrimination between groups.

DISCUSSION

Zoological Discussion

The initial question proposed by a taxonomic study at the subspecific level deals with identification. Specifically, are there any populations that are geographically continuous and also identifiable, following the 75% rule, in respect to other populations?

The multivariate analysis of variance shows that the populations proposed in this study are distinguishable at a high confidence level. This analysis was done using external morphological characters exclusively. The groupings of the cluster analysis, along with its test of independence, lends support to the actual existence of the proposed groups.

Once assured of the existence of these populations, the problem becomes one of identification. Using external morphological characters exclusively, an examination of the means and standard deviations reveals that although their means were different (the statistical tests of population difference showed this), their overlap was such that no one character could be used to identify an unknown specimen with complete accuracy. Discriminant analysis computes a new character, "Z," which is the value of a set of functions or equations. These functions are constructed from linear combinations of the original characters in such a way that as many members as possible from each population have high values for the function that corresponds to their population. In a sense, this is a new taxonomic character that identifies members of each

A key to the abbreviations used in Figs. 5 and 6.

auriceps - The Collared Lizard population of the Upper Colorado River Basin, north of the union of the Colorado and Green Rivers.

baileyi - The Collared Lizard population of central Arizona.

AxB - The intergrade population of *auriceps* and *baileyi*.

chihuahua - The Collared Lizard population of the Chihuahuan Desert.

BxC - The intergrade population of *baileyi* and Chihuahua

Unident - Individuals not assignable to any of the above groups.

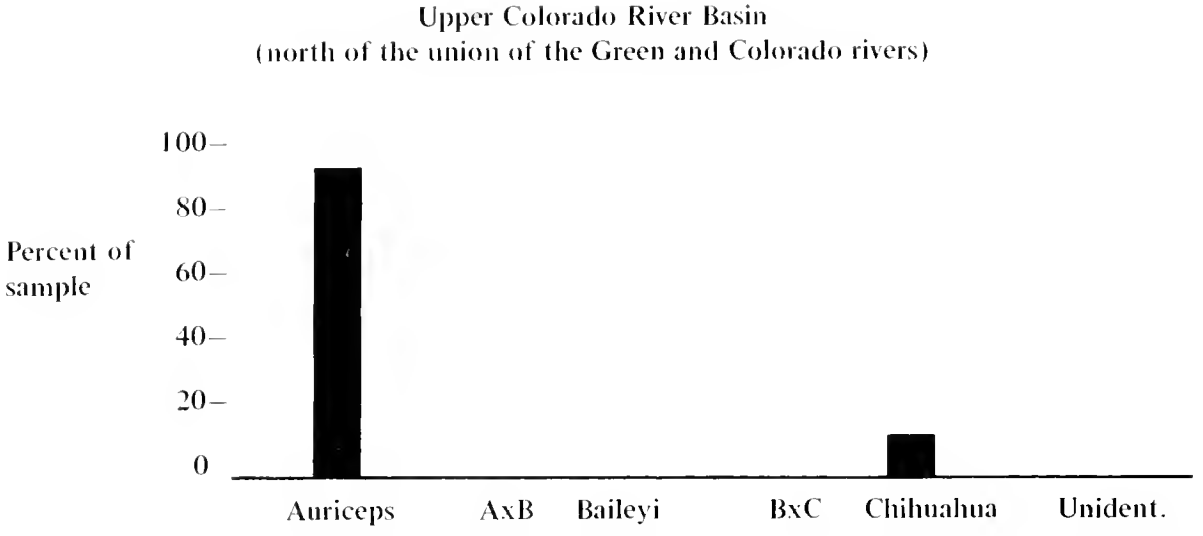


Fig. 5. A comparison of Collared Lizard populations along a line connecting Grand Co., Utah and northern Sonora, Mexico.

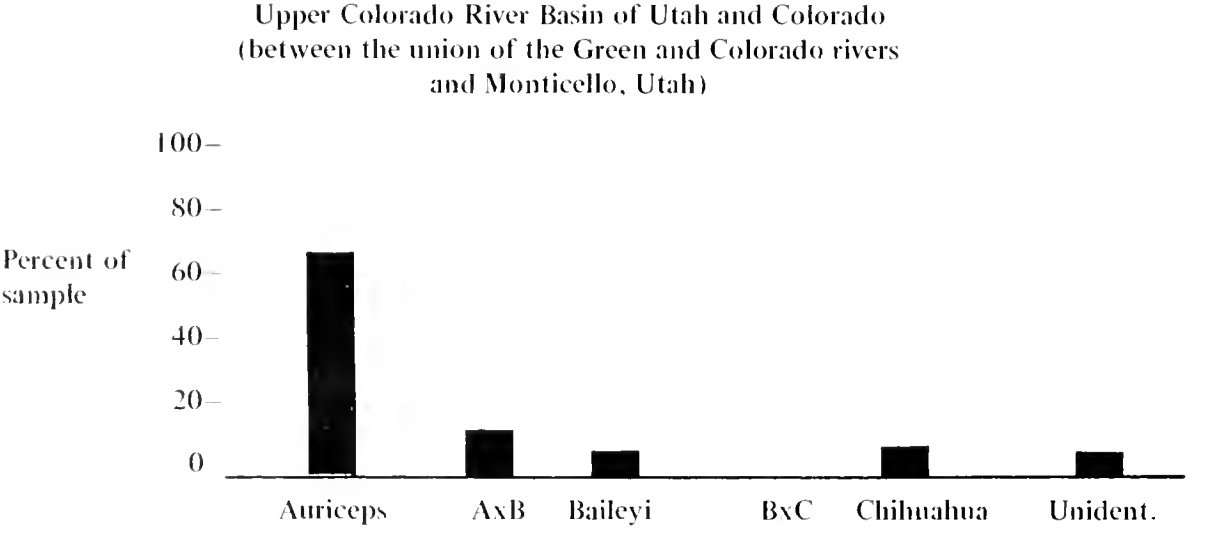
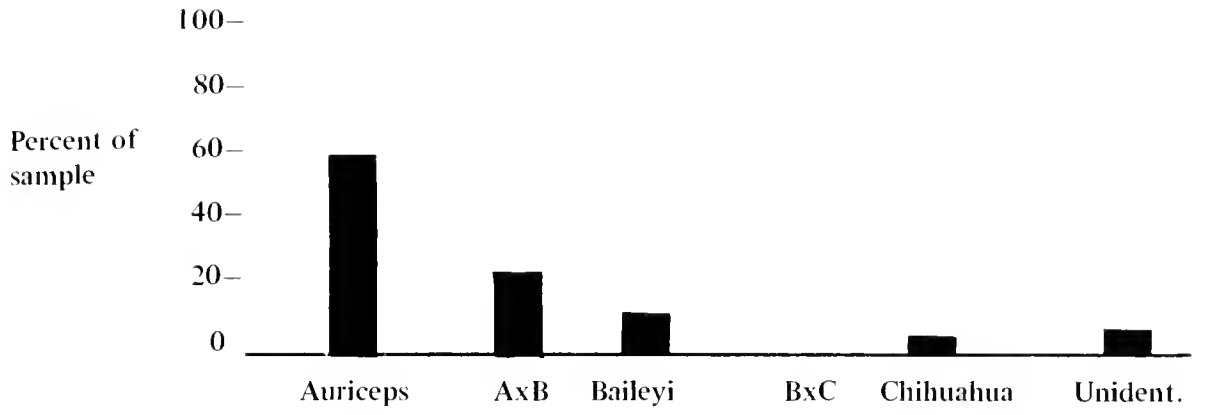
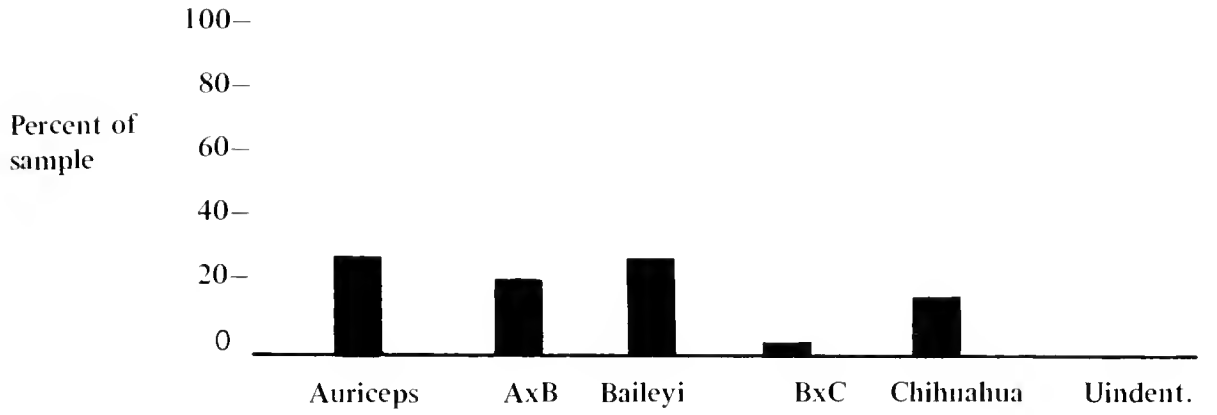


Fig. 5. (continued)

Upper Colorado River Basin of Utah and Colorado
(south of Monticello, the San Juan River drainage)



Upper Colorado River Basin of Arizona
(east of the Little Colorado River)



Central Arizona
(between the Little Colorado River and the Mogollon Rim)

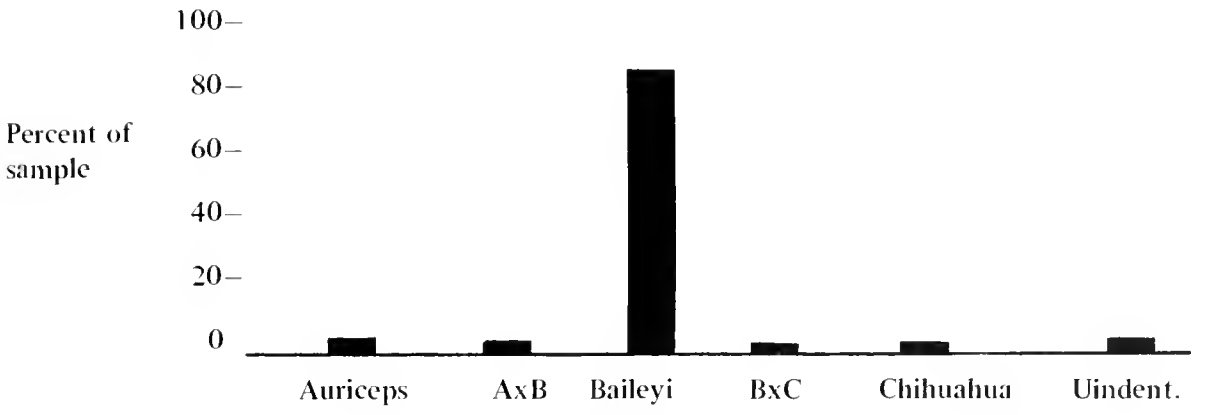
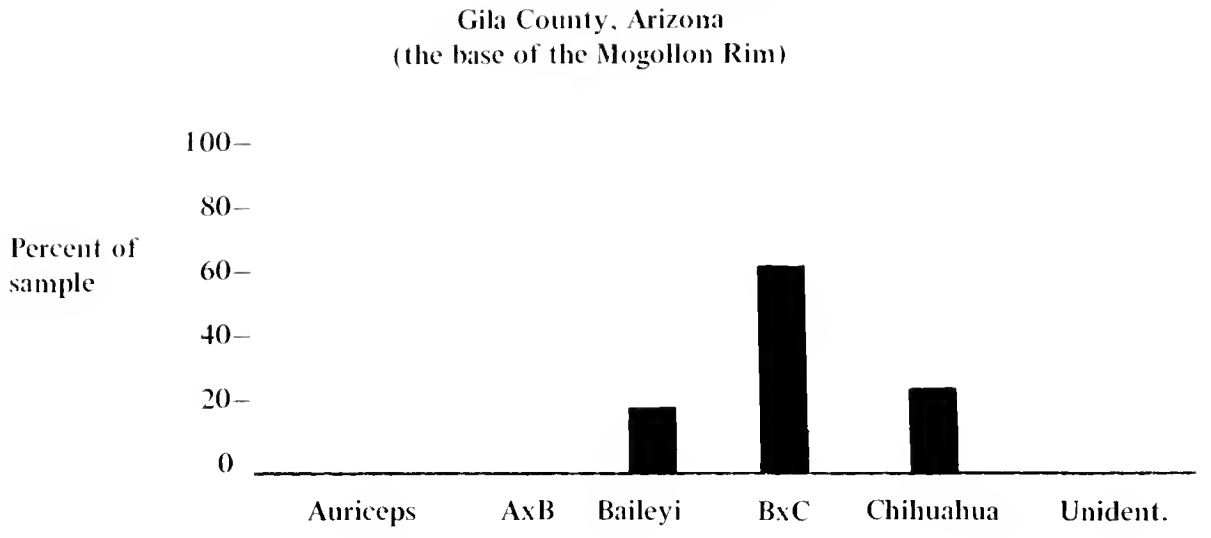
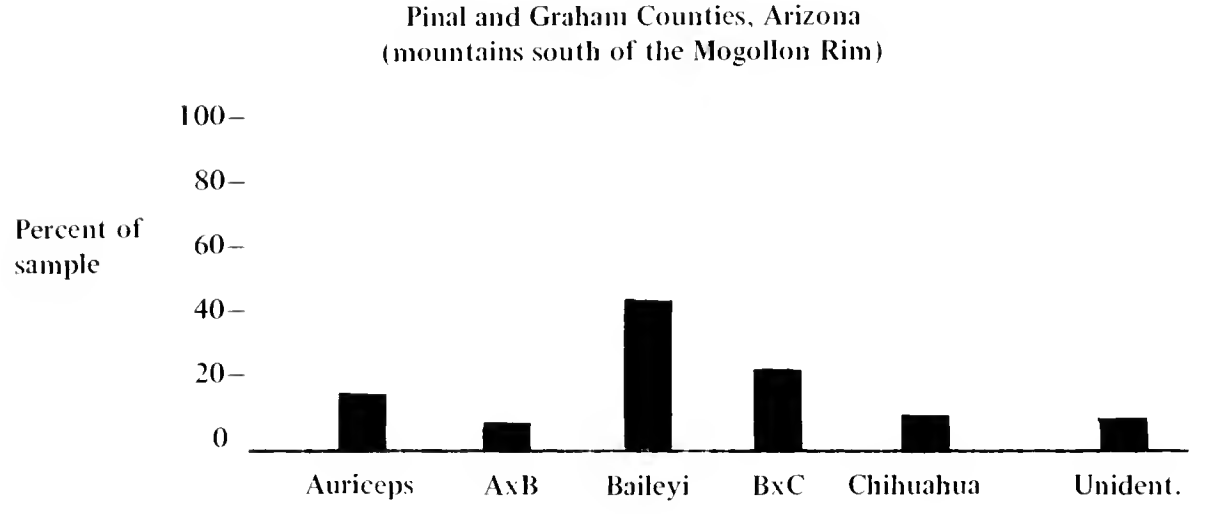


Fig. 5 continued





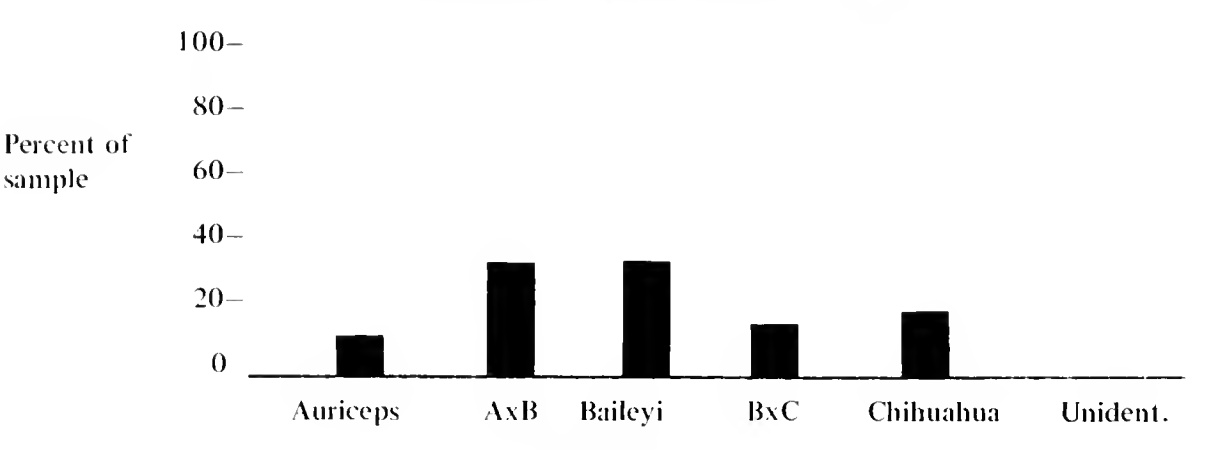


fig. 5 continued

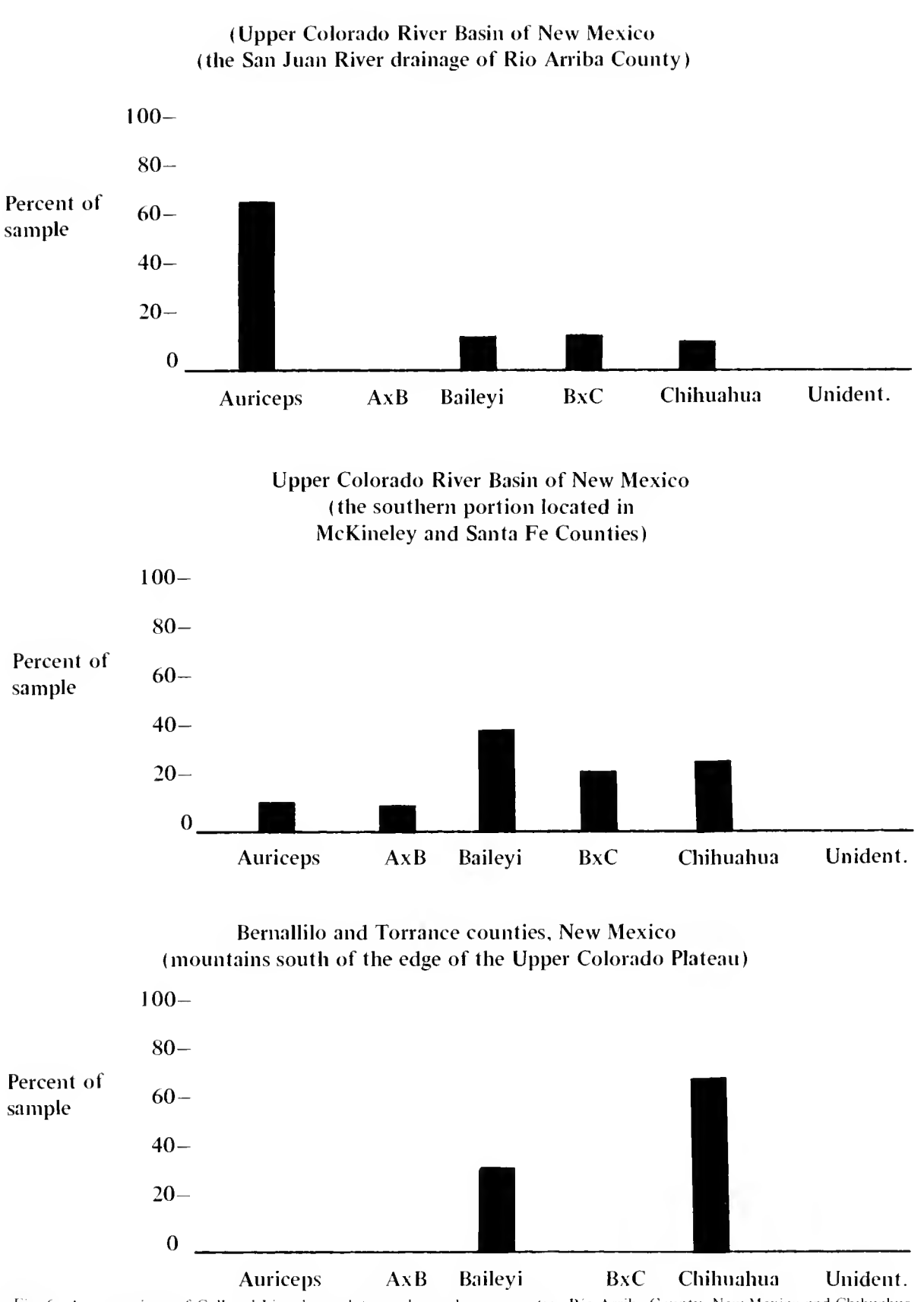
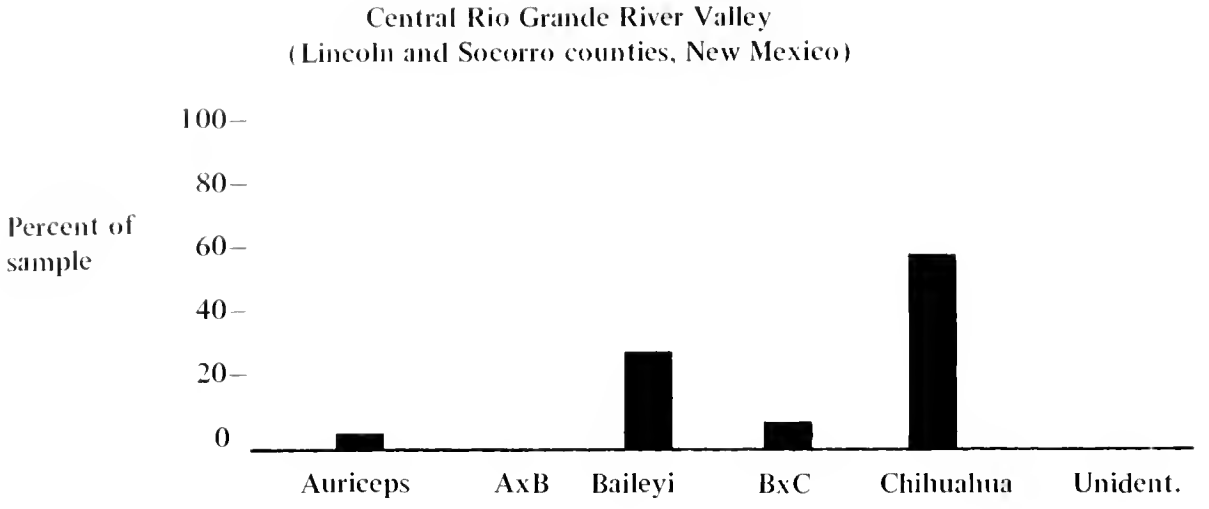
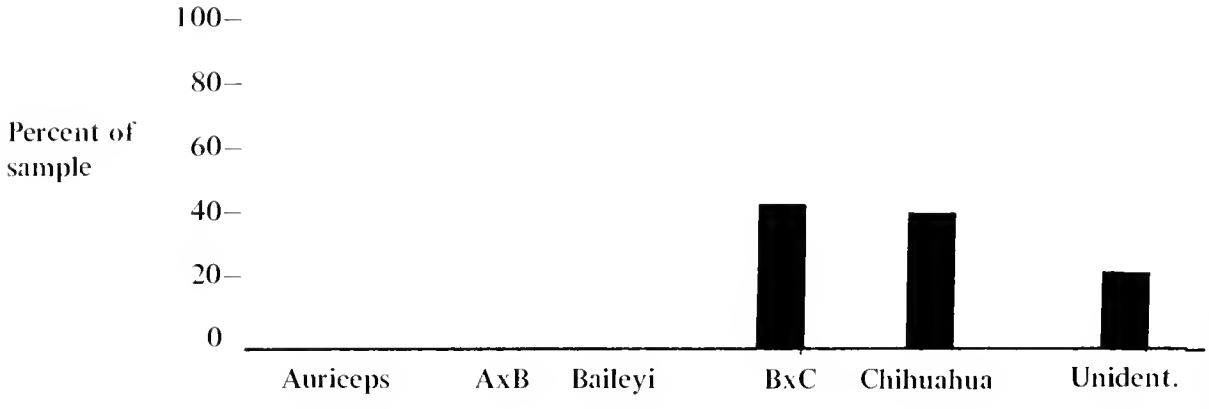


Fig. 6. A comparison of Collared Lizard populations along a line connecting Rio Arriba County, New Mexico and Chihuahua, Mexico.





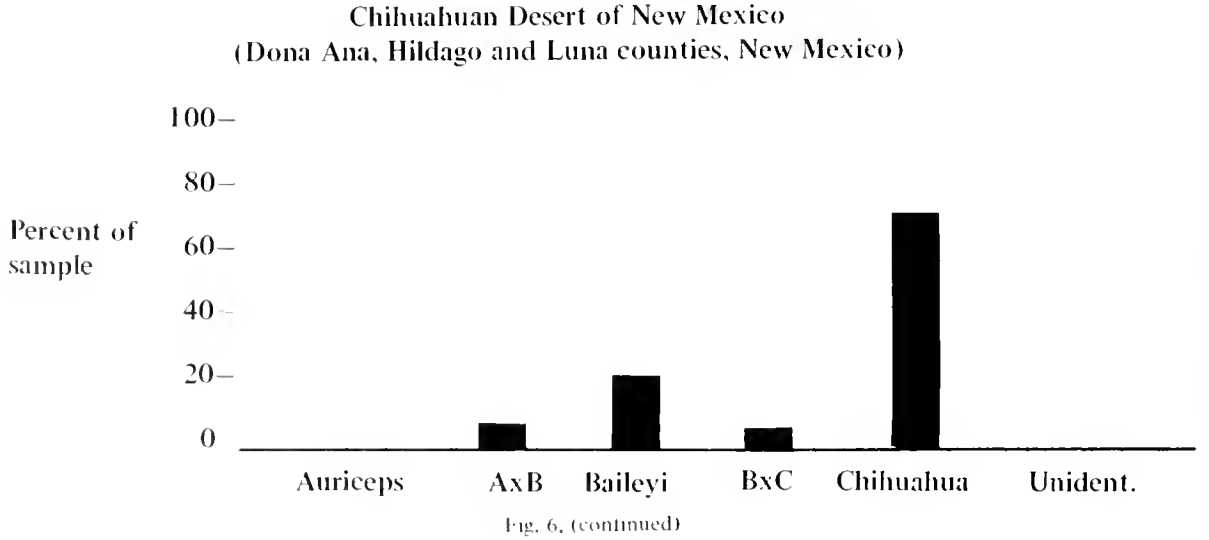
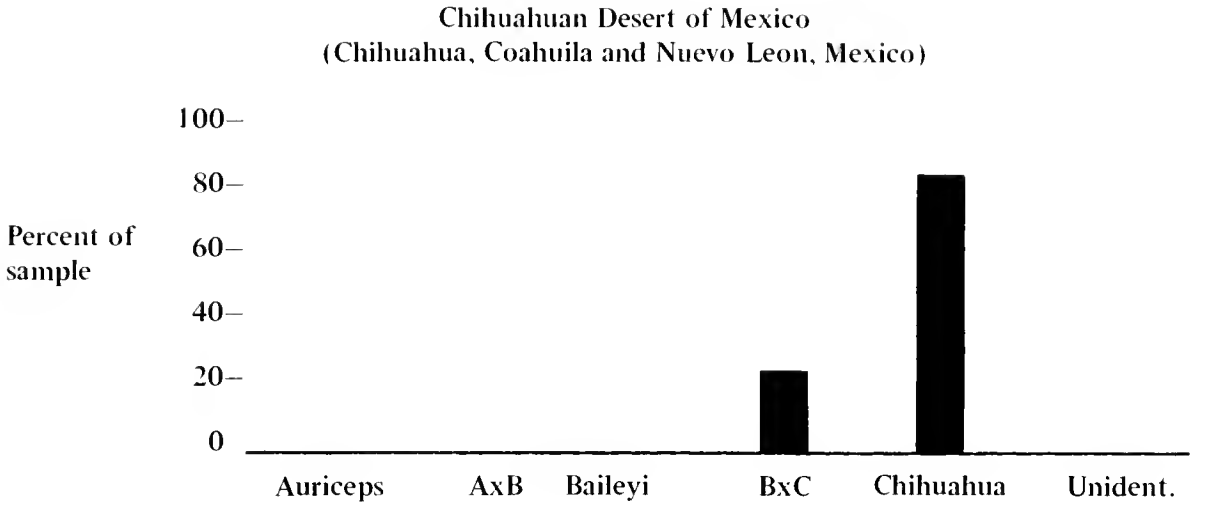


Fig. 6. (continued)



group with a high degree of reliability. This reliability is expressed in the form of a probability for joining each group (Sokal and Rohlf, 1969). The discriminant functions have demonstrated their ability to identify the three populations accurately.

Coloration was studied separately from the morphological characters. This aspect of a lizard's phenotype consistently demonstrated differences between populations. There may be some questions as to the validity of coloration when used as a taxonomic character due to a possible relationship between coloration and diet. However, the similarity of classifications of Collared Lizards by color patterns and by morphological characters tends to dispute this idea. In an animal such as the Collared Lizard, that is active, diurnal, highly territorial, and uses sight to recognize both territorial intruders and potential mates (Fitch, 1956), it is difficult to imagine a character more important than color pattern. Since coloration fades rapidly on preserved specimens, this method of identification works on live specimens only. The population of *C. c. auriceps* is characterized by coloration-patternal type 1; *C. c. baileyi*, by type 3; intergrades between the two, by type 2; the Chihuahuan Desert population, by type 5; and intergrades between the Chihuahuan Desert population and *C. c. baileyi*, by type 4.

By combining the information obtained from both coloration-patternal and morphological characters, it is possible to explain the structure of the Collared Lizard populations between the Rio Grande and Colorado Rivers (see Fig. 8). Located in the northern extension of the Upper Colorado River Basin is *C. c. auriceps*. Its range should now be restricted on the south, to the region of the union of the Green and Colorado rivers in the vicinity of Moab, Grand County, Utah. Northward, they extend at least to the Book Cliffs area and possibly further. South of the union of the Green and Colorado rivers, an increasing number of individuals is identified by the discriminant functions as *C. c. auriceps* X *C. c. baileyi* intergrades. This corresponds with a decreasing number identified as *C. c. auriceps*, which is also supported by the color patterns observed. In this region, numerous lizards are found of color type 2, which is intermediate to color type 1, *C. c. auriceps;* and color type 3, *C. c. baileyi*. The area of intergradation is limited to the region somewhat south of Moab, Utah, and extending to the vicinity of the Little Colorado River of Arizona.

Crotaphytus collaris baileyi is now restricted to the region south of the Painted Desert, across the center of Arizona. It is also expected to occur in the

Table 6. A comparison of the percent of correctly identified individuals within groups as new variables are added to the discriminant functions.

Step	Variable added	Groups			
		auriceps	*baileyi*	Chihuahua	*collaris*
1	5	0	90	16	75
2	8	40	43	47	92
3	7	80	50	60	83
4	21	80	60	69	92
5	10	80	63	69	92
6	14	80	67	73	92
7	4	80	60	73	100
8	17	80	70	73	100
9	18	80	67	71	100
10	3	80	73	73	100
12	19	80	73	78	100
13	20	80	80	84	100
14	13	80	77	89	92
15	15	80	70	88	100
16	12	80	70	88	100
17	22	80	73	88	100
18	23	80	77	89	92
19	11	90	77	89	92
20	2	90	77	92	92
24	6	90	77	92	100

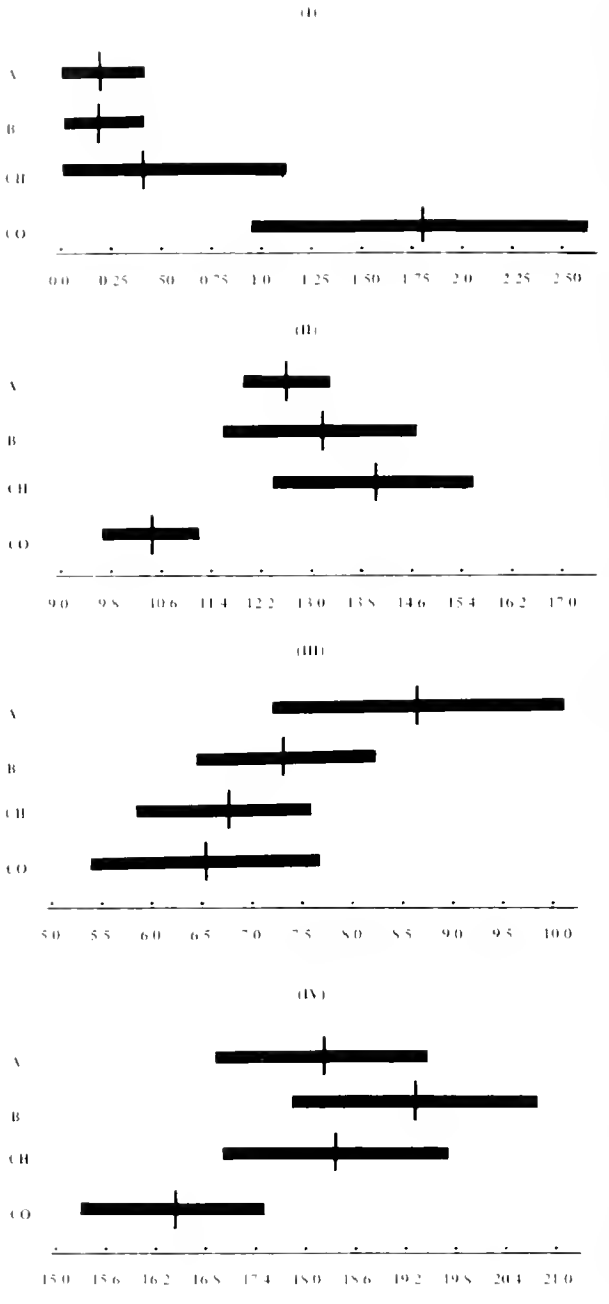


Fig. 7. Means and standard deviations plotted for the four characters that contribute the most to population discrimination: (I) fused interorbitals, (II) supralabials, (III) loreal-lorilabial series, (IV) subdigital lamellae of second toe on hind foot. (CO) Great Plains population, (CH) Chihuahuan Desert population, (B) central Arizona population, (A) Upper Colorado River Basin population.

western central mountains of New Mexico; however, specimens from this area were too few to state this with assurance. *C. c. baileyi* seems to be centered in Mohave, Yavapai, and southern Coconino counties of Arizona and follows the Mogollon Rim and adjacent mountains to the east. In the south, the picture becomes more confused. Isolated populations of *C. c. baileyi* are found on the mountain tops, and, in the lower elevations, intergrades between *C. c. baileyi* and the Chihuahuan population are found. In general, this area is populated by *C. c. baileyi* X Chihuahuan intergrades; however, the exact relationships are in need of further study.

The exact type locality of *C. c. baileyi* is unknown. Stejneger describes it as the Painted Desert of the Little Colorado River. In his original description of *baileyi,* two facts become apparent. First, the red spots described on the neck of the type (which is a male), and the time of collection (late August, when generally only juveniles and hatchlings are active) indicate the type to be a juvenile. Secondly, the type locality is somewhere between Cameron and Wupatki National Monument in Coconino County, Arizona. Stejneger describes the locality for collection of the type as in the vicinity of the Little Colorado River. The type was collected on the second excursion to the desert, which took him north from Flagstaff to Tuba City on a route that is followed by U.S. Highway 89 (Stejneger, 1890). Locating the type locality as south and west of the Little Colorado River places it within the range of *C. c. baileyi* as determined by this study.

The population centered in Chihuahua should now be recognized as a subspecies and separate from *C. c. baileyi* and *C. c. auriceps.* This is done on the basis of its overall morphological distinctiveness as expressed by the discriminant functions and also by its strikingly different coloration. The brown of its doral coloration is easily distinguished from the green of either *C. c. baileyi* or *C. c. auriceps.* The new population, centered in Chihuahua, Mexico, extends northward to Socorro County, New Mexico, dispersing up the lowlands of the Rio Grande River Valley. The eastern and southern extents of its range are in need of further study. To the west is an area where isolated populations of *C. c. baileyi* occur on the higher mountain ranges (e.g., Tanque Verde Mountains near Tucson). This provides for intergradation to occur and for the coloration-pattern type 4 to become common. The overall ranges are shown for the three populations in Fig. 8.

Twelve individuals from the area of the type locality of *C. c. collaris* were included in the discriminant analysis. This was done to obtain an idea as to the relationship of *C. c. collaris* to the populations studied. Also included in the analysis were a number of individuals from eastern New Mexico, Texas, and eastern Colorado. All are within the presently determined range of *C. c. collaris.* Two facts resulted from this analysis: (1) the lizards from the type locality were identified with 100% assurance, and (2) no meaningful pattern could be discerned for the remaining supposed *C. c. collaris.* This suggests that the subspecies, *C. c. collaris,* is also a heterogeneous grouping

Table 7. A listing of the means and standard deviations for the 24 characters measured on the individuals used in forming the discriminant functions.

Character	Groups							
	auriceps		*baileyi*		Chihuahua		*collaris*	
	Mean	Stand. dev.	Mean	Stand. dev.	Mean	Stand. dev.	Mean	Stand. dev.
1	2.2	0.3	2.2	0.2	2.2	0.2	2.1	0.1
2	1.8	0.2	1.9	0.1	1.9	0.2	1.8	0.1
3	94.3	7.2	93.1	6.2	95.3	7.8	91.8	7.8
4	5.8	0.8	6.0	0.7	6.0	0.7	4.8	0.8
5	0.1	0.3	0.1	0.3	0.4	0.7	1.8	0.8
6	2.3	0.8	2.0	0.7	2.0	0.9	1.2	0.4
7	8.6	1.5	7.3	0.9	6.7	0.9	7.4	1.2
8	12.5	0.7	13.2	1.6	13.9	1.6	10.5	0.8
9	0.9	0.3	1.0	0.2	0.9	0.2	0.8	0.4
10	66.1	4.5	61.0	6.2	62.8	6.0	52.8	6.1
11	0.1	0.3	0.5	0.7	0.6	0.7	0.1	0.3
12	15.7	1.2	14.7	1.7	14.4	2.7	14.7	1.0
13	24.5	6.1	25.4	7.3	28.6	3.9	26.2	2.6
14	33.7	6.5	33.1	5.8	28.4	4.3	24.5	3.9
15	158.1	7.9	163.5	11.7	155.8	10.4	142.1	9.5
16	195.4	9.8	187.5	11.5	187.7	10.9	170.2	6.2
17	28.9	4.7	24.2	7.8	23.3	5.8	24.2	10.3
18	1.4	1.8	4.3	3.8	5.4	4.3	7.8	6.1
19	1.9	0.3	1.7	0.6	1.9	0.4	1.0	0.3
20	0.2	0.0	0.2	0.0	0.2	0.0	0.1	0.0
21	17.3	1.3	19.5	1.5	18.7	1.4	16.4	1.2
22	33.0	3.9	34.7	3.0	34.4	3.0	28.8	2.1
23	15.0	1.7	15.5	1.5	15.0	1.8	13.9	1.5
24	18.6	1.6	17.8	1.4	18.2	1.9	17.6	1.3

and should be studied. The ease of separation of the specimens from the area of the type for *C. c. collaris* supports the present separation of three western populations from an eastern Great Plains group now designated as *C. c. collaris*. This was also supported by the grouping of the cluster analysis. Following Rao's technique (1952), a graph of the first two canonical variables was plotted (see Statistical Discussion). This provides a two-dimensional representation of the interrelationship of the populations (see Fig. 9).

A diagnosis of the three populations' characteristics and their comparison with the material representing the type population of *C. c. collaris* is as follows:

Crotaphytus collaris auriceps is separated, as are the other groups, primarily on coloration and pattern. It has a light green body with a bright yellow head. The yellow on the head extends posteriorly to or just past the second collar and ventrally onto the throat. In males, the yellow on the throat meets the green of the gular patch. Morphologically *C. c. auriceps* is separated from *C. c. collaris* by a fewer number of specimens with fused interorbitals. It is separated from *C. c. baileyi* primarily by a smaller number of supralabials, as indicated by Fitch and Tanner (1951), and a greater number in the loreal-lorilabial series. *C. c. auriceps* is also distinguishable from the Chihuahuan Desert population by the above characters and is further separated by possessing fewer subdigital lamellae on the second toe of the hind foot.

Crotaphytus collaris baileyi has a dark green body, and, if yellow is present on the head, it does not extend posteriorly beyond a line drawn between the rear of the supraorbital semicircles. Yellow is never found on the throat. Using morphological characters exclusively, *C. c. baileyi* is separated from *C. c. collaris* by a smaller number of specimens with fused interoribitals, a greater number of supralabials, and a greater number in the loreal-lorilabial series. *C. c. baileyi* was not separated with much assurance from the Chihuahuan Desert population until 14 characters had been added to the discriminant function. This suggests the differences between the populations are expressed as a function of many variables (a sum of many small differences) rather than just one.

The Chihuahuan Desert population differs from *C. c. collaris* morphologically mainly by having fewer individuals with fused interorbitals and having more supralabials. Color and patterns of *C. c. collaris* were not analyzed. The Chihuahuan Desert population has been demonstrated to be sufficiently different from all presently recognized populations to merit designation at the subspecific level. It is therefore named as

A key to the sumbols used in Fig. 8.

Range of the Upper Colorado River Basin population, *C. c. auriceps.*

Range of the central Arizona population, *C. c. baileyi.*

Range of *C. c. baileyi* x *C. c. auriceps* intergrades.

Range of the Chihuahua Desert population, *C. c. fuscus.*

Range of *C. c. fuscus* x *C. c. baileyi* intergrades.

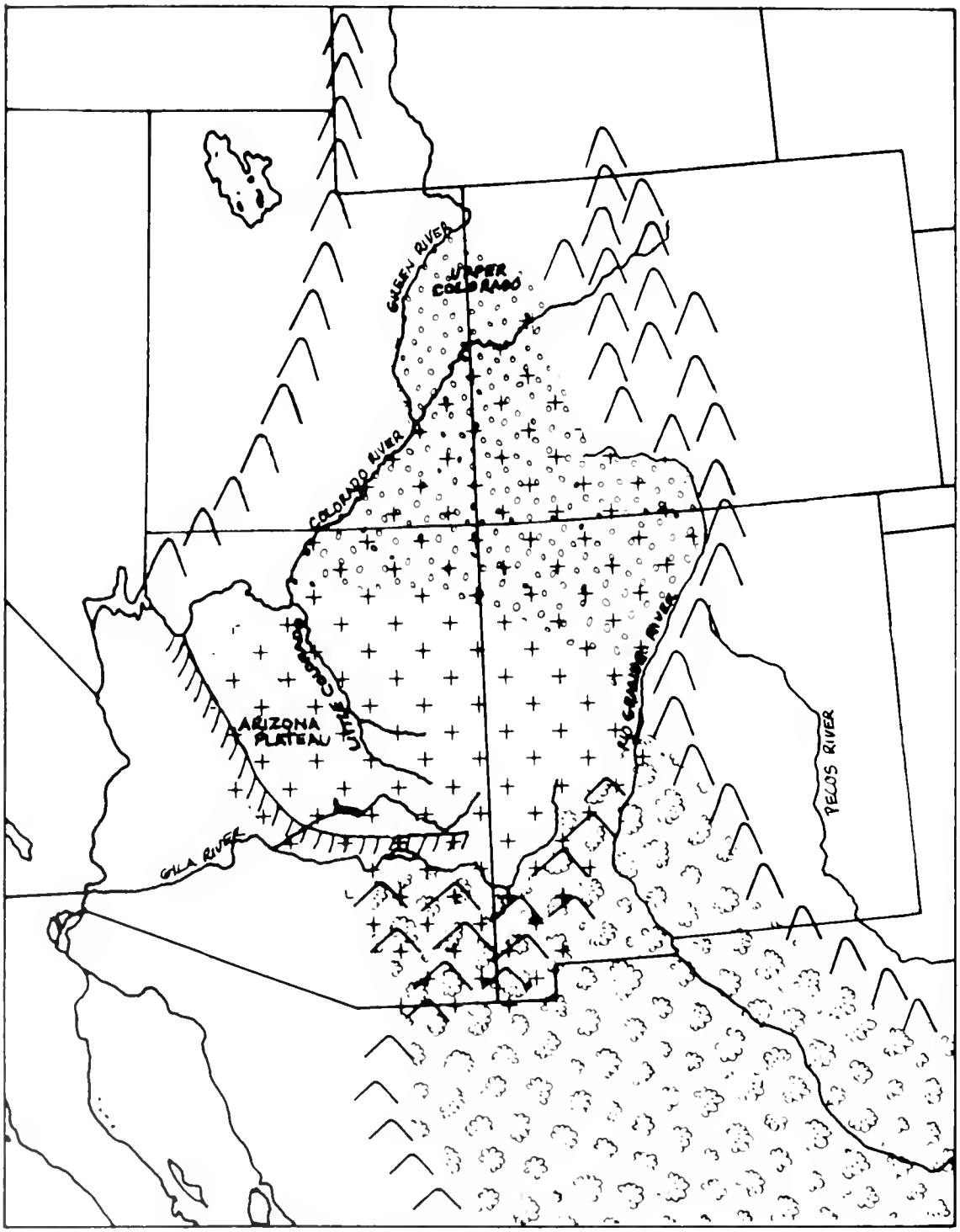


Fig. 8. A range map for the populations studied.

A key to the symbols used

A - The upper Colorado River Basin population.
B - The central Arizona population.
F - The Chihuahuan Desert population.
C - The Great Plains population.

& - Misidentified A
O - Misidentified B.
$ - Misidentified F.

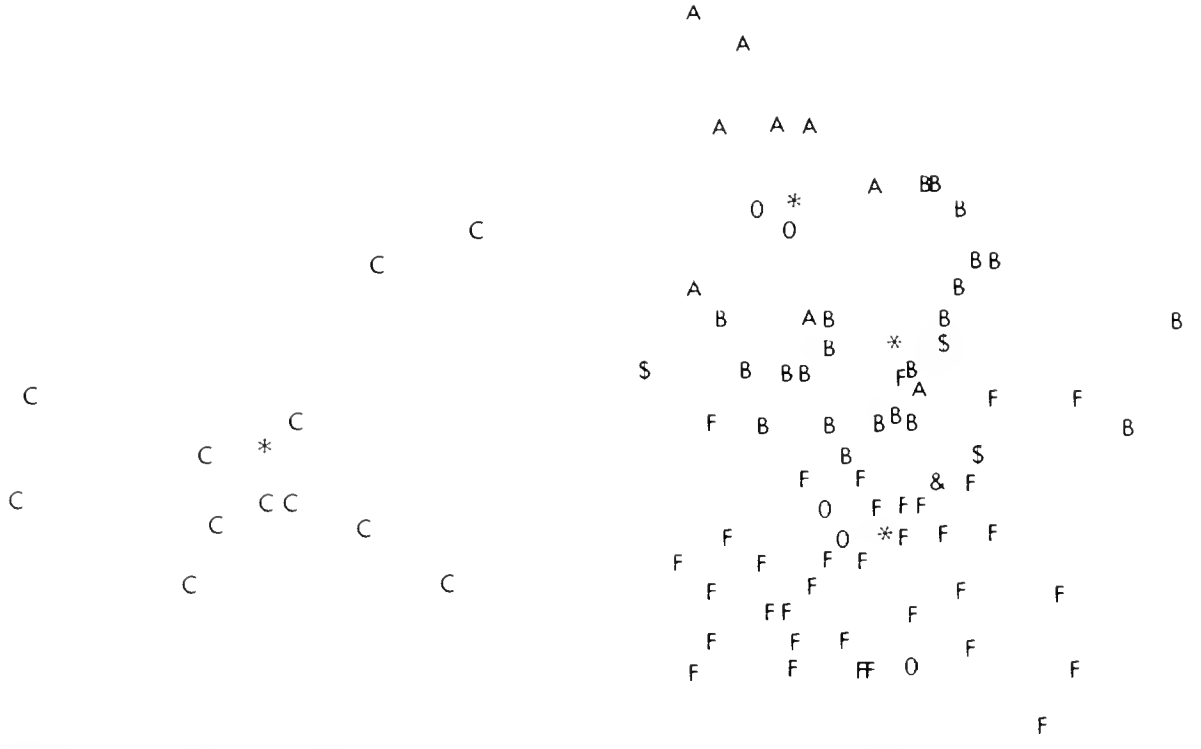


Fig. 9. A two-dimensional representation of the interpopulation morphological relationships formed from the canonical variates.

Crotaphytus collaris fuscus subsp. nov.

Type. – Adult male, Brigham Young University No. 16970, collected 6.5 mi. N. and 1.5 mi. W. of Chihuahua City, Chihuahua, Mexico, by Wilmer W. Tanner on July 21, 1960.

Paratypes. – Chihuahua: topotypes, BYU 14211, 14212, 15305, 15325-15331, 15817-15822, 16969, 16971-16977, 17010; Chihuahua City: UC 70704; Colonia Juarez: BYU 3736, 15185-15188; Hechichero: KU 33789; Nuevo Casas Grandes: BYU 15184; palomas: BYU 17014; Ricardo Magon: BYU 13382-13386, 13410, 13411; Victoria: KU 33788.

Diagnosis. – It differs from *C. c. baileyi*, *C. c. auriceps* and *C. c. collaris* in having a brown dorsal color with no trace of green and a light to cream colored head with no trace of yellow. The morphological differences, no one of which is conclusive, are many and add up to a general difference from the recognized populations that is best expressed by the previously mentioned discriminant functions.

Description of the type. – Head and body length 106 mm, tail length 222 mm, width of head at angle of jaw 28 mm, hindleg length from midline to tip of fourth toe 89 mm, femoral pores 20-20, supralabials 14-14, infralabials 12-11, fused interorbitals 0, internasals 6, frontoparietals 2, loreal-lorilabial series 7, postmentals in contact with infralabials, gular scale rows at angle of jaw 69, scales from rostral to interparietal 15, scales from interparietal to anterior edge of first collar 25, scales from anterior edge of first collar to posterior edge of second collar 28, total dorsals 140, total ventrals 181, scales within dorsal separation of first collar 26, scales within dorsal separation of second collar 5, number of spots within dorsal separation of first collar 2, subdigital lamellae of second toe of right hind foot 17, subdigital lamellae of fourth toe 31, subdigital lamellae of fifth toe 16.

Type described from preserved specimen and natural coloration not apparent. General pattern and coloration as described from living specimens. Head pale (white or cream) with a few small dark spots distributed randomly across back of head, gular patch black, bluish black or dark brown, never green, reticulation present on lateral edges of gular patch, reticulations to infralabials, first collar widely disjunct dorsally

with two small spots in disjunction, second collar narrowly disjunct dorsally, second collar on forearm, body dorsum of varying shades of brown, never green; small white spots, rarely any yellow, scattered profusely; front legs same color as body dorsum but patternless; hindlegs same as body dorsum with spotting of body continued to thigh; feet pale; body venter white or cream; body dorsum ground color, fades into venter in region of midbody; no dark axillary or groin patches present.

The populations represented by *C. c. collaris*, *C. c. baileyi*, *C. c. auriceps*, and *C. c. fuscus* should be considered as an evolutionary group because of their greater morphological and patternal similarity when compared with the Collared Lizards west of the Colorado River. This group will be referred to as the *collaris*-complex.

The following phylogeny is based on morphological and patternal evidence. The population ancestral to the *collaris*-complex originated in east central Mexico, probably Chihuahua or Coahuila, from which they established themselves in the border states of Mexico and the United States. With improving climatic conditions, following the Pleistocene, they advanced northward. The population followed three corridors of dispersal: (1) along the low mountains of southwestern New Mexico and southeastern Arizona, (2) up the Rio Grande River Valley, and (3) east of the central mountains of New Mexico.

The first corridor led to the high plateaus of central Arizona and the Upper Colorado River Basin. Upon reaching the elevation barrier presented by the southern edge of the plateaus, a segment of the ancestral population, which invaded the higher elevations, was isolated and continued to disperse along the drainages of the Colorado River and its tributaries. This population, *C. c. baileyi*, moved northeast into Utah and Colorado following the mountain ranges that skirt the relatively uninhabitable Painted Desert and Monument Valley region of Arizona. This resulted in a large population centered in the Upper Colorado River Basin of Utah and Colorado, loosely associated with the main population of central Arizona. The length of the connection, coupled with the spotty distribution in northeastern Arizona, reduced the amount of genetic exchange possible between the two main populations. This allowed a distinct population, *C. c. auriceps*, to form at the northern boundary of the Upper Colorado River Basin.

Crotaphytus collaris auriceps is probably the youngest population of the *collaris*-complex. Three facts support this idea: (1) *C. c. auriceps* is located in the area most recently open to expansion by reptilian forms, the central portion of the Upper Colorado River Basin. (2) *C. c. auriceps* presents the smallest change in color and pattern from *C. c. baileyi*, thus suggesting recent evolution from that form, and the greatest change from the population closest to ancestral stock (the Chihuahuan Desert population, *C. c. fuscus*). (3) *C. c. auriceps* still possesses a wide intergrade zone with *C. c. baileyi*, suggesting that they have had little time to separate.

Crotaphytus collaris fuscus has probably changed little from the ancestral form, as it occupies essentially the same range. As conditions improved, following the Pleistocene, *C. c. fuscus* dispersed northward following the Rio Grande River along the low mountain ranges and river basins. It appears to be contained by the higher elevations encountered to the north and west. The range of *C. c. fuscus* may be outlined by constructing a line following the 5,000 foot elevation level in southern Arizona and New Mexico.

The population that dispersed eastward presently inhabits the Great Plains region. It became isolated from the western segment of the *collaris*-complex by the Rocky Mountains and differentiated into a distinct population now considered to be *C. c. collaris* (see Fig. 10).

Statistical Discussion

One of the major difficulties in using statistics in the zoological sciences is the lack of descriptions of the techniques phrased in the language of a zoologist. The purpose of this section is twofold: (1) to explain the necessity of using multivariate statistics in the taxonomy of subspecies, and (2) to explain in understandable terms the statistical methods used in this paper.

One of the more important discoveries of this study has been in the realm of methodology. Univariate methods are those techniques of data analysis and statistical decision-making where only one variable is measured on each experimental unit. Examples of this type of analysis are T-test of means, Chi-square, and Analysis of Variance. In recent years, a new statistical technique has grown out of classical univariate analysis. This form of statistics, the multivariate or generalized analysis, should be recognized as the proper form to use in taxonomic studies where more than one character is being analyzed. Multivariate analysis is designed to perform analyses that are analogous to those of univariate methods for cases where more than one measurement, or variate, is being determined on each experimental unit or specimen (Anderson, 1958).

There are definite hazards to using univariate methods where multiple measurements are being made on a single experimental unit. These hazards are centered in the inability of knowing the exact alpha-level of a statistical test, unless the assumptions of that test are complied with. The alpha-level of a test is the probability that the difference observed in the data is due to chance.

In most herpetological taxonomic studies, more than one variate or taxonomic character is measured

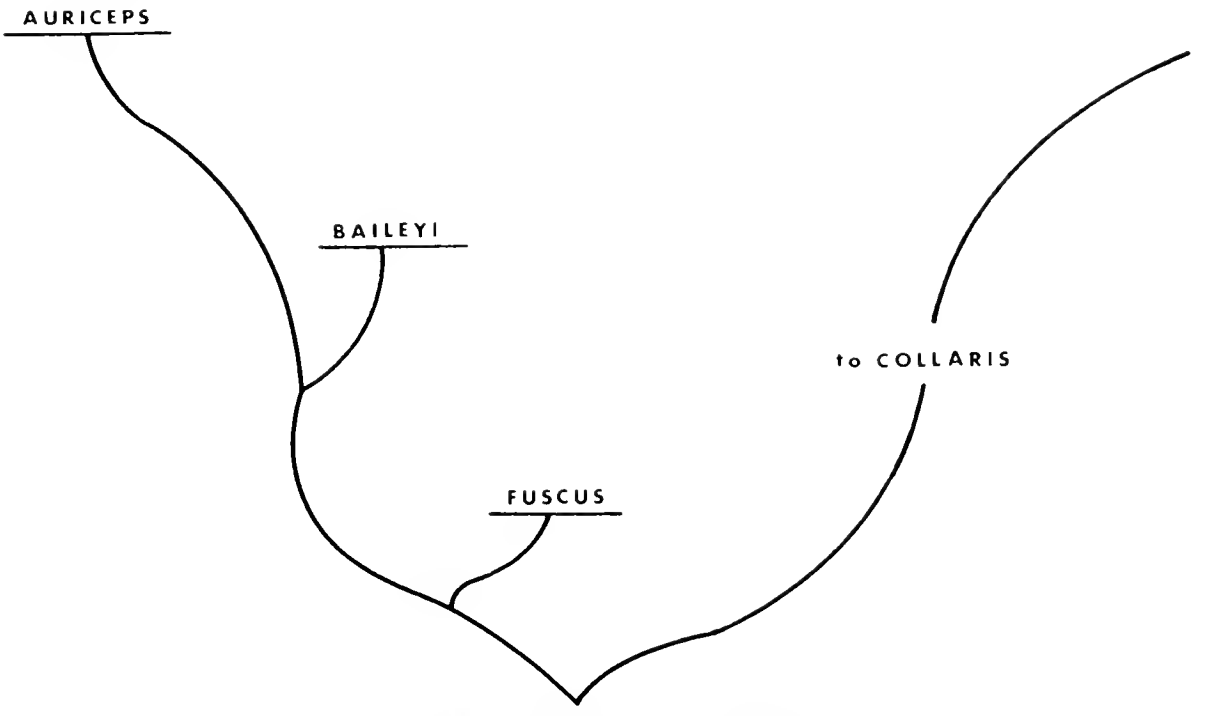


Fig. 10. Proposed phylogenetic relationship of the populations of the *collaris*-complex.

on each individual. These variates usually are then analyzed separately with a univariate method, and the results are combined to support a conclusion.

If such multiple measurements are analyzed on the basis of separate univariate treatments of the variables, the combination of the results of the univariate tests and the assignment of a level of confidence to any inference drawn from these tests present a problem. If all the variables are perfectly correlated, the same conclusion is drawn from each variable, and univariate methods are acceptable. Perfect correlation means that all the variables change values in the same relationship to each other (e.g., for each five scale increase of the dorsals, the femoral pores increased one). However, variables that are perfectly correlated are each measuring the same source of variation. To prevent heavy weighting of that source of variation, only one of the correlates should be measured. If the variables are completely independent and significance at the 0.10 level is claimed (when at least one variable shows significance), the true level of significance is $1-(.90^n)$ with ^{n} equal to the number of variables measured (Steel, 1955). Suppose four different variables are measured and tested at an alpha-level of 0.10. Using the above formula, it can be seen that the true alpha-level of any conclusion drawn from the combination of the four tests is actually $1-(.90^4) = 1-(.66) = 0.34$. This differs greatly from the alpha-level of 0.10 that would normally be assumed. If the rule would be to claim significance when all the variables show significance, the alpha-level would become $(0.10)^n$, with ^{n} equal to the number of variables measured. Using the previous example, the true alpha-level becomes 0.0001. This makes it practically impossible ever to detect a difference. Often independence of variables is assumed without proof. For a variable to be considered completely independent, its value must not be influenced by the value of any other of the measured variables. In taxonomy, which deals with characters controlled by an unknown arrangement of the genotype, the assumption of independence of variables without prior verification seems untenable.

If either complete dependence or independence of variables were known to be the case, rules could be formulated to allow inferences from a combination of univariate analyses of the data. However, the true situation invariably lies somewhere between the two extremes. Thus, one would not know the true level of significance of the inferences on the combined results of univariate analyses. By using the multivariate generalizations of univariate methods, this problem of indeterminant alpha-level is controlled (Steel, 1955).

Mayr (1969) has advocated the use of multivariate methods wherever multiple measurements are used. He states also that often the calculations (e.g., the determinant of a 100 X 100 matrix) are prohibitive. With the advent of fast digital computers and packaged programs, this is no longer true.

Another more compelling reason for using multivariate analysis of data concerns what is actually being analyzed. Taxonomists are classifying whole organisms, not any one scale count (Mayr, 1969; Sokal and Sneath, 1963). Univariate methods con-

sider only one variable at a time as completely unrelated to all other variables. Multivariate methods consider groups of characters, as a unit, and their relationships with each other. This is a better approximation of the organisms with which taxonomists are concerned. The following is a description of the multivariate techniques used:

Multivariate analysis of variance. A method to test the difference of group means for those cases where more than one variable is recorded for each individual. This is the multivariate extension of the familiar analysis of variance and F-Test. It is appropriate for testing hypothesis concerning differences between populations.

Cluster analysis. When a taxonomic study is made taking two measurements on each individual, the specimens studied could be represented as points on a two-dimensional space. The resulting graph would illustrate the phenotypic interrelations of the individuals. Expanding this to 90 measurements on each individual, the specimens could be represented as points in a hypothetical 90 (or p)-dimensional hyperspace. The representation of individuals on a 90-dimensional graph is best grasped by visualizing many points in space grouped in clusters of varying size. The number of dimensions in the hyperspace is equal to the number of variables measured. This concept of individuals being represented as points in a p-dimensional space is essential to cluster and discriminant analyses.

Ward's method of cluster analysis forms spherical clusters of individuals in the hyperspace. New clusters are formed by measuring the distance from each individual in the original cluster to the center of the cluster, called the centroid. These distances are summed to form the error sum of squares for the cluster. The individuals to be added to the cluster are conditionally added, and the new centroid formed. An error sum of squares for the newly formed cluster is calculated. This procedure is done for all possible entries to the original cluster (possible entries include other clusters as well as individuals). The entry that causes the least increase in the error sum of squares is joined to the original cluster. Each new cluster is formed by joining those individuals that move the centroid the smallest distance. In other words, each cluster is composed of those individuals located closest to each other in the hyperspace. Thus, it is seen that this method unites individuals of the highest morphological similarity first (Wishart, 1969). The main assumption that must be valid for this procedure to give meaningful results is that the characters chosen represent the phenotype of the animal as well as possible.

Canonical analysis. This method allows the examination of the relationship of two sets of variables. The two sets used in this study were (1) groups and (2) variables measured on the individuals. This resulted in two variables, evaluated for each individual, formed from a linear function of all the variables measured. These two new variables maximized the correlation between groups and originally measured variables. When plotted on an x and y axis, the variables form a two-dimensional graph of the relationships of the groups to each other (Dixon, 1968; Rao, 1952).

Discriminate analysis. This technique theoretically constructs p-dimensional planes in the hyperspace, which separate the clusters of individuals. In practice, it builds a single variable from all the variables measured and maximizes the difference between groups (Anderson, 1958; Sokal and Rohlf, 1969).

Rao (1952) describes a "gray" area located between two clusters, in which a few individuals may occur. In this area the individual's probability of belonging to either cluster is not great enough to grant membership with assurance. Rao states the possible conclusions in a system consisting of three clusters. The individuals either belong to (1) one of the three clusters, (2) one of two clusters, or (3) all three clusters and no conclusion may be drawn.

The procedure for using discriminant analysis in a subspecific problem, as developed in this study, parallels Rao's concept. The major distinction is because of the ability of members of two distinct clusters (subspecific population) to interbreed and produce individuals with characteristics intermediate to either of the clusters. Thus, Rao's "gray" area becomes a region occupied by intergrades between the two clusters. As in Rao, an individual with an equal probability of joining all of the groups is considered unidentifiable (see Fig. 11). This procedure, like so many procedures in taxonomy, is based on certain subjective decisions. Therefore, the validity of its results is dependent upon the validity of the assumption made. The assumptions are as follows below:

(1) Among the individuals to be classified, at least two distinct populations must be represented. Prior to using discriminant analysis, an appropriate method must be employed to determine the number of populations present. A test of the population difference is also advisable.

(2) The most crucial assumption concerns the selection of members used in forming the discriminant functions. In order to identify intergrade populations correctly, the individuals used to form the functions must be selected so that only "pure stock" of the populations being investigated is represented. The sample used to form the discriminant functions define, as far as the analysis is concerned, the parameters of that population. Thus, as more intergrades are included in the sample, a less precise definition of the population and its parameters results; and the identification of individuals by the discriminant analysis declines in reliability.

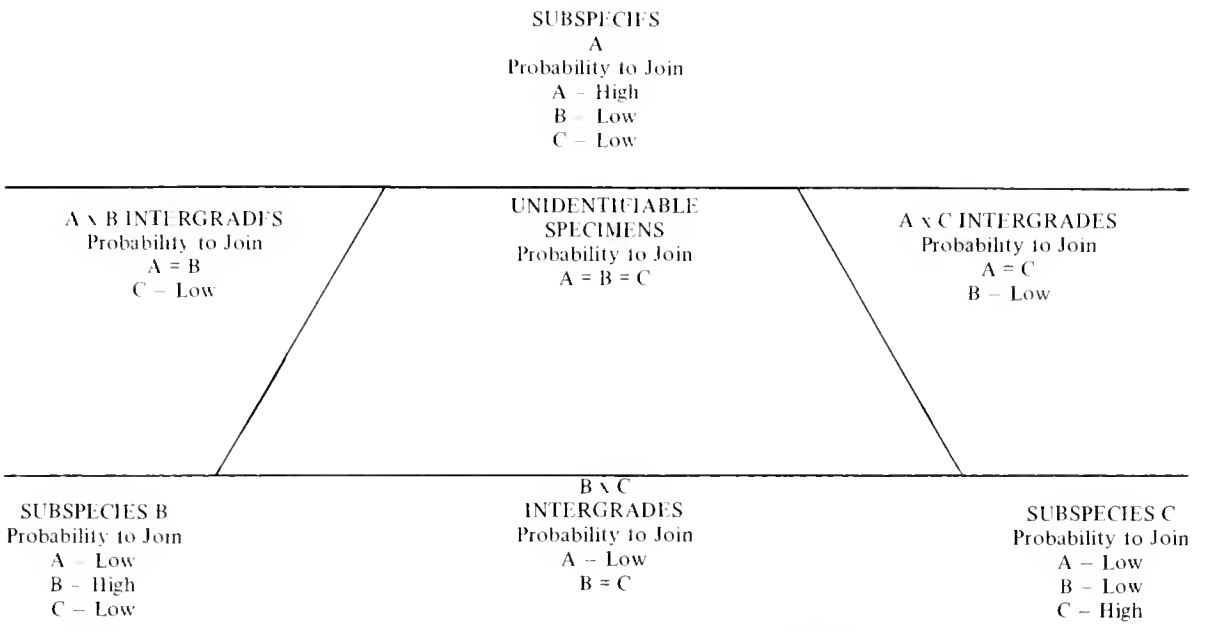


Fig. 11. The subspecific identification problem as viewed by discriminant analysis (modified after Rao, 1952).

(3) Any one individual to be identified, must be considered to have an equal prior probability of belonging to any of the populations. This can be assured by placing an equal number in each of the groups used to form the discriminant functions. It is acceptable to use unequal numbers if specimen availability or some other factor necessitates. In this study, availability of pure *C. c. auriceps* and *C. c. collaris* limited those samples and a decision was made to sacrifice equality of *a priori* probabilities to gain a better definition of the population parameters of the other two subspecies.

(4) Discriminant analysis is a statistical method, and, as such, its reliability hinges on the amount of information put into it. As the number of individuals and variables used in forming the functions increases, so does the reliability of the results. This is also true of the reliability of identification of new specimens. The results of statistics are always phrased in probabilities and the higher the probability, the more sure the conclusion. It is possible, especially in a subspecific problem, to have any one individual wrongly identified as belonging to a population. This becomes more likely, the closer the populations resemble each other. Therefore, conclusions about which population is present in a certain area should be made on a basis of the population most frequently identified from that area. One specimen (or perhaps a few) is not enough to make a valid conclusion about the population structure of an entire area.

SUMMARY AND CONCLUSIONS

Little work has been done previously on the taxonomy of *Crotaphytus collaris baileyi*. This and the demonstration by Fitch and Tanner that *C. c. baileyi* is a heterogeneous grouping prompted the present study. Only the populations of the type material, the Upper Colorado River Basin, and the Chihuahuan Desert were studied. Multivariate, variance, canonical and discriminant analyses of external characters were performed, and pattern-coloration characters were examined on living specimens.

The results of the analyses show significance between all three populations. The discriminant functions distinguished between the populations with 80% reliability and patternal characters were discriminatory with near 100% reliability. Therefore, a new subspecific name, *C. c fuscus*, was applied to the Chihuahuan population.

The *collaris*-complex was shown to consist of at least four subspecies: *C. c. auriceps*, *C. c. baileyi*, *C. c. collaris* and the new subspecies, *C. c. fuscus* from the Chihuahuan Desert. *C. c. auriceps*' range was restricted to the area near Moab, Utah, and north of the union of the Green and Colorado rivers. A broad intergrade zone south into the Painted Desert was established between *C. c. auriceps* and *C. c. baileyi*. The range of *C. c. baileyi* was established as central Arizona. Southern and central New Mexico and most of Mexico east of central Sonora were established as the range for *C. c. fuscus*. Further study of the populations presently recognized as *C. c. collaris* was ad-

vised.

While all the populations were separable on the basis of morphology, the best characters for identification were color and pattern. *C. c. auriceps* has a light green body and the yellow of the head extends onto the side of the throat. *C. c. baileyi* has a darker green body with reduced yellow on the head. The area of the throat between the infralabials and the gular patch is always white. *C. c. fuscus* has a brown body and a white to cream head.

Important discoveries were also made in methodology. The necessity for using multivariate statistics in taxonomic studies which investigate more than one character was demonstrated. The use of *a posteriori* probabilities was presented as a new technique for investigation of taxonomic problems involving intergradation.

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Brigham Young University
Science Bulletin

A TAXONOMIC REVISION OF THE WEEVIL GENUS TYCHIUS GERMAR IN AMERICA NORTH OF MEXICO (COLEOPTERA: CURCULIONIDAE)

by
Wayne E. Clark

BIOLOGICAL SERIES — VOLUME XIII, NUMBER 3

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A TAXONOMIC REVISION OF THE WEEVIL GENUS TYCHIUS GERMAR IN AMERICA NORTH OF MEXICO (COLEOPTERA: CURCULIONIDAE)[1]

by

Wayne E. Clark[2]

ABSTRACT

A study of morphological characters of 4,000 adult weevils used in preparing a key and descriptions indicates there are fifteen North American species in the genus *Tychius* Germar. Adults occur on plants in the genera *Astragalus*, *Baptisia*, *Hedysarum*, *Lotus*, *Lupinus*, and *Oxytropis*.

The genus is divided into two species groups. The *T. sordidus* group appears to have representatives in the Old World fauna, but the *T. semisquamosus* group is probably native to North America.

New names, *Tychius caesius*, and *T. hirsutus* are proposed for *T. armatus* Green, 1920 (not Tournier, 1873), and *T. hirtellus* LeConte, 1876 (not Tournier, 1873) respectively. Three species, *T. badius*, *T. montanus*, and *T. phalarus*, are described as new. A neotype is designated for *T. aratus* Say. Lectotypes are designated for *T. tomentosus* (Herbst), 1785, *T. stephensi* Schoenherr, 1836, *T. lineellus* LeConte, 1876, *T. semisquomosus* LeConte, 1876, and *T. hirtellus* LeConte, 1876. The name *Paratychus* Casey, 1910, is newly placed in synonymy with *Tychius* Germar, 1813.

INTRODUCTION

Weevil species assigned to the genus *Tychius* Germar, 1817, have been described from North and South America, Europe, Africa, Asia, and Australia. The majority of approximately 266 species occur in the Mediterranean region (Klima, 1934). Fourteen native and one introduced species are known to occur in North America.

So far as is known, all species of *Tychius* infest the pods of leguminous plants. Several species are of economic importance in the Old World (Muka, 1955). One of these, *T. stephensi* Schoenherr, 1836, has been introduced into North America and is a pest of cultivated clover. The native North American species have been recorded from plant species in the genera *Astragalus*, *Hedysarum*, *Oxytropis*, *Lotus*, *Lupinus* and *Baptisia*. Some *Tychius* species may play a part in the natural control of these plants (Marcovitch, 1916), some of which are poisonous to livestock (Hulbert and Oehme, 1961).

To date the most complete treatments of the genus are the works of LeConte (1876), and Casey (1892, 1910). These papers provide keys and descriptions of some species, but are of limited use in identifying specimens. The objectives of this revision have been to provide accurate descriptions and keys for the identification of new and known species, and to contribute to the knowledge of the biology and phylogeny of the group.

HISTORY

The genus *Tychius* was established by Germar (1817:34), who used the name in association with the previously validated specific names, *quinquepunctatus* L. (cited 5-punctatus), *venustus* Fabricius, and *picirostris* Fabricius. By subsequent designation, Schoenherr (1825:583) designated *Curculio quinquepunctatus* Linnaeus as the type-species. In the same work Schoenherr

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erected *Miccotrogus* as a subgenus of *Tychius*. Later (1826:245-247) he characterized *Tychius* as having seven and the subgenus *Miccotrogus* as having six antennal funicular segments. Stephens (1839:229) elevated *Miccotrogus* to the rank of genus.

Tychius stephensi was described by Schoenherr (1836:412), evidently prior to its introduction into North America. Thomas Say (1831) described *Tychius aratus* and *T. amoenus*. *Tychius amoenus* was transferred to *Pachytychius* Jekel by LeConte (1876:168, 216), and was included in *Smicronyx* Schoenherr by Anderson (1962:264-266). Gyllenhal (1836:414-415) applied the name *Tychius arator* to a specimen received from Thomas Say, identified by Say as *T. aratus*. LeConte (1876:216-218) described as new, *Tychius lineellus*, *T. sordidus*, *T. teetus*, *T. semisquamosus*, *T. hirtellus*, and *T. setosus*.

Casey (1892:411-425) divided the North American species of *Tychius* into four subgenera; I and II possessing seven and III and IV possessing six antennal funicular segments. Subgenus I was characterized as having ". . . the elytral intervals entirely devoid of recurved setae," and subgenus II as having ". . . elytral intervals with recurved semi-erect setae." Subgenus III was defined as ". . . with recurved setae, the entire facies almost as in group II . . . ," and subgenus IV as ". . . the species generaly minute, with or without erect setae. . . ." Subgenus I contained *T. lineellus* LeConte, *T. sordidus* LeConte, *T. tectus* LeConte, and *T. arator* Gyllenhal. Subgenus II contained *T. hirtellus* LeConte, *T. semisquamosus* LeConte, *T. aratus* Say, and two species described as new, *T. soltani* and *T. lamellosus*. In subgenus III Casey placed a single species described as new, *T. proxilus*. Subgenus IV contained *T. setosus* LeConte and six others described as new, *T. variegatus*, *T. simplex*, *T. sibinoides*, *T. mica*, *T. subfasciatus*, and *T. hispidus*. Casey did not recognize *Miccotrogus* in this work because a specimen sent to him by Desbrochers, identified as *M. picirostris*, had seven instead of six antennal funicular segments, and because his own North American species with six funicular segments, *T. proxilus*, agreed closely in other respects with the other species of *Tychius*. I have examined a specimen in the Casey collection identified as *M. picirostris* and found it to be a *Tychius stephensi* Schoenherr. Casey (1897:664-666) described three species which he assigned to subgenus IV; *T. sulcatulus*, *T. inermis*, and *T. transversus*. Another North American worker, Schaeffer (1908:217-219) described *T. griseus*, *T. suturalis*, *T. pallidus*, and *T. albidus*. In a subsequent note (1915:197) he stated that *T. griseus* was a synonym of a species he called *Tychius* (*Miccotrogus*) *picirostris* (Fabricius).

Casey (1910:132-142) established the subgenus *Paratychius* for *T. proxilus* which he had formerly assigned to subgenus III and *T. imbricatus* which he described as new. In the same publication he erected the subgenus *Microtychius* to include the species formerly assigned to subgenus IV, as well as thirteen species described as new; *T. erraticus*, *T. puellus*, *T. atomus*, *T. echinus*, *T. vernilis*, *T. fatuus*, *T. fraterculus*, *T. grypus*, *T. dulcis*, *T. imbellis*, *T. porcatus*, *T. curtipennis* and *T. errans*. He also described nine species belonging to subgenus I, *T. tacitus*, *T. hesperis*, *T. radians*, *T. dilectus*, *T. probus*, *T. texanus*, *T. carolinae*, and *T. languidus*. Five species occurring in the eastern United States, including one described as new, *T. liljebladi*, were treated by Blatchley and Leng (1916:245-247). Leng (1920:321) listed all of the species described by Schaeffer (1908:217-219), except *T. griseus*, under *Microtychius* Casey.

Kissinger (1964:57-58) transferred *Paratychius* and *Microtychius* to the genus *Sibinia* Germar and suggested further study to determine the true relationship of these groups to *Tychius*. I have followed his classification, but I include *Paratychius* in *Tychius* instead of *Sibinia*.

MATERIALS AND METHODS

Most of approximately 4,000 specimens examined in this study were borrowed from collections of institutions in the United States and Canada. I collected about 1,500 specimens.

The following abbreviations are used to indicate the collections in which the specimens examined are deposited: AMNH, American Museum of Natural History, New York; UA, University of Arizona, Tucson; BYU, Brigham Young University, Provo; CAS, California Academy of Sciences, San Francisco; CIS, California Insect Survey, University of California, Berkeley; CNC, Canadian National Collection, Ottawa; CU, Cornell University, Ithaca; FMNH, Field Museum of Natural History, Chicago; INHS, Illinois Natural History Survey, Urbana; ISU,

Iowa State University, Ames; UK, University of Kansas, Lawrence; LA, Los Angeles County Museum, Los Angeles; MCZ, Museum of Comparative Zoology, Harvard University, Cambridge; CWO, collection of Charles W. O'Brien, Texas Tech University, Lubbock; OSC, Ohio State University, Columbus; OSU, Oregon State University, Corvallis; PANS, Academy of Natural Sciences of Philadelphia; TAM, Texas A. & M. University, College Station; USNM, United States National Museum, Washington, D.C.; USU, Utah State University, Logan; WEC, collection of the author.

I have examined the types of all known North American species and their synonyms except the types of some alleged synonyms of *Tychius stephensi* Schoenherr and the type of *T. aratus* Say which is presumably destroyed (LeConte, 1859:vi).

All measurements were made using a calibrated eyepiece reticule with a dissecting microscope at magnifications up to 80 times. Total length and width were measured from the dorsal aspect, length from the dorsal margin of the eyes to the elytral apices, width at the widest point across the elytra. Length of the rostrum was measured from the lateral aspect from the apex to the anteroventral margin of the eye. Length of the pronotum was measured from the lateral aspect from the anterior margin to the base. Other measurements require no further explanation.

Male external genitalia were removed for study. Specimens were taken directly from alcohol, or if previously mounted, soaked in warm water until soft. Holding the specimen between the thumb and forefinger, the abdomen was forced down with a pin exposing the tergum. The tergum was torn with a pin and the pin inserted beneath the median lobe to lift it into view. The structure was then removed with a pair of jeweller's forceps. Genitalia were placed in 10 percent KOH to remove muscle tissues, washed in 90 percent alcohol, then stored with glycerin in polyethylene microvials attached to the pin with the specimen.

Line drawings were made with grid paper and an eyepiece reticule in a dissecting microscope. Genitalia were drawn immersed in glycerin. Definitions of terms used, except those describing genitalia, may be found in Torre-Bueno (1962). Terms used in reference to genitalia are those of Sharp and Muir (1912).

BIOLOGY

Biology of the red clover seed weevil *Tychius stephensi* Schoenherr, has been studied by Muka (1955). According to him larvae feed on developing seeds of red clover while adults feed on reproductive portions of flowers of the same plant. Adults overwinter in soil around the host plants, and emerge in the spring and commence a migration flight. Females oviposit in the florets, laying one egg per floret on the ovary inside the corolla tube. In New York state there are two generations per year on red clover.

Adults of *Tychius lineellus* were observed on *Lupinus leucophyllus* at the mouth of Hobble Creek Canyon, Utah County, Utah, on May 3, before the plants were in bloom. Copulating pairs were seen on florets; females with their rostra piercing the corolla of partially opened flowers. Apparently females feed on pollen grains. This was indicated by examination of gut contents and fecal material which were similar in color and texture to pollen of the Lupines.

Before ovipositing, the female makes a hole in the calyx and deposits one or two eggs on the side of the ovary. Larvae feed on seeds in the developing pods. When the larvae are mature they evidently chew a hole in the side of the pod and drop to the ground to pupate. Although no larvae or pupae were actually found in the soil, holes were observed in the sides of mature pods which showed signs of infestation. Muka (1955) described similar habits in *T. stephensi*. According to Mitchell and Pierce (1911), larvae of *T. sordidus* "emerge" from *Baptisia* pods and pupate in the ground.

On May 19, pods of *Astragalus utahensis* (Torr.) T. and G., the host of *Tychius prolixus*, were collected at Provo, Utah. Several larvae were taken from the pods at that time, and on July 28, four adult weevils were taken from the bag containing the pods. These pods were subsequently dissected and out of 266 pods, 18 showed signs of infestation including several containing dead larvae. White cocoons about 3.5 mm in length were found in two of the pods, and holes about 1.3 mm in diameter were observed in the sides of the pods in the portion covered by the cocoons. This does not provide

conclusive evidence that the weevils normally pupate in pods, since Muka (1953) states that *T. stephensi* can be "forced" to pupate in the pods. On August 1, a few live adults were sifted from soil taken beneath *A. utahensis* indicating that the weevils may overwinter as adults.

INTRASPECIFIC VARIATION

The sexes can be distinguished by differences in the structure of the pygidium. The pygidium of the male in its normal position is nearly perpendicular to the longitudinal axis of the body and is visible for more than half its length beyond the elytral apices. A transverse carina divides it along the line normally attained by the elytral apices. The pygidium of the female in its normal positon is oblique rather than perpendicular to the longitudinal axis, nearly covered by the elytra, and lacks a transverse carina.

The rostrum of the female is usually longer and more slender than that of the male especially in *T. aratus* (Fig. 3), where the rostrum of the female is more than half the length of the body. The antennal insertion is normally more distad and the distal portion less strongly tapered and with deeper pits and rugae in the male. The apical tibial mucrones are smaller in females of most species. Females average about 0.1 mm longer than males.

The average difference in length of native North American species was 32 percent of the length of the smallest specimen. Environmental conditions, especially size and number of seeds and or larvae per pod, probably influence the size attained by individual specimens.

Color of the integument ranges from light piceous to black. The general color of a specimen is imparted to it by the color of the scales. In *T. stephensi* and *T. tectus*, scale color ranges from light gray to tawny in specimens within a given series. Muka (1953) observed that newly emerged specimens of *T. stephensi* were yellowish brown and that with age scale color changed in many specimens to pale gray. Specimens of the *T. semisquamosus* species group often exhibit variation in the color of the round or elongate-oval, nonstrigose scales of the elytra and prothorax. These vary from white to dark reddish brown on each specimen. They are usually darkest on interspaces five through seven. The long, narrow, strigose scales on the pronotum and elytra also vary from very light to dark reddish brown in these species.

Specimens may also exhibit variation in the distribution of certain types of scales. In *T. tectus* and *T. liljebladi*, white, round scales on the elytra may be very dense or sparse. The number and uniformity of the median rows of long, narrow, strigose scales on the elytral interspaces may vary, especially in *T. semisquamosus* and *T. lamellosus*, and to a lesser extent in other members of the *T. semisquamosus* species group.

In some species the rostrum from lateral aspect may vary from evenly and prominently arcuate from the base to the apex, to prominently arcuate in the basal portion, and nearly straight to the apex. In other species one extreme or the other may be consistent.

Geographic variation was noted mainly in the overall size of specimens and in the shape, color, and distribution of scales. Where geographic variation was observed, it is described in greater detail in the discussion following the description of the species involved.

TAXONOMIC CHARACTERS

Color, shape and distribution of scales, shape of the rostrum and structure of the male genitalia, provide good characters for distinguishing species.

Scale color varies from gray as in *T. sordidus* to tawny yellow as in *T. tectus* and a combination of nearly white and reddish brown as in most species of the *T. semisquamosus* species group. The presence or absence of rows of erect or suberect setae on the elytral interspaces is important in separating species groups. Possession or absence of fine erect setae on the abdomen and metathorax is an important character in separating species.

The relative length of the rostrum in comparison with the prothorax varies. From the dorsal aspect, the rostrum may be wide at the base, becoming acuminate towards the apex as in *T. lamellosus*, or narrow basally and widening at the apex as in *T. sordidus*. Sculpture of the portion distad of the antennal insertion may be shallow or deep.

The shape of the apical portion of the median lobe is an important character for separating closely related species. In its simplest form the apex is more or less evenly rounded or with a slight apical prominence as in *T. sordidus* (Fig. 17), *T. caesius* (Fig. 15), *T. liljebladi* (Fig. 13), *T. tectus* (Fig. 12), *T. soltani* (Fig. 11), *T. phalarus* (Fig. 7), and *T. prolixus* (Fig. 6). In *T. lineellus* (Fig. 16), the apical prominence is greatly exaggerated. In *T. badius* (Fig. 5), *T. montanus* (Fig. 18), and *T. hirsutus* (Fig. 14), the apical portion bears prominent lateral apical prominences. Weak lateral apical prominences are present in *T. aratus* (Fig. 4). In *T. semisquamosus* (Fig. 9) and *T. lamellosus* (Fig. 8), the apical portion is asymmetrical. Size and shape of the median apical membraneous area is important in distinguishing between the closely related species *T. liljebladi* (Fig. 13) and *T. tectus* (Fig. 12), and between *T. soltani* (Fig. 11) and *T. phalarus* (Fig. 7). The median struts may be stout in some species as in *T. badius* (Fig. 5), or very slender as in *T. sordidus* (Fig. 17). The terminal clubs on these structures in some species such as *T. tectus* (Fig. 12) may also be important. Structure of the genitalia of *T. stephensi* (Fig. 10) appears unrelated to any of the native North American species.

PHYLOGENY

Since most species of *Tychius* occur in the Old World and have not been studied, a detailed discussion of their phylogeny will not be attempted. Some trends are evident however, among the North American species.

The native North American species are divided into two species groups. These are characterized in the discussion following the description of the genus. The *T. sordidus* species group is probably the most primitive. The palearctic fauna contains species which appear to be closely related to this group. In this group *T. sordidus*, *T. caesius*, and *T. lineellus* are relatively large in size with gray scales. The toothed protibia of *T. lineellus* is unique among North American species but some European species possess a similar tooth. Several characters expressed by *T. liljebladi* and *T. tectus* suggest intermediacy between the two species groups. In addition to the long, narrow, strigose scales, *T. liljebladi* possesses a few scattered, round, white, nonstrigose scales on the elytra. *Tychius tectus* usually possesses definite rows of white, round scales on interspace one, near the humeri, and on the pronotum, giving the insect a striped appearance. The general body form in these two species is also intermediate. The body form in *T. liljebladi* is more like the species of the *T. sordidus* species group, whereas *T. tectus* more closely resembles species of the *T. semisquamosus* species group. These two species occur on *Astragalus* as do species of the *T. semisquamosus* species group. The other members of the *T. sordidus* species group occur on species of the plant genera *Baptisia* and *Lupinus*.

The species of the *T. semisquamosus* species group appear to be more distantly related to the palearctic fauna.

Reduction of the rows of long, narrow scales on the elytral interspaces from multiseriate to uniform, median, uniseriate rows, and the development of erect, hairlike setae on the ventral surfaces appear to be important trends within the *T. semisquamosus* species group. *Tychius semisquamosus* and *T. lamellosus* have multiseriate rows of long, narrow scales on the elytral interspaces but lack erect, hairlike setae on the ventral surfaces. This indicates relationship to the *T. sordidus* species group in which the elytral interspaces are clothed exclusively with long, narrow scales. *Tychius badius* appears to occupy a position intermediate between *T. lamellosus* and *T. soltani*. This species has a reduced number of rows of long, narrow scales on the elytral interspaces and also lacks erect hairlike setae on the ventral surfaces.

Structural variation in the male genitalia does not appear to indicate major trends. The assymmetrical apical portion of the median lobe in *T. semisquamosus* (Fig. 9), and *T. lamellosus* (Fig. 8) is unique among the North American species. The apical and lateral prominences on the median lobes of the genitalia of *T. badius* (Fig. 5), *T. montanus* (Fig. 18), and *T. hirsutus* (Fig. 14), may function as isolating mechanisms.

Possession of uniseriate rows of long, narrow scales on the elytral interspaces, the absence of erect, hairlike setae from the venter, and close resemblance to *T. lamellosus* indicates that *T. proxilus*, for which Casey (1910) erected the subgenus *Paratychius*, arose in North America with the *T. semisquamosus* species group. The difference in number of antennal funicular segments does not appear to warrant giving this taxon generic or subgeneric rank.

Tychius phalarus appears similar to *T. soltani*, but several characters of the rostrum and vestiture suggest that they are not closely related. This species is associated with the plant genus *Lotus* rather than *Astragalus*.

The trend in the *T. semisquamosus* species group toward refinement of the long, narrow scales on the elytral interspaces is culminated in *T. hirsutus*; these scales taking the form of very long, white, hairlike setae.

Tychius aratus is distinct in many features from the other members of the *T. semisquamosus* species group. Its relationship to the group is uncertain.

SYSTEMATIC SECTION

Genus *Tychius* Germar

Tychius Germar, 1817, Magazin der Entomologie (Germar) 2:340 (Type-species, *Curculio quinquepunctatus* Linnaeus, 1758, by subsequent designation, Schoenherr, 1825:583).

Paratychius Casey, 1910, Can. Entomol., 42:135 (Type-species, *Tychius proximus* Casey, by original designation). NEW SYNONYMY.

The genus *Tychius* in North America may have six or seven antennal funicular segments. It is closely allied to *Miccotrogus* Schoenherr, 1825, one species of which, the introduced *M. picirostris* (Fabricius, 1787), occurs in North America. *Tychius* and *Miccotrogus*, in the female, have the elytral apices conjointly rounded concealing the pygidium. Four related genera, *Hychus* Kissinger, 1962, *Paragoges* LeConte, 1876, *Mecynoppyga* Pierce, 1908, and *Sibinia* Germar, 1817, each with six antennal funicular segments, occur in North America. These genera all have the elytral apices separately rounded, leaving the pygidium broadly exposed in both sexes.

Description. Length 2.0-5.3 mm, female usually 0.1-0.2 mm longer than male; integument light reddish brown to black; appendages and rostrum usually lighter in color than body. Vestiture of gray, yellowish or reddish brown and white scales.

Rostrum longer or shorter than prothorax; in dorsal aspect both nearly parallel from base to apex, apex wider than frons between dorsal margin of eyes, or finely tapered from base to apex, frons between dorsal margin of eyes as much as 2.5 times wider than rostrum at tip; usually glabrous or with a few elongate scales distad of antennal insertion, antennal insertion at middle of rostrum in female, in distal third or fourth in male.

Antennae with last funicular segment with [illegible] of alternately long and short scales.

Pronotum as wide or wider than long, sides [illegible] evenly rounded, slightly constricted [illegible] much at base than at apical constriction. Vestiture of long, narrow scales on dorsum, round or elongate-oval; usually lighter colored scales on ventral portion of lateral surface, often with round or elongate-oval scales on dorsum in median and lateral vittae.

Elytra nearly parallel sided in basal two thirds, humeri not prominent; in lateral aspect either broadly rounded or nearly flat in basal half, declivity evenly rounded; striae deep, punctures even, clearly visible, strial setae fine, hairlike or broad. Vestiture of long, narrow scales of uniform size and shape, or round to elongate-oval, usually broadly imbricated scales with median rows of long, narrow scales on each interspace.

Ventral surface with broadly imbricated, usually white, round to elongate-oval scales; suture between sterna two and three strongly produced posterolaterally, reaching or passing suture between sterna three and four (Fig. 3). Sterna three and four about equal to sternum five in length; sternum five usually with deep median fovea.

Front coxae contiguous, femora usually swollen in apical two thirds, usually with strongly developed apical, ventral emargination; often with minute tooth or spine on proximal portion of apical ventral emargination; vestiture of long, narrow and elongate-oval scales, or elongate-oval scales alone.

Tibiae mucronate, mucro on protibia usually larger and stouter; apex of tibia with uniform row of stout, usually light yellowish brown bristles; vestiture of long, narrow, and round or elongate-oval scales, and elongate, very fine, hairlike setae.

Tarsi with pads of very fine white setae on ventral surfaces, dorsal surfaces with long, narrow scales and fine, hairlike setae; claw with basal process about two thirds length of claw.

Male genitalia with median, usually apical, membranous area; apex of median lobe rounded, or asymmetrical, often with apical, lateral prominences; median struts articulating with

ventral-lateral projections of median lobe; tegmen small, Y-shaped (Fig. 12), not forming ring.

Discussion. The native North American species may be divided into two species groups. Species of the *T. sordidus* species group have a simple vestiture in which all scales on the elytra are long, narrow, and strigose, the elytral interspaces lacking discrete rows of setae. The introduced *T. stephensi* is most closely related to this group. The *T. semisquamosus* species group has a complex vestiture in which the elytral interspaces are clothed with round, usually imbricated, light colored, nonstrigose scales, and multiseriate or uniseriate rows of long, narrow setae.

Forms included and host records. A list of the species groups and species of *Tychius* in North America and host plants from which they have been recorded is given below. Synonyms are given in parenthesis following the valid name of each species.

Tychius species	Host Plants
Introduced species	
T. stephensi Schoenherr, 1836	*Melilotus* spp.
	Fragaria spp.
	Crataegus spp.
	Vicia spp.
	Trifolium pratense L.
T. sordidus species group	
T. sordidus LeConte, 1876	*Baptisia leucantha* Torr. & Gray
(*nimius* Casey, 1910)	*B. bracteata* Muhl.
(*texanus* Casey, 1910)	*B. cuneata* Small.
(*carolinae* Casey, 1910)	*B. villosa* (Walt.) Ell.
T. caesius, new name	None Cited
T. linecllus LeConte, 1876	*Lupinus albifrons* Benth.
(*tacitus* Casey, 1910)	*L. ammophilus* Greene
(*hesperis* Casey, 1910)	*L. argenteus* Pursh
(*radians* Casey, 1910)	*L. arborus* Sims.
(*dilectus* Casey, 1910)	*L. bicolor* Lindl.
(*probus* Casey, 1910)	*L. caudatus* Kell.
	L. chamissionis Eseh.
	L. excubitus Jones
	L. leucophyllus Dougl.
	L. sericeus Pursh
T. liljebladi Blatchley, 1916	*Astragalus canadensis* L.
T. teetus LeConte, 1876	*Astragalus adsurgens* Pallas
(*languidus* Casey, 1910)	ssp. *robustior* (Hook.) Welsh
	A. bisulcatus (Hook.) Gray
	var. *heydenianus* (Gray) Barneby
	A. scopulorum T. C. Porter ex Port. & Coult.
	A. tenellus Pursh
	Oxytropis besseyi (Rydb.) Blank
	O. campestris (L.) DC.
	O. lambertii Pursh
	O. sericea Nutt.
	Hedysarum sp.
T. semisquamosus species group	
T. semisquamosus LeConte, 1876	None Cited
T. lamellosus Casey, 1892	*Astragalus beckwithii* T. & G.
	A. drummondii Dougl. ex Hook.
	A. lentiginosus Dougl. ex Hook. var. *palans* (M. E. Jones) M. E. Jones
	A. lonchocarpus Torr.
T. proxilus Casey, 1892	*Astragalus amphioxys* Gray
(*imbricatus* Casey, 1910)	*A. douglasii* Gray
	A. utahensis (Torr.) T. & G.
	A. lentiginosus Dougl. ex Hook.

I	*bidius*, n.sp.	*Astragalus scopulorum* T. C. Porter ex Port. & Coult. *A. bisulcatus* (Hook.) Gray
I	*soltani* Casey, 1892	*Astragalus flavus* Nutt. ex T. & G. var. *flavus* (M. E. Jones) Barneby *A. flexuosus* (Hook.) Dou
I	*montanus*, n.sp.	None Cited
I	*hirsutus*, new name	*Astragalus nuttallianus* A. DC.
I	*phalarus*, n.sp.	*Lotus rigidus* (Benth.) Greene
I	*aratus* Say 1831 (*arator* Gyllenhal, 1836)	*Astragalus crassicarpus* Nutt.

Key to North American species of *Tychius*

1 Elytral interspaces bearing long, narrow, strigose scales of uniform size and shape; round, or oval, white scales, if present, not present on all interspaces; dorsal profile of elytra broadly rounded ..... *sordidus* group 2

1' Each elytral interspace bearing two distinct types of scales; round to elongate-oval, recumbent, usually broadly imbricated, nonstrigose scales and long, narrow, often fine and setiform, strigose scales in uniseriate or multiseriate, median rows; dorsal profile of elytra straight on disc, broadly rounded to apices on declivity ..... *semisquamosus* group 7

2(1) Male with large triangular tooth near middle on ventral margin of protibia; scales generally gray in color, often alternate elytral interspaces with bronze colored scales ..... *lineellus*

2' Male without large triangular tooth near middle on ventral margin of protibia, scales gray or yellow in color, not gray and bronze on alternate elytral interspaces 3

3(2') All femora with small tooth or spine on proximal portion of apical, ventral emargination; pronotum with sides broadly rounded, widest in about middle; all scales gray or yellowish gray in color ..... *caesius*

3' Metafemur often with a small tooth or spine on proximal portion of apical ventral emargination but profemur and mesofemur without tooth; pronotum widest at middle or at base; scales gray or yellow in color 4

4(3') Rostrum from dorsal aspect wider at apex than frons between dorsal margin of eyes; pronotum widest at base; scales yellow; yellowish gray, or gray, often lateral margins of individual scales metallic bronze in color; no round white scales on elytra ..... *sordidus*

4 Rostrum from dorsal aspect narrower at apex than frons between dorsal margin of eyes; pronotum wider in middle than at base; scales yellow, several round, white scales on elytra 5

5(4) Rostrum from lateral aspect prominently swollen at base; acuminate, smooth, with very shallow punctures distad of antennal insertion; round, white scales on elytra sparse, unevenly distributed ..... *liljebladi*

5 Rostrum from lateral aspect not prominently swollen at base; portion distad of antennal insertion not acuminate, punctures and rugae deep; round white scales concentrated on interspaces one and around humeri on interspace eight 6

6(5) Round white scales on elytra limited to interspace one, small, 2.0-2.6 mm in length ..... *stephensi*

6' Round, white scales on elytra on interspaces one and eight, especially dense on humeri, a few scattered scales rarely occur on other interspaces; larger, 2.5-3.8 mm in length ..... *tectus*

7(1') Antennal funiculus seven-segmented 8

7' Antennal funiculus six-segmented ..... prolixus

8(7) Abdominal sterna each bearing a distinct transverse row of erect, hairlike setae; rostrum usually with several round, white, nonstrigose scales on lower portion of sides, or rostrum longer than prothorax 9

8' Abdominal sterna without distinct, transverse rows of erect, hairlike setae; rostrum without round, white, nonstrigose scales on lower portion of sides 13

9(8) Rostrum longer than prothorax, especially in female (Fig. 3); scales unicolorous; length 4.1-4.4 mm ..... *aratus*

9' Rostrum shorter than prothorax; insect with white and dark reddish brown scales; length 2.6-3.9 mm 10

10(9') Rostrum distad of antennal insertion acuminate; white scales on dorsum of prothorax forming broad median vitta from base to apex of pronotum 11

10' Rostrum distad of antennal insertion not acuminate, often slightly expanded in dorsal aspect at extreme apex; white scales on dorsum of pronotum, limited to basal median patch 12

11(10) Long, narrow scales on elytral interspaces fine, hairlike, longer than width of interspace, usually lighter in color than round, nonstrigose scales; rostrum distad of antennal insertion finely acuminate; elongate scales on dorsum of prothorax narrow, integument broadly visible; median lobe of male gentalia with lateral, apical prominences (Fig. 14) ..... *hirsutus*

11' Long narrow scales on elytral interspaces short, stout, shorter than width of interspace, usually darker in color than round, nonstrigose scales; rostrum distad of antennal insertion evenly tapered, not finely acuminate; elongate scales on dorsum of prothorax broad, integument concealed or only slightly visible; median lobe of male genitalia without apical, lateral projections (Fig. 11) ..... *soltani*

12(10') White scales on dorsum of prothorax forming a large median, basal patch (Fig. 2); metathorax and visible abdominal sternum one with fine, erect, hairlike setae; long, narrow, scales on femur darker than nonstrigose oval, white scales; median lobe of male genitalia without lateral, apical projections (Fig. 7) ..... *phalarus*

12' White scales on dorsum of prothorax forming small, median basal patch; metathorax and visible abdominal sternum one lacking fine, hairlike setae; long, narrow scales on femora lighter in color than nonstrigose oval scales; median lobe of male genitalia with weakly developed apical, lateral projections (Fig. 18) ..... *montanus*

13(8') Long, narrow scales on elytral interspaces in nearly uniform uniseriate rows; median lobe of male genitalia with well-developed lateral, apical projections (Fig. 5) ..... *badius*

13' Long, narrow scales on elytral interspaces in confused, multiseriate rows; median lobe of male genitalia with apical portion asymmetrical, lacking apical, lateral projections (Figs. 8, 9) 14

14(13') Round, nonstrigose scales on elytral interspaces dense, imbricated; distal portion of rostrum finely acuminate; length 2.4-3.4 mm ..... *lamellous*

14' Round, nonstrigose scales on elytral interspaces sparse, rarely imbricated; distal portion of rostrum not finely acuminate; length 2.3-2.7 mm ..... *semisquamosus*

Tychius stephensi Schoenherr

(Figs. 10, 20)

Curculio picirostris Fabricius, 1787, Mantisa insectorum; 1:101 (Holotype, "Hafniae Dom. Lund." Copenhagen Museum, Fabricius collection); Paykull, 1792, Monographia curculionum Succiae, p. 63.

Curculio fuscirostris Paykull, 1792, Monographia curculionum Succiae, p. 62 (see discussion for information on the "type").

Curculio tomentosus Herbst (not Olivier, 1790), *In*: Jablonsky, 1795, Natursystem aller bekannten in und ausländischen insecten . . . . kaefer, 6:278, Tab. 81, Fig. 7 (Lectotype here designated: female, "Deutschland", Zoologisches Museum, Berlin, 54577).

Rhynchaenus picirostris: Gyllenhal, 1813, Insecta Succica . . . . , 1(3):121.

Tychius picirostris: Germar, 1817, Magazin der Entomologie (Germar), 2:340.

Tychius tomentosus: Stephens, 1829, Systematic catalogue of British insects. . . . , p. 160.

Tychius stephensi Schoenherr, 1836, Genera et species curculionidum . . . 3:412 (Lectotype here designated: Female, "Anglia." British Museum Natur. Hist., J. F. Stephens collection).

Tychius stephensi: Stephens, 1839, A manual of British coleoptera, or beetles. . . . , p. 229 (Emendation of *stephensi* Schoenherr).

Miccotrogus picirostris: Casey, 1892, J. New York Entomol. Soc., 6:411-412.

Tychius brevicollis Rey, 1895, Echange, 11:3 (types not seen, synonymy from Klima, 1934:25).

Tychius clavipes Rey, 1895, Echange, 11:3 (types not seen, synonymy from Klima, 1934:26).

Tychius mixtus Rey, Echange, 11:4 (types not seen, synonymy from Klima, 1934: 26).

Tychius griseus Schaeffer, 1908, J. New York Entomol. Soc. 16:217-218 (Holotype: male, Ithaca, New York, USNM, type 42484).

This is the red clover seed weevil of North American economic literature. It was probably introduced into North America from Europe. It closely resembles *T. tectus* and *T. liljebladi* in several characters but differs by its smaller size, by the structure of the male genitalia (Fig. 10), and by its host preferences. It also closely resembles *Miccotrogus picirostris* (Fabricius) but can easily be distinguished by the seven- rather than six-segmented antennal funiculus and other characters enumerated by Milliron (1949). Muka (1955) studied the biology of *T. stephensi* and, Takenouchi (1965) described the chromosomes of *T. stephensi* and *M. picirostris*.

Description. *Male*: Length 2.0-2.5 mm, width 0.9-1.2 mm, integument black to dark reddish brown, appendages light reddish brown. Vestiture on appendages, thorax and elytra of long, narrow, light yellowish brown scales, ventral surface with white scales.

Rostrum shorter than prothorax, moderately, evenly arcuate, slightly tapered to apex. Frons slightly wider between dorsal margin of eyes than rostrum at apex. Integument distad of antennal insertion smooth and shining, rugae very deep, especially laterally; glabrous except for sparse fine setae on extreme tip. Scales proximad of antennal insertion of uniform size, shape and color, parallel sided, truncate to rounded at apices.

Antennal funicle seven-segmented, pedicel longer than next three segments combined.

Prothorax 1.2 times wider than long, sides broadly, evenly rounded, slightly constricted at apex, less than two times as broad at base than at anterior margin. Scales on dorsum of uniform size, shape, and color, long, narrow, rounded at apices; scales on lateral surface round to elongate-oval; long, narrow scales of dorsum ending abruptly about one-fourth of the way down sides, not intermingled with round or elongate-oval scales on sides.

Elytra with sides broadly rounded; dorsal profile broadly rounded, not flat in basal third. Scales on dorsum slightly broader than those on dorsum of prothorax. Interspace one usually with distinct row of round, white, nonstrigose scales extending entire length; round, nonstrigose scales absent from other interspaces. Strial setae narrow, light colored on dorsum, broader and darker in color laterally.

Ventral surface with dense, slightly imbricated, round to oval, white scales, often with plumose margins; elongate, hairlike setae absent. Sternum five lacking median fovea.

Femora with ventral apical, emargination weakly developed, no minute tooth on proximal portion of emargination. Scales of uniform size and shape, similar to scales on elytra and prothorax. Tibiae mucronate, mucro on protibia largest; vestiture of long, narrow scales and fine hairlike setae, no round, nonstrigose scales.

Male genitalia (Fig. 10), with median lobe stout, strongly curved in lateral aspect, median dorsal membranous area large, extending nearly to proximal portion of median lobe, with row of sclerotic inclusions on each side; median struts stout, finely tapered.

Female: length 2.0-2.6 mm. Rostrum more finely tapered, antennal insertion slightly distad of middle.

Hosts. Recorded by Muka (1955): In Europe from *Melilotus*, *Fragaria*, *Crataegus*, and *Vicia*, and red clover, *Trifolium pratense*; in North America from *Trifolium pratense*.

Distribution. (Fig. 20).

Alberta: Edmonton, V-14-21, H. W. Wenzel, 1 male, 2 females (OSC).

Arizona: Globe, III, D. K. Duncan, 1 male, 2 females (CU).

British Columbia: Chilliwack, VI-15-53, G. J. Spencer, 1 female (CNC).

Colorado: Bellvue, 13 mi. W., Buckhorn Mts., 8500', VI-22-66, S. G. Wellso, 1 male (TAM).

Connecticut: Canaan, VI-12-28, L. B. Woodruff, 2 males, 2 females (AMNH); Cornwall, IV, V, VI, VII-28, 29, 8, 15, 6, 10, 11-20, 21, 22, 24, Chamberlain, 4 males, 3 females (CU), 3 males, 2 females (CAS), 1 male (USNM); Littlefield, V-30-13, L. B. Woodruff, 1 male (AMNH); New Haven, V-23-19, Chamberlain, 1 male, 1 female (CU); Westport, V-28-31, L. Lacey, 1 female (BYU).

Illinois: Hebron, VII-29-52, C. E. White, red clover, 1 male (INHS); Lombard, VII-29-52, C. E. White, mixed red clover, alfalfa, ragweed, 1 male (INHS); Plainfield, VII-30-52, C. E. White, red clover, 1 female (INHS); Yorkville, VII-30-52, C. E. White, red clover, 1 female (INHS).

Indiana: Decatur, F. W. Poos, red and white clover, 3 males, 1 female (USNM).

Maine: Cumberland Co., VI, VII-1, 26-16, A. Nicolay, 3 males (BYU); Bridgton, VIII-20-34, M. E. Griffith, 1 female (UK); Lincoln Co., VIII-20-40, D. J. Borror, 1 female (OSC); Medomak, VII-4-38, 1 male (OSC); Millinocket, VII-27-30, C. G. Siepmann, 3 males, 3 females (OSU); Orono, VIII-19-18, H. Osborn, 1 female (OSC); Weld, VII-2-51, A. Stone, 1 female (USNM).

Maryland: Montgomery Co., Great Falls, VI-25-63, D. C and K. A. Rentz, 1 male (CAS); Raspeburg, IV-14-43, Schaeffer, red clover, 5 males, 2 females, (USNM).

Massachusetts: 1 male (BYU); Ashland, VI-18-51, C. A. Frost, 1 male, 1 female (ISU); Fall River, VI-1, 20-19, 34, N. S. Easton, 3 males, 3 females (MCZ); Harwichport, VIII-33, L. Lacey, 1 male, 2 females (BYU); Hopkinton, VI-1-13, 1 male, 1 female (BYU); Marblehead, VIII-26-30, H. Dietrich, 1 female (CU); Salisbury, VI-11-28, H. Dietrich, 1 male, 2 females (CU); Sherborn, VI-6-25, C. A. Frost, 1 male, 1 female (BYU); Sherborn, VI-1, C. A. Frost, 2 females (PANS); Wilmington, VI-26-20, C. C. Speery, 1 female (USNM); Woods Hole, VII-11-19, L. L. Buchanan, 1 female (CU).

Michigan: Sheboygan, VII-14-41, H. B. Hungerford, 1 male (UK); Sheboygan, VII-1-42, E. L. Todd, 1 male (UK); Sheboygan, VII-2-51, D. M. Anderson, 1 female (CIS); VII, 23, 27, 29-51, E. P. Marks, 23 males, 22 females (CIS); Ingram Co., VII-23-47, 1 male (USNM); Missaukee Co., VII-14-45, R. R. Dreisbach, 1 female (UA).

Minnesota: St. Paul, VI-19-48, H. E. Milliron, red clover, 1 male (USNM).

New Brunswick: Halcomb, VIII-9, 11, 14-51 E. E. Gilbert, 2 males, 4 females (CIS).

New Hampshire: Mt. Washington, VII-6-14, C. A. Frost, 1 male (INHS); Peabody River, White Mts., VII-11-25, A. Nicolay, 1 male (USNM); VII-11-25, E. D. Quirsfeld, 2 males, 3 females (UA); Valley Meadow, White Mts., VII-11-25, F. R. Mason, 900', 2 males, 2 females (PANS).

New Jersey: Haddon Hts., IV-29-35 L. J. Bottimer, 2 males, 2 females (CNC); Irvington, A. Bischoff, 1 male (USNM), 1 male (AMNH); Montclair, E. D. Quirsfeld, 2 males, 1 female (CAS), Bischoff, 1 female (AMNH); Palisades, VI-22-39, Malkin, 1 male, 2 females (FMNH); Phillosburgh, V, VI-12, 20-17, 31, J. W. Green, 1 male, 1 female (CAS).

Nova Scotia: Digby Co., VI-27-58, C. V. Reichart, 1 male (OSC); Sidney Mines, VI-19-65, W. J. Brown, 1 male, 1 female (CNC).

New York: Austerlitz, VI-25-34, H. Dietrich, 1 male (CU); Bear Lk., VI-2-40, 3 females (FMNH); Bridgeport, V-20-14, 8 males, 7 females (USNM); Canton, VI-19-25, Bably, 1 female (CU); Crosby Landing, VI-26-14, L. Keuke, 1 male (CU); Croton Falls, IV-26-40, 1 male, 2 females (FMNH); Crown Pt., VI-26-34, H. Dietrich, 1 female (CU); Greenport, VII, VIII-63, R. Latham, 1 female (CU); Hancock, VI-18-34, H. Dietrich, 1 female (CU); Ithaca, VII-8-07, 1 male (FMNH), V, VI-18, 2-14, 15, 2 males, 1 female (AMNH), VI-2-15, 5 males, 5 females (BYU), V-30-14, 1 male (USNM); III, IX-14-20, 6 males, 8 females (CU), V, VII-3, 24-17, 19, H. Dietrich, 2 females (OSU), 1 female (CU), VIII-31-15, C. W. Leng, 2 females (BYU); Renwich, VI-2-19, 1 male, 1 female (CU); H. Morrison, VI-1-13, 1 female (TAM); Courtland Co., Labrador Lake, VI-4-38, J. C. Bradley, 1 male, 1 female (CU); Cape Hopafrieng, VI-9-40, 3 females (FMNH); Lancaster, VII-25-46, L. D. Beamer, 1 male (UK). McLean, VII-2, 3-04, 1 male (CU); Tompkins Co., McLean Bogs, V-30-19, H. Dietrich, 1 female (CU); Minetto, VI, VIII-1-52, A. A. Muka, 36 males, 41 females (CU); 6 males, 20 females (OSU); VIII-52, 1 female (USNM); Oliverea, VI-18-34, H. Dietrich, 2 males, 4 females (CU); Oswego, VII-2, 16, 19-1896, 4 males, 5 females (CU); Paulsmith, VI-19-25, Bably, 2 males (CU); Pelham, VI-7, 2-30, 34, Lacey, 1 male, 2 females (BYU); Penn Yen, VII-12-25, Bably, 1 female (CU); Perry, VII-31-19, 1 male, 1 female (CU); Clinton Co., Peru, VI-10-16, 3 females (CU); Peterburg, VI-25-34, H. Dietrich, 1 female (CU); Phoenicia, VI-30-35, J. W. Green, 1 female (CAS); Port Jarvis, VI-6-56, M. Playter, alfalfa, 1 female (CU); Pulaski, VI-20-25, Bably, 2 females (CU); Rochester, V-14, M. D. Leonard, 1 female (LA); 2 males, 2 females (CU); Salem, VI-26-34, H. Dietrich, 2 females (CU); Slaterville, V-27-38, J. C. Bradley, 1 female (CU); Sonyea, VI-22, 1 male (CU); Cayuga Co., Springlake, VII-23-18, 1 male (CU); Stoney Island, VII-8-96, 2 females (CU); Staatsburg, VI-23-34, H. Dietrich, 2 males, 1 female (CU); Ticonderoga, VII-3, F. R. Mason, 1 male (PANS); Tuxedo, V-26-40, 1 female (FMNH); Van Cortland Park, V, VI-9, 23, 26-39, 2 males, 3 females (FMNH); West Point, VI-3-12, W. Robinson, 1 female (CU).

OHIO: Adams Co., VIII-20-67, R. and L. Hamilton, 1 female (OSC); Clinton Co., VI-10-61, F. J. Moore, 2 males, 2 females (OSC); Columbus, VI-8-64, Hamilton and Black, 2 females (OSC); Wayne Co., Daes, V-3-60, alfalfa and clover, 1 male (OSC); Delaware Co., IV, V, VII, VIII-13, 2, 30, 4, 9, 56, 65, 66, 67, 68, R. and L. Hamilton, 6 males, 9 females (OSC), VII-4-66, E. Sims, 1 male (OSC); Franklin Co., V-10-67, R and L. Hamilton, 1 female (OSC); Greene Co., VI-2-59, D. J. and J. N. Knull, 1 male (OSC); Highland Co., V, VI-2, 18, 3-61, 67, 68, R. and L. Hamilton, 3 males, 1 female (OSC); Hocking Co., V-30-64, Hamilton and Black, 1 female (OSC); V-4-68, R. and L. Hamilton, beaten from *Prunus virginiana*, 1 male, 1 female (OSC); V-2-57, D. J. and J. N. Knull, 1 male (OSC); Clear Fork Valley, VI-5-66, R. and L. Hamilton, 1 male (OSC); Licking Co., VII-30-47, Ladino red clover, 5 males, 3 females (OSU); Pike Co., V-12-63, R. E. White, 4

mdale, 1 female (OSC), Strongsville, VI-30-20, W. H. Lorimer, 1 male, 1 female (USNM); Vinton Co., IV-15-67, R. and L. Hamilton, 1 female (OSC); Wood Co., VII-30-47, red clover, 2 males (OSU); Madison Co., V-27-67, R. and L. Hamilton, 1 male, 1 female (OSC).

Ontario: Prince Edward Co., V-11-23-20, 21, Brimley, 4 females (UK), 1 male 9 females (CAS); Ottawa, V-20-50, H. F. Howden, 1 male, 1 female (CNC); VI-18-16, 1 male 1 female (CU); Rideau Lk., VII-17, F. R. Mason, 1 male (PANS).

Pennsylvania: Downington, VII-4-35, L. J. Bottimer, 1 male (CNC), Duncannon, V-8-40, F. W. Poos, 1 female (USU); Easton, VI-VII-3, 4-30, 26, J. W. Green, 2 females (CAS); Effort, VI-6-31, J. W. Green, 1 female (CAS), Greentown, VI-16-20, D. E. Quirsfeld, 1 male, 6 females (UA), Hummelstown, V-20-25, J. N. Knull, 1 male (PANS), New Hope, V-30-35, L. J. Bottimer, 3 males, 1 female (CNC); Nottingham, V-10-36, L. J. Bottimer, 1 male (CNC); Milford Pike Co., V, VI-30, 1-41, B. Malkin, 3 females (FMNH); North East, VI-11-17, R. H. Cushman, red clover, 1 female (USNM); Snyder Co. IX-4-11, J. O. Pepper, clover seed heads, 2 females (USNM); Spring Bridge, V-26-45, 1 male (USNM), Wilawana, VI-12-39, R. H. Crandall, clover, 2 females (UA); Wind Gap, V, VI-28, 18-31, J. W. Green, 7 males, 4 females (CAS).

Quebec: Aylmer, V-31-28, W. J. Brown, 1 male, 1 female (UK), VI-19-36, G. Stacesmith, 3 males, 5 females (CAS), Chelsea, VI-20, 25-16, 1 male, 1 female (CU); Covey Hill, VI-27-24, C. E. Petch, 1 male (CNC); Deparquet, V-27-44, G. Stacesmith, 1 male, 1 female (CAS); Gaspe, 25 mi. W., VI-22-54, W. J. Brown, 1 male (CNC); Georgesville, VI-23, 36, G. S. Walley 1 female (CNC); Hull, VI-19, 23-16, 1 female (CU), V-31-54 W. J. Brown, 2 males (UK); 1 male, 3 females (AMNH); Megantic, VII-6, 7-16, 1 female (CU); Laurentian Mts., Montfort, VI-30-16, 1 female (CU); Montreal, V-31-19, E. S. Ross, 1 male (AMNH); Perkins' Mills, VI-23-36, G. Stacesmith, 1 male, 1 female (CAS); Sherbrooke, VII-5-16, 1 male (CU); Ste. Anne's, VI-12-15, Webster, 1 male (USNM); St. Lambert, VII-4-27, W. J. Brown, 1 female (CNC).

Rhode Island: VI-7-51, red clover, 2 males (USNM); Arawan Cliffs, VII-3-50, C. V. Reichart, 1 male (OSC).

Vermont: Chelsea, VI-16, H. E. Smith, 1 male (USNM).

Virginia: Arlington, IV-9-37, F. F. Dicke, 1 male (USNM), 1 female (OSC).

Washington: Bellingham, VI-4-45 M. J. Forsell, red clover, 1 female (USNM), 3 mi. N., III-3-60, G. G. Scudder, 2 females (OSU).

Wisconsin: Racine Co., Dover, VII-10-66, alfalfa, 1 male (USNM), Walworth Co., Geneva, VIII-4-66, alfalfa, 1 female (USNM); Green Co., Jefferson, VIII-4-66, alfalfa, 1 female (USNM); Kanosha Co., Randall, VII-7-66 alfalfa, 1 female (USNM).

Total specimens examined, 547

Discussion. The nomenclature of two closely related weevil pests of cultivated clover was the subject of a paper by Milliron (1949). He determined that one of the species which possesses seven antennal funicular segments belongs to the genus *Tychius*. The correct name of this species was determined to be *T. stephensi* Schoenherr. He stated that the other species which possesses six antennal funicular segments belongs to the genus *Miccotrogus*. The correct name for this species was determined to be *M. picirostris* (Fabricius). Since then these names have been in use for the two weevils in the literature of North American economic entomology.

Milliron's determination of the nomenclature of these species was made without recourse to the type specimens. During the course of this revision I have examined the types and other material which relate to this problem. These were borrowed from the European museums in which they are preserved. The identity of other type specimens has been ascertained through correspondence with Dr. R. T. Thompson of the British Museum (Natural History) and Per Inga Persson of the Stockholm Museum of Natural History. Examination of this material has revealed that the current application of the two names in question is incorrect.

For convenience of discussion the synonymy revealed by reference to the types is listed below. The names listed under *Tychius* conform to the current concept of *T. stephensi* Schoenherr. Those listed under *Miccotrogus* conform to the current concept of *M. picirostris* (Fabricius).

Tychius

Curculio picirostris Fabricius, 1787
Curculio fuscirostris Paykull, 1792?
Curculio tomentosus Herbst, 1795
Tychius stephensi Schoenherr, 1836
Tychius griseus Schaeffer, 1908

Miccotrogus

Curculio cinerascens Marsham, 1802
Tychius posticus Gyllenhal, 1836

Dr. Thompson reported that specimens of *T. stephensi* from the British Museum (Natural History) and the type of *Curculio picirostris* Fabricius in the Copenhagen Museum were compared by Dr. B. D. Valentine at Dr. Thompson's request and determined to be conspecific.

According to Persson there are no specimens in the Paykull collection at the Stockholm Museum of *C. fuscirostris* Paykull. Paykull (1800) lists *fuscirostris* under *C. picirostris*. Apparently Paykull thought that the name was incorrectly applied and either removed the specimen or specimens from his collection or placed them with his specimens of *C. picirostris*. I have examined a series of five specimens labeled *C. picirostris* from the Paykull collection. These all conform to the current concept of *T. stephensi*. I can find no evidence for linking *fuscirostris*

with *Miccotrogus* under which it is listed by Klima (1934).

The lectotype designated above for *T. tomentosus* Herbst is a female, the first specimen of a series of eight syntypes received from the Zoologische Museum der Humboldt-Universität, Berlin. This specimen and the second, third, fifth, seventh, and eighth conform to the current concept of *T. stephensi* Schoenherr. The fourth is a *Tychius* which is unfamiliar to me and the sixth conforms to the current concept of *M. picirostris* (Fabricius). The name *tomentosus* is in current use in Europe for the *Tychius* species but Milliron (1949) rejected it because it is a junior homonym of *Curculio tomentosus* Olivier, 1790.

Schoenherr (1836) gave the name *T. stepheni* to the species described by Stephens (1831) as *T. tomentosus*. Schoenherr apparently considered it to be a new species only on the basis of Stephens' description and had no specimens in his collection. According to Thompson there are nine specimens identified as *T. tomentosus* in the Stephens' collection. The first of these which I have examined bears the label by the late Sir Guy Marshall: "Type of *T. stephensi* Schönh. (em)' 1836." I have designated this specimen as lectotype of *T. stephensi*. According to Thompson all of the series agree with the current concept of *T. stephensi* except the fifth, which is an *Elleschus bipunctatus* (L.), and the sixth, which agrees with the current concept of *M. picirostris* (Fabr.).

Schoenherr's original spelling of the name was *stepheni*. This does not qualify as a *lapsus calamus* as it is also spelled *stepheni* in the index to his 1836 work. Stephens (1839) was the first to use the spelling *stephensi* which is in current use today.

I also examined the type of *T. griseus* Schaeffer at the U.S. National Museum. There is no question on its synonymy with *T. stephensi*.

The only types which were found to agree with the current concept of *Miccotrogus picirostris* were those of *Curculio cinerascens* Marsham and *Tychius posticus* Gyllenhal. The identity of *cinerascens* was confirmed by Thompson who states that its type is in the Stephens collection. I examined the type of *T. posticus* from the Stockholm Museum.

Thompson also checked the type of *C. villosus* Marsham which Klima (1931) lists in synonymy with *T. tomentosus*. The type is in the Kirby collection and is a *Sibinia potentillae* Germar, under which species it is also listed by Klima.

The early workers knew the identity of Fabricius' *C. picirostris*. I have examined the specimens described by Paykull (1792:253) as *C. picirostris* Fabr. These conform to the current concept of *T. stephensi* Schoenherr. Gyllenhal (1813:121) considered his *Rhynchaenus picirostris* to be the same as *R. picirostris* Fabr. 1801, Paykull's *C. picirostris*, and *C. tomentosus* Herbst. Germar (1817:340) cited *tomentosus* Herbst in synonymy with *picirostris*. Stephens (1829:160) listed Paykulls *picirostris* as synonymous with *R. picirostris* Gyllenhal and later (1839:228) listed *tomentosus* Herbst, *T. stephensi* Schoenherr, and Paykull's *picirostris* as synonyms.

The association of Fabricius' *picirostris* with the name *Miccotrogus* came about as the result of a mistake made by Schoenherr. Germar apparently did not consider *C. picirostris* Fabr. 1787 to be the same as *R. picirostris* Fabr. 1801. He (1824:291) associated *R. picirostris* with the generic name *Sibinia* and listed *R. picirostris* "var. b" Gyllenhal in synonymy. The following year Schoenherr (1825:583) listed Gyllenhal's *picirostris* under *Tychius* and under his newly established subgenus *Miccotrogus* listed *Sibinia picirostris* Germar and *R. picirostris* "var. Gyll" (presumably referring to the "var. b") thus associating the specific name *picirostris* with *Miccotrogus* for the first time. Schoenherr (1836: 111) then correctly associated Paykull's *picirostris* with Gyllenhal's *picirostris* "var. a" and then listed Gyllenhal's *picirostris* "var. b," which he considered to belong to *Miccotrogus*, in synonymy with *C. picirostris* Fabricius. Later workers and catalogers copied Schoenherr's error thus establishing the usage of Fabricius' *C. picirostris* for the *Miccotrogus* species instead of the *Tychius* species to which its type belongs.

Apparently Fabricius' *Cursulio picirostris* and his *Rhynchaenus picirostris* are not the same species. Dr. Thompson reports that Dr. Valentine saw a specimen in the Fabricius collection, labeled *Rhynchaenus picirostris*. He noted that this specimen was a tychiinine, but "much larger than *T. stephensi*."

I have examined Gyllenhal's specimens of *R. picirostris* including the "var. b" from the Gyllenhal collection at Uppsala, Sweden. There are 46 specimens of "var. a," all of which conform to the current concept of *T. stephensi*. Of the series of ten specimens designated as *R. picirostris* "var. b" nine are *T. stephensi*. Only one conforms to the current concept of *M. picirostris* (Fabr.).

According to the synonymy revealed in this study the name *picirostris* Fabricius should replace *stephensi* Schoenherr for the *Tychius* species described above. The name *cinerascens* should replace *picirostris* for the *Miccotrogus*

species. I have decided to retain the current usage of the names in question, however, since I do not consider that the changes indicated would be in the interest of stability of nomenclature. I intend to appeal to the International Commission on Zoological Nomenclature to use its plenary powers to such extent as may be necessary to provide a valid basis for the continued use of the names *Tychius stephensi* Schoenherr, 1836, and *Miccotrogus picirostris* (Fabricius, 1787) as they are currently applied.

Tychius sordidus LeConte

(Figs. 17, 20)

Tychius sordidus LeConte, 1876, Proc. Amer. Philos. Soc., 15:217 (Holotype: male, Illinois, MCZ type 5232); Casey, 1892, Ann. New York Acad. Sci., 6:414; Sanderson, 1904, Tex. Agr. Exp. Sta. Bull., 74:3-13; Hunter and Hinds, 1904, USDA Bur. Entomol. Bull., 51; Mitchell and Pierce, 1911, Proc. Entomol. Soc. Wash., 13:45-62; Pierce, 1907, Entomol. News, 18: 362; Pierce, 1907, Stud. Zool. Lab. Univer. Nebr., p. 273; Casey, 1910, Can. Entomol. 42:134-135; Pierce, 1912, USDA Bur. Entomol. Bull., 100:77; Blatchley and Leng, 1916, Rhynchopora or weevils of northeastern America, p. 245; Frost, 1945, J. New York Entomol. Soc., 53:221.

Tychius nimius Casey, 1910, Can. Entomol., 42:134 (Holotype: male, Iowa, USNM 36731, T. L. Casey collection).

Tychius texanus Casey, 1910, Can. Entomol., 42:134 (Holotype: female, Haw Creek, Texas USNM 36732, T. L. Casey collection).

Tychius carolinae Casey, 1910, Can. Entomol. 42:134-135 (Holotype: female, Southern Pines, North Carolina, IX, A. B. Mance, USNM 36750, T. L. Casey collection).

Tychius sordidus carolinae, Blatchley and Leng, 1916, Rhynchophora or weevils of northeastern America, p. 245-246.

Miccotrogus sordidus: Klima, 1934, *Coleopterorum Catalogus*, 29(138):32.

This is the largest North American species. It can be distinguished from other North American species by its size, its gray or yellowish gray color, its obese shape, and the shape of the pronotum which is wider at the base than at the apex. It closely resembles *T. caesius* and *T. lineellus*. From the former it can be distinguished by the broad prothorax and the absence of a minute tooth on the pro- and mesofemora; from the latter by the absence of a triangular median tooth on the protibia and the absence of the apical projection of the median lobe of the male genitalia (Fig. 17).

Notes on the biology of this species are given by Sanderson (1904), Pierce (1907a, 1907b, 1912), Mitchell and Pierce (1911), Blatchley and Leng (1916), and Frost (1945).

Description. Male: length 3.0-4.9 mm, 1.8 times longer than wide; integument shining black on dorsum often piceous to black on ventral surface; appendages dark reddish brown. Vestiture of gray to yellowish gray scales often with metalic bronze margins.

Rostrum shorter than prothorax; from lateral aspect nearly straight to antennal insertion then tapered slightly to apex; in dorsal aspect wider at apex than frons between eyes; dorsoventrally flattened distad of antennal insertion, without dorsal depression between scrobal apices, rugae deep. Vestiture sparse, composed of long, narrow, apically truncate scales; apical portion glabrous except for row of bristles extending nearly to apex from beneath apical portion of scrobe distad of antennal insertion.

Antennal funiculus seven segmented, pedicel longer than next two segments combined.

Prothorax 1.2 times wider than long, widest at base, base more than twice as wide as apex from dorsal aspect. Scales on dorsum of uniform size, shape and color, long, narrow with rounded apices, broader than scales on elytra; scales on lower half of sides round to elongate-oval.

Elytra with sides broadly rounded, widest just before middle; strongly convex in dorsal profile. Scales on dorsum of same shape and color as those on pronotum; usually denser on interspace one but scales of other interspaces of similar size and density. Strial scales slightly, if at all, narrower than scales on interspaces. Interspaces nine and ten with rounded scales similar to those on venter.

Ventral surface clothed with dense, imbricated, round to elongate-oval, white or light gray scales.

Femora stout, especially apically; ventral, apical emargination prominent, usually with small tooth on posterior portion of emargination. Scales of two distinct types, long, narrow, strigose scales and broad scales with rounded sides.

Tibiae mucronate, mucrones on protibia slightly larger than on mesotibia and metatibia. Vestiture of long, narrow, strigose scales, and very fine hairlike setae.

Tarsi with long, narrow scales and fine hairlike setae on dorsal surface. Claws long, divergent, basal processes convergent.

Male genitalia (Fig. 17) with apical portion of median lobe slightly angulate; apical, dorsal, median membranous area nearly round, strongly

defined posteriorly; median struts very fine, not clavate.

Female: length 3.7-5.3 mm, rostrum slightly longer and more slender, especially distad of antennal insertion, antennal insertion median.

Hosts. *Baptisia leucantha*, and *B. bracteata* (Blatchley and Leng, 1916:245; Pierce, 1907-a: 273; Pierce, 1907-b:362; Frost, 1945:221), *B. cuneata* (Mitchell and Pierce, 1911:61-62); *B. villosa*. Also recorded from *Acerates* and *Croton*.

Distriution. (Fig. 20)

Arkansas: 1 male (USNM); "southwestern," Palm, 2 males, 1 female (AMNH).

Illinois: 2 males (USNM); F. Blanchard, 2 females (MCZ); Liebeck, 1 male (MCZ); Pana, VII-20-38, J. H. Bigger, *Acerates*, 7 males, 5 females (INHS); "southern," 1 male (PANS); F. C. Bowditch, 1 male, 1 female (MCZ).

Iowa: W. G. Dietz, 3 males (MCZ); Horn, 1 male, 1 female (PANS); Burlington, Liebeck, 2 males, 1 female (MCZ); Ft. Madison, 2 males (UK).

Kansas: 2 males, 3 females (PANS); Douglas Co., F. H. Snow, 1 female (UK); Kansas Co., Liebeck, 1 male, 2 females (MCZ); Chautauqua Co., Niotazi, 2 mi. E., VI-3-68, D. R. Harris, 3 males, 1 female (WEC); Onaga, V-20-01, F. C. Bowditch, 1 female (MCZ), VI-27-03, Crevacoeur, 1 male, 1 female (UK), 1 female (USNM); Jefferson Co., 8 mi. N. Lawrence, VII-8-65, J. B. Karen, 1 male (CWO).

Louisiana: Logansport, (Pierce, 1907-a:273; 1907-b: 362), Natchitoches, III-28-07, Cushman and Pierce, *Baptisia leucantha*, 6 males, 9 females (USNM); Natchitoches, III-28-07, Pierce, *Baptista villosa*, 1 male, 1 female (USNM).

Michigan: Adrian, Liebeck, 1 male, 1 female (MCZ).

New Jersey: Cape May Co., Woodbine, 1 mi. E., VI-21-66, D. G. Kissinger, *Baptisia*, 5 males, 2 females (WEC).

New York: Bellport, Long Island, VII-18-14, A. Nicolay, 2 males (BYU).

North Carolina: Southern Pines (Blatchley and Leng, 1916:246).

Oklahoma: Okfuskee Co., VI-31-34, Hinton, 1 male (BYU); Stillwater, V-3-31, H. Whitaker, 2 males, 3 females (BYU).

Texas: 2 males (INHS); F. H. Chittenden, 2 males, 2 females (USNM); Horn, 1 female (PANS); Liebeck, 2 males (MCZ); Brazos Co., College Sta., III-18-64, J. C. Schaffner, 9 males, 6 females (TAM), IV-3, 11-70, on *Baptisia*, 62 males, 45 females, W. E. Clark (WEC). IV-27-50, H. J. Reinhard, 1 male (TAM); Colorado Co., IV-7-22, G. Wiley, 1 male (UK); Eagle Lake, IV-12-1899, A. M. Wangh, 1 male (USNM); Edna, III-24-07, J. D. Mitchell, 1 male, 3 females (USNM); Anderson Co., Elkhart, 10 mi. S., III-27-67, H. R. Burke, 3 females (TAM); Grand Saline, III-25-04, W. D. Hunter, 1 female (USNM); Houston, IV-1-04, G. W. Curtis, 1 female (USNM); Jackson Co., III-25-07, J. D. Mitchell, 1 male (USNM); Keechi IV-4-22, 1 male (TAM); Kirbyville, III-20-08, E. S. Tucker, *Croton* and *Baptisia*, 6 males, 7 females (USNM); Leon Co., IV-10-48, J. L. Ward, 1 male (USNM); Maud, IV-29-41, D. J. and J. N. Knull, 2 males (OSC); Panola Co., IV-15-05, J. Johnson, *Baptisia*, 2 males, 4 females (USNM); Swiss Alps, III-24-1899, Hubbard and Schwarz, wild pea, 5 males, 10 females (USNM); Tenaha, III-23-08, E. S. Tucker, *Baptisia*, 3 males, 1 female (USNM); Timpson, III-25-08, E. S. Tucker, *Baptisia*, 2 males, 2 females (USNM); Victoria, III-25, 29, 30-05, W. E. Hinds and E. S. Tucker, *Baptisia* and Flowers of "Bull Weed," 5 males, 5 females (USNM); Whitewright, IV-15-08, J. W. Henry, 3 females (USNM); Yoakum, III-27-1899, Roos Bros., *Baptisia bracteata*, 2 males, 8 females (USNM); Fayette Co., LaGrange, III-30-70, on *Baptisia*, W. E. Clark, 4 males, 5 females (WEC).

Total specimens examined: 307.

Discussion. Specimens of this species from adjacent localities or from the same series may be entirely gray in color or have several scales with bronze margins giving a general yellowish hue. Specimens from the eastern and southern portion of the range average smaller in size than those from the northern and western portion. Specimens from New Jersey averaged 3.65 mm in length, those from Arkansas 3.85 mm, Louisiana 4.30 mm, Texas 4.30 mm, Iowa 4.40 mm, Michigan 4.60 mm, Kansas 4.55 mm, and Illinois 4.70 mm.

Tychius caesius, new name

(Figs. 15, 20)

Tychius armatus Green (not Tournier, 1873), 1920, Entomol. News, 31:198 (Holotype: female, Graybeard Mountain, North Carolina, CAS).

Sibinia armata: Klima, 1934, *Coleopterorum Catalogus*, 29(138):45.

This species appears to be most closely related to *T. sordidus*. It can be distinguished from other North American species by its gray vestiture; stout, short rostrum which is slightly widened at the antennal insertion and prominently tapered from the antennal insertion to the tip; and the toothed femora.

Description. Female: Length 3.0-3.6 mm, 2.0 times longer than wide; integument shining black, appendages and antennae dark reddish brown. Vestiture of bluish or yellowish gray scales.

Rostrum as long or shorter than prothorax, antennal insertion in apical third, slightly wider at antennal insertion than frons between dorsal margin of eyes, from lateral aspect prominently evenly arcuate; pits and rugae distad of antennal insertion deep, especially on dorsum between apices of scrobes. Vestiture proximad of antennal insertion of long, narrow scales, nearly glabrous, distad of antennal insertion. Eye nearly round, gold in color.

Antennae with seven funicular segments; pedicel equal in length to next two segments combined.

Pronotum 1.2 times wider than long, from dorsal aspect nearly parallel sided in basal half, narrower than elytra at base. Scales on dorsum elongate, broader than scales of elytra, usually apically rounded, sides with elongate-oval, white scales.

Elytra 1.1 times longer than wide; nearly parallel sided in basal two thirds, widest just behind humeri, rounded broadly to apices; evenly, broadly rounded in dorsal profile. Scales on interspaces long, narrow, denser on interspaces one, five, and seven. Strial scales narrower than scales on interspaces.

Ventral surface sparsely covered by nonimbricated, oval, plumose margined scales; integument finely visible between scales; no erect setae. Sternum five usually with deep median fovea.

Femora toothed on posterior portion of ventral apical emargination, tooth large and prominent on metafemur, small or very minute on mesofemur and profemur; ventral apical emargination very prominent. Vestiture of long, narrow scales, sometimes with sparse oval scales on proximal portion.

Tibia muconate, muciones on protibia larger than on mesotibia and metatibia; scales long, narrow, very fine, hairlike, toward apex of tibia.

Tarsi clothed dorsally with long, narrow scales and fine hairlike setae; claws short, divergent, basal processes parallel or slightly convergent.

Male: length 2.7-3.5 mm, rostrum shorter than prothorax, stout, antennal insertion in apical fourth; pits and rugae on distal portion very deep.

Male genitalia (Fig. 15) with apical portion of median lobe rounded, apical, dorsal, median membranous area elongate-oval, sharply defined posteriorly, median struts narrow, moderately elevate.

Host. Unknown.

Distribution. (Fig. 20).

North Carolina, Black Mts., VI, VII-02, Van Dyke, 52 males, 29 females (CAS); V-15-12, Beutenmuller, 1 male (CAS); Mt. Graybeard, V, VI-26, 9, 19-04, 25, 26 males, 21 females (AMNH), 1 female (Paratype 4-09) (USNM); V-15-12, W. Beutenmuller, 8 males, 4 females (CAS); VI-02, F. C. Van Dyke, 7 males, 5 [illegible] (CAS).

[illegible] Carolina, Rocky Bottom, V-22-34, J. A. Bequ[illegible] (USNM).

[illegible] specimens examined, 153.

Discussion. Green states that the "type" is a [illegible] but the type specimen examined is del[illegible] female.

Tychius lineellus LeConte

(Figs. 16, 21)

Tychius lineellus LeConte, 1876, Proc. Amer. Philos. Soc., 15:217 (Lectotype here designated: male, California, MCZ type 5231); LeConte, 1881, Trans. Amer. Entomol. Soc., 9:xxii; Casey, 1892, Ann. New York Acad. Sci., 6:412-413; Casey, 1910, Can. Entomol., 42:132; Yothers, 1916 Bull. Wash. State Agr. Exp. Sta., 124:7, pl. 1, Fig. 8; Bruhn, 1947, Gr. Basin Natural., 8:3, 18, Fig. 38 a & b (genitalia described); Kissinger, 1963, Ann. Entomol. Soc. Amer., 67(6):771 (proventiculus described).

Tychius tacitus Casey, 1910, Can. Entomol., 42:132 (Holotype: female, California "without more definite statement of locality," USNM 36745. Paratypes: 3 males, USNM 36745, T. L. Casey collection).

Tychius hesperis Casey, 1910, Can. Entomol., 42:132-133 (Holotype: female, Siskiyou Co., California, USNM 36746, T. L. Casey collection).

Tychius radians Casey, 1910, Can. Entomol., 42:133 (Holotype: female, San Diego, California, USNM 36747, T. L. Casey collection).

Tychius dilectus Casey, 1910, Can. Entomol., 42:133 (Holotype: female, San Francisco Co., California, USNM 36748. Paratype: 1 male, USNM 36748, T. L. Casey collection).

Tychius probus Casey, 1910, Can. Entomol., 42:133-134 (Holotype: female, "near San Francisco," California, USNM 36749).

Miccotrogus lineellus: Klima, 1934, *Coleopterorum catalogus*, 29(138):30-31.

The prominent triangular tooth on the middle of the protibia of the male and the projection on the apex of the median lobe of the male genitalia (Fig. 16), readily distinguish this species from its North American relatives. The relatively large size and gray or brownish gray color are also characteristic. This is the only North American *Tychius* known to be associated with *Lupinus*.

Description. Male: length 3.0-4.5 mm, width 1.4-2.1 mm; integument piceous to black, appendages reddish to orangish brown, scales either entirely gray in color or with combination of gray and bronze colored, often metallic scales.

Rostrum shorter than prothorax, antennal insertion in apical third; slightly expanded at antennal insertion, width at antennal insertion equal to or slightly less than width between dorsal margin of eyes; apical third dorsoventrally flattened, in lateral aspect slightly tapered from antennal insertion to extreme tip, slightly expanded before eye; pits and rugae very deep, especially dorsally between antennal insertions where slight depression between elevated lateral carinae is often evident. Vestiture of long, narrow, usually sparse scales, no erect setae, usually

with sparse fine hairlike setae around distal portion of scrobe.

Antennal funicle seven-segmented; pedicel longer than segments two and three combined.

Pronotum as wide or wider than long; sides rounded, 1.6-2.3 times wider at base than at apex. Vestiture on dorsum of long, narrow, apically truncate or acuminate scales; usually with broad median and lateral vittae of slightly wider scales; either all scales gray in color or median and lateral vittae with gray and remaining portion with bronze colored scales; integument usually clearly visible between scales. Lower portion of sides with elongate-oval gray scales.

Elytra in dorsal aspect parallel sided or tapering slightly in basal two thirds, widest at, or just beyond humeri, broadly rounded to apices in distal third; dorsal profile usually prominently convex but sometimes nearly flat in basal third, broadly rounded to apex. Vestiture of long, narrow, apically truncate or acuminate, recumbent scales; scales usually denser and lighter in color on interspace one and alternate interspaces; often alternate interspaces with bronze colored scales. Strial scales narrower than scales on interspaces.

Ventral surface with recumbent, oval, often plumose margined scales; usually with discrete transverse rows of suberect hairlike setae on each sternum. Sternum five without median fovea.

Femora with prominent, apical, ventral emarginations, often with minute tooth on basal portion of emargination of metafemur. Scales long, narrow, gray in color, usually longer and pointed on ventral portions especially on profemur.

Tibiae mucronate, mucro on protibia slightly larger and stouter than meso- and metatibiae; protibia with prominent median, ventral, triangular tooth. Vestiture of fine setae, especially fine apically.

Tarsi clothed with very fine hairlike setae, sparse on segments three and four, tarsal claws long, divergent, basal processes convergent.

Male genitalia (Fig. 16) with apical portion of median lobe constricted, forming narrowed apical process; apical, dorsal, median membranous area sharply defined posteriorly; median struts stout, not strongly clavate.

Female: length 3.6-4.6 mm; rostrum more slender and elongate than in male, pits and rugae distad of antennal insertion shallow; antennal insertion median. Sternum five with deep median fovea. Tibiae with slightly smaller mucrones, protibia lacking median, ventral triangular tooth.

Hosts. *Lupinus albifrons*, *L. caudatus*, *L. ammophilus*, *L. argenteus*, *L. arborus*, *L. bicolor*, *L. chamissionis*, *L. excubitus*, *L. leucophyllus*, and *L. sericeus*. also recorded from Burr Clover and *Gilia*.

Distribution. (Fig. 21)

Alberta: Lethbridge, V-30-33, R. M. White, 1 male (CNC).

Arizona: Williams, IV-6, Barber and Schwarz, 1 male (USNM); Fort Valley, Coconino Co., Flagstaff, 7½ mi. N.W., VI-7-64, R. W. Poole, 7350', 1 female (CU).

British Columbia: Osoyoos, V-30-58, H. and A. Howden, 2 females (CNC); Vernon, VI-2, 5, 31-21, 28, R. Hopping, 9 males, 4 females, (CAS), V-16-53, J. E. H. Martin, 1200', 1 female (CNC), Venables, 1 female (USNM).

California: ALAMEDA COUNTY: Koebele, 4 males, 4 females (CAS); 11-30-17, E. R. Leach, 1 female (CAS); Berkeley Hills, N.E. Oakland, IV-8-64, P. Rude, 1400', 1 male (CIS); Oakland, VI-2-46, B. Adelson, 1 male (CIS); Hayward, V-21, 1 male, 1 female (CNC); Hayward, V-21-30, F. E. Blaisdell, 7 males, 13 females (CAS); Oakland, IV-8-06, E. C. Van Dyke, 5 males, 3 females (CAS); Oak Hills, IV-8-06, E. C. Van Dyke, 2 males, 6 females (CAS); BUTTE COUNTY: IV-29-39, F. W. Nunemacher, 3 males (FMNH); Oroville, IV-30-27, H. H. Kelfer, *Lupinus albifrons*, 2 males, 1 female (CAS); Yankee Hill, V-8-28, H. H. Kelfer, 2 females (CAS); CALAVERAS COUNTY: V-15-36, 2 males, 1 female (ISU); Murphys, V-14, 15, 18, 19-36, F. E. Blaisdell, Alt. 2500', 15 males, 28 females (CAS), 1 male (PANS); Mokel Hill, V, F. E. Blaisdell, 1 male (CAS); CONTRA COSTA COUNTY: Koebele, 1 male (CAS); Antioch, III-29-56, B. J. Adelson, 1 male, 1 female (CIS), V-22-48, E. Ehrenford, 1 male (CIS), III-31-33, G. A. Marsh, 2 males, 3 females (CIS), IV-5-56, J. Powell, 1 male (CIS), IV-9-49, L. W. Quate, 1 male, 1 female (CIS), II-26-39, J. G. Shenafelt, 1 male (LA); Berkeley, V-33, E. S. Ross, 1 male (CAS); Orinda, V-4-34, 1 male, 7 females (LA); EL DORADO COUNTY: F. W. Nunemacher, 1 male (BYU); Placerville, V-20-13, 1 male (ISU); 3 males (CIS), F. H. Wymore, 1 male (CAS); FRESNO COUNTY: Coolinga, IV-8-51 E. G. Lindsay, 3 males, 3 females (CIS); HUMBOLDT COUNTY: V-2, 3, 7-11, F. W. Nunemacher, 14 males, 12 females (FMNH); Fieldbrook, V-29-03, H. S. Barber, *Lupinus*, 4 males, 6 females (USNM); Korbel, VI-16-16, F. E. Blaisdell, 1 male, 4 females (CAS); INYO COUNTY: Argus Mts., IV-91, Koebele, 1 female (CAS); Independence, 2 males (CAS); IV-19-19, Blaisdell, 2 males, 2 females (CAS), VI, A. Fenyes, 1 male (CAS), IV, V-27, 19, 2-18, 19, L. L. Muehmore, 12 males, 7 females (LA); Lone Pine, V-26-37, 2 males (LA); KERN COUNTY: Glennville, V-7-31, A. T. McClay, 5 males, 6 females (CIS), 3 males, 2 females (CAS); Indian Wells, IV-19-62, E. Lehre, 1 male (CIS), IV-18-62, C. A. Toschi, 3 males, 4 females (CIS); Isabella, IV-4-34, R. P. Allen, 1 female (CAS), R. Hopping, 1 female (CAS); Woody, 1 mi. E., V-3-64, J. Powell, 1 male (CIS); LASSEN COUNTY: Doyle, V-20-34, E. O. Essig, 7 males, 8 females (CIS); LOS ANGELES COUNTY: IV, 10 males, 13 females (USNM); III-22-39, K. E. Stager, 1

male (LA); IV 2-40, 1 male (LA); Antelope Valley, III-[illegible]-35, 1 male (CAS); Azusa, IV, 2 males, 2 females (CAS); Dr. A. Feynes, 2 males, 2 females (CU); Cole, VII, 1 female (CAS); Duarte, Wickham, 1 male, 1 female (USNM); Fairmont IV-15-28, 1 female (CNC); El Segundo, IV 27 38, D. Poole, *Lupinus chamissionis*, 1 female (LA); Lancaster, V, 1 male (CAS); Neenach, V 17-28, J. O. Martin, 5 males, 3 females (CAS); Pasadena, IV, 1 female (CAS); Pasadena, C. Schaeffer, 2 males, 2 females (BYU); Pomona 1 female (INHS), 1 male, 1 female (LA), 3 males, 2 females (MCZ); MADERA COUNTY: Coarsegold, V-26-42, C. Kennett, *Lupinus*, 3 males, 1 female (CIS); MARINA COUNTY: Fairfax, V-9-20, E. P. Van Duzee, 11 males, 8 females (CAS); Mill Valley, IV-20-24, F. E. Blaisdell, 3 males, 4 females (CAS), 1 male, 1 female (CU); IV-21-24, E. P. Van Duzee, 3 males, 2 females (CAS); Olema, V-25-52, O. Bryant, 1 male (BYU); MARIPOSA COUNTY: El Portal, V-18-38, C. T. Sierra, 2 females (LA), J. R. Warren 2 females (LA), Coulterville, IV-17-55, J. R. Jessen 1 male (CIS), Mariposa, V-17-59, C. H. Toschi, 1 female (CIS), Yosemite, V-24-38, J. R. Warren, 3880-4000', 1 female (LA); MODOC COUNTY: Goose Lake, VII-21-22, C. L. Fox 1 male, 1 female (CAS); Lassen Creek, VII-22-22 F. E. Blaisdell, 1 male (CAS); MONO COUNTY: VI-4-17, F. E. Blaisdell, 1 male (CAS); MONTEREY COUNTY: Arroyo Seco Camp, V-5-56, 1 female (USU); Bryson, IV, V-19, 20, 26-17, 20, E. P. Van Duzee, 9 males, 11 females (CAS); Carmel, IV-2-11, E. C. Van Dyke, 4 males, 1 female (CAS); IV, V-2, 25, 11 8-29, 23, L. S. Slevin 1 male, 2 females (CAS), Monterey, IV-12-54, R. P. Allen, 2 females (CIS), VI, A. Feynes, 1 male (CAS), 3 males (CU), 2 males, 1 female (CNC); Pacific Grove, VI, A. Feynes, 1 female (CAS), VII-16, 18-1898, *Lupinus arborus*, 1 male, 1 female (USNM); Pine Canyon, III-19-20, L. S. Slevin, 1 male (CAS); Tassajara, V-26-20, L. S. Slevin *Lupinus*, 2 males, 4 females (CAS), Carmel, Tularcitos Ranch, IV-27-54, 1 male (CIS); NAPA COUNTY: E. C. Van Dyke, 1 female (CAS); ORANGE COUNTY, E. C. Van Dyke 1 male (CAS), PLUMAS COUNTY, 3 mi. S. Frenchman Res. 6000', W. Gagne and C. W. O'Brien, *Lupinus caudatus*, 12 males, 7 females (CWO); RIVERSIDE COUNTY, Aguanga, V-12-29, 1 male (CNC), Benning, IV-13-1898, L. O. Howard, 2300' (USNM), Ribbon Wood, San Jacinto Mts., V-30-39, E. G. Lindsay, 1 male (CIS); SACRAMENTO COUNTY: Fair Oaks V-11-13, Smith and Vosler, 7 males, 1 female (LA), 1 male (CAS); SAN LUIS OBISPO COUNTY, Guyama Valley, VI 21-51, E. P. Van Duzee, 1 female (CAS); Pozo, IV-30-62, C. A. Toschi, 1 male (CIS), Summler, III-20-40, J. W. Tilden, and G. S. Mansfield, 1 female (CAS), SAN BERNARDINO COUNTY, Coquillett, 1 male (USNM), Cajon V-14 52, O. Bryant 7 males, 8 females (BYU), Ontario III-7-10, Hopper and Graves, Box Clover, 16 males 19 females (USNM), SAN DIEGO COUNTY, 2 males, 1 female (CIS); III-12-14, E. P. Van Duzee, 1 female (CIS), Alvarado Co., IV-[illegible]-51, J. Powell, 1 male (CIS), Jacumba, X-26-26, Van [illegible], 1 female (CAS), Mount Palomar VI-28-63, H. L. [illegible], 1 male 2 females (CIS), Poway F. E. Blaisdell, [illegible] 2 females (CAS), San Diego, 2 males (CU), [illegible] Blaisdell, 1 female (CIS), E. C. Van Dyke, 1 [illegible] (CAS), Wickham, 1 male 1 female (MCZ), SAN [illegible]ISCO COUNTY, Coquillett, 1 female (USNM), [illegible] 2 males, 1 female (CAS), San Francisco, [illegible] E. Blaisdell, 1 male, 6 females (CAS), Van [illegible] (CAS), SAN JOAQUIN COUNTY, Ripon, [illegible] M. Cazier, 1 male (AMNH), Ripon, III-23-31, C. H. Schwab 1 female (LA); Stockton, III-19-34, M. Crazier, 1 male (LA); Tracy, V-4-33, A. E. Michelbrucher, 1 male (CIS); SANTA CLARA COUNTY: Mt. Hamilton IV-15-47, G. E. Bohart, *Cilia*, 8 males, 2 females (CIS); San Antonio Valley, IV-8-47, R. F. Smith, *Lupinus*, 1 male (CIS); SANTA CRUZ COUNTY: Ben Lomond, V-17-31, E. C. Van Dyke, 1 male (CAS), VI-1-30, L. Saylor, 1 female (USNM); Santa Cruz Mts., VI-11-22, 1 male (CIS); VI-20-12, Coleman, 1 male, 3 females (CIS); SIERRA COUNTY: Gold Lake VII-16-21, 1 female (CAS); SISKIYOU COUNTY: VII, 2 females, (USNM); SOLANO COUNTY: Rio Vista, V-19-49, E. G. Lindsay, *Lupinus*, 7 males (CIS); SONOMA COUNTY: Mark West Spgs., V-10, 11-30, E. P. Van Duzee 8 males, 3 females (CAS); IV-27-30, J. O. Martin, 2 males, 2 females (CAS); Mt. St. Helena, IV-17-32, C. E. Morland, 1 female (LA); V-6-30, E. C. Van Dyke, 3 males (CAS); Sobre Vista, IV-24-10, E. C. Van Dyke, 1 female (CAS); TRINITY COUNTY: Carrville, V-28-34, 2400-2590' 1 male (FMNH); TULARE COUNTY, Fairview, 9 mi. So., V-1-64, J. Doyen, 1 males, 3 females (CIS), IV-29-64, P. Rude, *Lupinus excubitus*, 1 males, 1 female (CIS); Greenhorn Mts., V-7-31, E. C. Van Dyke, 3 males, 3 females (CAS); White River, V-17-30, E. C. Van Dyke, 5 males, 3 females (CAS); TUOLUMNE COUNTY: North Fork Tuolumne River, 3 mi. N.E. Tuolumne, V-1-61, R. M. Brown 2 males, 6 females (CAS); Strawberry, VIII-4-60, G. W. Colliver, 1 male (CIS); YOLO COUNTY: Rumsey, V-3-36, B. E. White, 2 males, 2 females (CAS); SANTA ROSA and SANTA CRUZ ISLANDS: Santa Cruz Is., IV-8-41, C. P. Kamakoff, *Lupinus bicolor*, 4 males, 7 females (LA).

Colorado: 1 male, (USNM); Palm, 1 female (AMNH); Boulder, VI-10-61, B. H. Poole, 5500', 1 male (CNC); Denver VII-7, Hubbard and Schwarz, 1 male (USNM); Denver, VII-7, F. C. Bowditch, 1 male (MCZ); Denver, Adams Sp., VI-15-49, B. L. and J. G. Rozen, 1 female (CIS), Glenwood Springs, VII, VIII, A. Feynes, 2 males 2 females (CAS); Pueblo, V-20, H. Soltau, 1 female (USNM); Steamboat Springs, VII-42, VIII-45, 21 males, 28 females (BYU); Valmont Butte, Boulder, VI-20, VII-61, J. R. Stainer, 5300', 1 female (CNC).

Idaho: Caribou Co., Soda Springs, 1 mi. N., VII-9, 10-68, D. R. Harris, *Lupinus*, 2 males (WEC); Coeur D'Alene, VI, Wickham, 1 female (USNM); Winchester, V-11-24, M. C. Lane, 1 female (USNM).

Montana: Boulder, Jefferson Co., VII-31-68, W. E. Clark, *Lupinus sericeus*, 5 males, 2 females (WEC); Bozeman, VII-25-03, 4800', 1 male (USNM); Bridger Canyon, VII-12-02, 5000' 1 female (USNM); Big Horn Co., Bushby, 4 mi. W., VI-8-69, W. E. Clark, *Lupinus*, 2 males (WEC); Florence, V-24-13, H. P. Wood 2 males (USNM), VI-1, 17-12, 1 male, 2 females, (USNM), Custer Co., Miles City, 17 mi. N.E., VI-8-69, W. E. Clark, 1 male (WEC), Missoula, VII-6-68, 1 female (USNM), Silver Bow Co., Nissler, 5 mi. N., VIII-6-68, W. E. Clark, *Lupinus sericeus*, 1 male (WEC); Ravalli Co., Roaring Lion Canyon VI-23-35, W. L. Jellison, *Lupinus*, 9 males, 7 females (USNM); Big Horn Co., Wyola, 11 mi. S., VI-8-69, W. E. Clark, *Lupinus*, 1 male 2 females (WEC).

Nevada: Horn, 1 male (PANS), Carson City, VI-25, 26-29, R. R. Usinger, 9 males, 10 females (CAS); Wickham, 1 female (USNM), Ormsby Co., VII, Baker, 2 males (FMNH), 1 male (USNM).

Oregon: Athena, VI-12-38, K. Gray and J. Schuh, 1 male (USNM), Corvallis, VI-7-32, E. C. Van Dyke, 1 female (CAS), V-22-35, K. Gray, 1 female (CAS);

Elgin, VI-20-22, A. L. Lovett, 1 female (CAS); Hood River, VI-4-17, F. R. Cole, 1 male (USNM); Kameda, VI-10-25, M. C. Lane, 1 male (USNM); No Powder, VI-8-24, 1 male (USNM); Steen Mts., 4 mi. W. Fish Lake, VII-15-53, Roth and Beer, 1 male, 1 female (OSU); Woods, VI-13-39, K. M. and L. M. Fender, 1 female (FMNH).

Saskatchewan: Farewell Creek, 1 male, 2 females (BYU).

Utah: Avon, V-29-39, G. F. Knowlton, 1 female (USNM); Beaver Co., VI-14-57, G. F. Knowlton, 2 males, 2 females (OSC); Bellevue, Schaeffer, 1 female (BYU); Blue Springs Hills, Box Elder Co., VI-28, V. M. Tanner, 1 male (BYU); Cache Jct., VI-11-03, 1 female (BYU); Cove Fort, V-29-37, G. F. Knowlton, 1 male (USNM); Dixie Nat'l. Forest, VI-15, 35, G. F. Knowlton, *Lupinus*, 2 females (USU); Eden, VII-23-37, 1 female (USU), Enterprise, 8 mi. S., VI-15-35, G. F. Knowlton, *Lupinus*, 2 females (USU); Utah Co., Hobble Creek Canyon, Springville, 5 mi. E., V, VI, VII, VIII-3, 24, 17, 11, 16-68, 69, W. E. Clark, *Lupinus leucophyllus*, 33 males, 30 females (WEC), 19 mi. E., VI-6-68, *Lupinus sericeus*, 14 males, 22 females (WEC); Huntsville, V. M. Tanner, 1 male (BYU); Leeds, IV-25-35, G. F. Knowlton and C. F. Smith, *Lupinus*, 2 males, 2 females (USNM); Logan, VI-10-50, John V. Bruce, 1 male (USU); Mantau, VI-20-61, G. F. Knowlton, 1 male (USU); Mt. Meadows, VI-15-35, G. F. Knowlton, 1 male (USU); Iron Co., Orton, 12 mi. N.W., VII-17-67, H. R. Burke, 1 female (TAM); Salt Lake City, Big Cottonwood Canyon, V-22-33, G. F. Knowlton, *Lupinus*, 1 male, 4 females (USU), 2 females (USNM), VI-6-35, 1 male (USU); St. George, V-28-35, E. C. Van Dyke, 1 male (CAS); Duchesne Co., Mtn. Home, 7 mi. N., VII-13-68, W. E. Clark, *Lupinus sericeus*, 11 males, 11 females (WEC); Trout Creek, V-8-34, T. O. Thatcher, *Lupinus*, 1 male (USU); Wasatch, VI-27, Hubbard and Schwarz, 8 males, 8 females (USNM), VI-27, Horn, 2 males (PANS).

Washington: Blewett, V-29-32, J. Wilcox, 1 female (OSU); Brewster, IV-29-12, 1 female (USNM); Dryden, V-16-42, E. C. Johnston, 1 female; Kooskooski, V-1-46, G. Nelson, 1 female (TAM); Walla Walla, VI-9-38 E. C. Van Dyke, 1 male, 1 female (CAS); Sanpoil, Keller, VII-3-21, M. C. Lane, 1 female (USNM); Wawawai, 1 male (USNM).

Wyoming: Johnson Co., Buffalo, 8 mi. S.W., VI-20-68, W. E. Clark, *Lupinus ammophilus*, 8 males, 5 females (WEC), 5 mi. W. *Lupinus argenteus*, 1 male, 1 female (WEC), VI-7-69, 3 males, 1 female (WEC); Campbell Co., Gillette, 22 mi. W., W. E. Clark, *Lupinus argenteus*, 8 males, 2 females (WEC); Niobrara Co., Lusk, 11 mi. S., VI-15-68, W. E. Clark, *Lupinus argenteus*, 3 male, 1 female (WEC); Teton Co., 12 mi. S. Jackson, VI-23-62, 6000', 1 male, 1 female, C. W. O'Brien (CWO).

Total specimens examined: 1011.

Discussion. Variation is evident in the size, shape, and color of the scales. Specimens from California exhibit a wide range of variation and some distinct varieties can be associated with particular geographic areas. Some specimens from the Los Angeles area have gray and bronze-colored scales which are unusually long and acuminate. The lectotype locality is probably Los Angeles, as the lectotype has this type of vestiture. Specimens from the west slope of the Sierra Nevada Mountains are relatively small and have gray and metallic bronze areas on the prothorax and on alternate elytral interspaces. Specimens from the east slope have no bronze-colored scales. The scales on these are also denser and broader. Two populations were sampled from Hobble Creek Canyon in Utah County, Utah. Specimens from the mouth of the canyon taken on *Lupinus leucophyllus* exhibit contrast between gray and bronze scales, but specimens taken a few miles up the canyon from *L. sericeus* are nearly unicolorous, as are specimens from the same host at Mountain Home, Duchesne County, Utah.

Tychius liljebladi Blatchley

(Figs. 13, 19)

Tychius liljebladi Blatchley, 1916, *In*: Blatchley and Leng, Rhynchophora or weevils of northeastern America, p. 246-247 (Holotype: male, Steuben Co., Indiana; Purdue).

Tychius arator: LeConte, 1876, Proc. Amer. Philos. Soc., 15:216; Casey, 1892, Ann. New York Acad. Sci. 6:415, Blatchley and Leng, 1916, Rhynchophora or weevils of northeastern America, p. 247; Marcovitch, 1916, Rep. State Entomol. Minn., 16:140.

Miccotrogus liljebladi: Klima, 1934, *Colcopterorum Catalogus*, 29(138):30.

This species resembles *T. tectus* LeConte, in general facies. It can be distinguished from other North American species by the shape of the rostrum which is prominently swollen basally, and smooth, shining, and finely acuminate beyond the antennal insertion; by the light yellowish brown scales; and by the sparse, scattered, round, white scales on the elytra.

Description. Male: Length 2.8-3.4 mm, width 1.5-1.7 mm; integument black on pronotum, usually dark reddish brown on elytral apices, appendages light to dark reddish brown. Vestiture of light yellowish brown scales on dorsum, scales on ventral surface white.

Rostrum shorter than prothorax; from lateral aspect swollen basally, prominently arcuate from dorsal margin of eyes to basal fourth, then slightly to moderately arcuate to apex; antennal insertion in apical third; moderately to strongly acuminate, smooth, shining, glabrous, with shallow punctures distad of antennal insertion. From dorsal aspect not strongly tapered from base to apex, slightly expanded at antennal insertion, scales of uniform color, size and shape, long, narrow or wedge shaped, no erect or suberect setae.

Antennal funicle seven-segmented, pedicel shorter than next three segments combined.

Pronotum 1.2 times wider than long, sides prominently arcuate, slightly constricted at anterior margin, nearly twice as wide at base as at anterior constriction. Dorsum covered mainly by broad, usually apically rounded scales. Sides and often small median basal portion of dorsum with round to elongate, white scales.

Elytra moderately convex in dorsal profile; in dorsal aspect widest just beyond middle, prominently rounded in apical third. Scales on interspaces of uniform size, shape and color; long, narrow, often spatulate; sparse, scattered, white scales mainly on apical third, denser on sides. Strial scales narrower than scales on interspaces.

Ventral surface with pale yellow to white, round to elongate-oval recumbent scales; erect or suberect setae absent. Sternum five with deep median fovea.

Femur with prominent, apical, ventral emargination, usually with minute tooth on proximal portion of emargination. Vestiture of uniform size and shape, similar to that of elytra but lighter in color.

Tibia mucronate, mucro on protibia usually larger than mucrones on mesotibia and metatibia; vestiture of long, narrow, scales and fine setae, setae predominant apically and ventrally.

Tarsi clothed with fine, elongate, white to yellow scales; claws short, stout; tooth connate in basal fourth, not as long as claw.

Male genitalia (Fig. 13) with apical portion of median lobe broadly rounded; apical, dorsal, median membranous area small, oval, strongly defined posteriorly; median lobe constricted medially; median struts clavate.

Female: similar to male but with rostrum longer and more finely acuminate beyond antennal insertion.

Host. *Astragalus canadensis.*

Distribution. (Fig. 19).

Alberta: Cypress Hills, VI-30, F. S. Carr, 1 male, 1 female (UA), 1 male (CNC); Medicine Hat, VI-6, 28-26, 28, F. S. Carr 3 males, 1 female (CAS), 1 female (UK), 1 male (UA), VI-28-26, 2 males (USNM), 1 male, 1 female (CNC), 1 male, 3 females (BYU).

Colorado: Denver, VII-7, Hubbard and Schwarz, 1 female (USNM).

Illinois, H. Soltau, 1 female (USNM).

Iowa: Ames, VII-26-51 J. Lafloon, *Astragalus canadensis*, 2 males 2 females (ISU), VI-3-32, J. A. Adams, 1 male (ISU), IV VIII-30, 25-1897, 2 males, 1 female (ISU), VII-7-34, H. E. Jacques, 1 male, 2 females (ISU), Iowa Co., VII-30-35, H. E. Jacques, 1 female (ISU), VII-5-35, G. Warren, 1 female (USNM); Grundy, VII-28-16, D. Stoner, 1 male (USNM); Lake Okoboji, VII-VIII-0-13, 22-16, 17, L. L. Buchanan, D. Stoner, 11 males, 11 females (USNM), Ledyard, 2 mi. S., V-9-26, G. O. Hendrickson, 1 female (ISU); Lemars, 6 mi. N.W., VII-26-28, G. O. Hendrickson, 1 male, 1 female, (USNM), 2 females (ISU).

Kansas: 1 male (USNM); Douglas Co., F. H. Snow, 900', 1 female (UK); Topeka, VI, VIII-12, Popenoe, 3 males, 4 females (USNM); Leavenworth Co., 6 mi. W. Linwood, VI-17-64, J. B. Karen, 1 female (CWO); Wallace Co., F. H. Snow, 300', 1 male (UK).

Manitoba: Aweme, IV, VIII-19, 12-30, R. M. White, *Astragalus canadensis*, 1 male, 2 females (CNC).

Michigan: Grand Ledge, VII-16, Hubbard and Schwarz, 2 males (USNM); Monroe, Hubbard and Schwarz, 1 male, 1 female (USNM).

Minnesota: Chisago Co., Chisago Lake, VII-19-21, F. P. Metelaf, in seed of *Astragalus canadensis*, 1 female (USNM); St. Anthony Park, *Astragalus canadensis*, 2 males (USNM).

Missouri: C. Schaeffer, 2 males, 1 female (BYU).

Nebraska: Seward, 1 male, 1 female (BYU).

North Dakota: Case Co., VII-15-63, R. Gordon, 1 male (BYU); Fargo, VII-22-22, R. L. Webster, 1 female (BYU); Wahpeton, 1933, Wickham, 1 male, 1 female (USNM).

South Dakota: 2 males (CU); Volga, 1 male, 2 females (LA); Truman (Wickham Coll.), 1 female (USNM); Roberts Co., 21 mi. S. Sisseton, VII-1-64, L. and C. W. O'Brien, 3 males (CWO).

Texas: Dallas, F. C. Bowditch, 1 female (MCZ).

Washington: Metaline Falls, VII-20-32, T. Terrell, 1 female (USNM).

Total specimens examined: 101.

Discussion. The type specimen of this species was examined and determined to be conspecific with specimens identified as *T. arator* Gyllenhal in collections in North America. Specimens labeled *T. arator* Gyllenhal have been examined from the LeConte, Casey and Blatchley collections and found to be *T. liljebladi*. The basal swelling and acuminate apical portion of the rostrum are not well developed in the holotype. *Tychius arator* Gyllenhal is a synonym of *T. aratus* Say.

Tychius tectus LeConte

(Figs. 1, 12, 19)

Tychius tectus LeConte, 1876, Proc. Amer. Philos. Soc., 15:217 (Holotype: female, Kansas, MCZ type 5233); LeConte, 1879, Bull. U.S. Geol. and Geog. Survey., 5:506; Casey, 1892, Ann. New York Acad. Sci., 6:414-415; Casey, 1910, Can. Entomol., 42:135.

Tychius languidus Casey, 1910, Can. Entomol., 42:135 (Holotype: male, Garland, Colo., USNM 36753, T. L. Casey collection).

Miccotrogus tectus: Klima, 1934, *Coleopterorum Catalogus*, 29(138):32.

This species differs from other members of the *T. sordidus* species group by the yellow or reddish brown rather than gray vestiture. The body is oblong (Fig. 1); the sides of the elytra nearly parallel, elytra with basal portion flat

rather than rounded in dorsal profile. It can be distinguished from *T. liljebladi*, which it resembles in general facies by the shape of the rostrum, which is not tumidus at the base nor acuminate in the apical portion, and by the deeply rugulose distal portion.

Description. Male: length 2.5-3.8 mm; integument piceous to black, appendages light to dark reddish brown. Vestiture of yellowish or reddish brown scales, usually with median and lateral vittae of white scales.

Rostrum shorter than prothorax; in lateral aspect usually moderately to prominently and evenly arcuate, but often nearly straight proximad of antennal insertion; antennal insertion in apical third; in dorsal aspect moderately, evenly tapered from base to apex; apex narrower than frons between dorsal margin of eyes, distal portion oval in cross section, deeply rugulose. Vestiture of elongate-oval or parallel sided scales with rounded or truncate apices, scales on sides usually of lighter color; glabrous distad of antennal insertion except for sparse setae around apical portion of scrobe.

Antennal funicle seven-segmented, pedicel usually as long or longer than next three segments combined; scales on antennae elongate, clavate.

Pronotum wider than long, usually widest in front of middle, rounded slightly to base and strongly to apical constriction (Fig. 1); 1.4-1.7 times wider at base than at apical constriction. Vestiture of elongate-oval or parallel sided, apically rounded or truncate, light to dark yellowish or occasionally reddish brown, strigose scales, usually with median vittae and lateral, patches of white scales. Lower portion of sides with elongate-oval, nonstrigose, usually white or light colored scales, some of which may extend to dorsum, especially basally.

Elytra in dorsal aspect with sides converging slightly or parallel in basal two-thirds; prominently tapered to apices, usually widest just distad of humeri; nearly flat or very slightly rounded in basal half in dorsal profile, declivity broadly rounded. Interspaces with scales similar to those on prothorax. Interspace one with dense, oval, white, nonstrigose scales from base to apex, and with several long, narrow, darker colored scales intermingled throughout; usually with broad lateral vittae of white, oval scales. Scales of strial punctures elongate, narrower than scales on interspaces.

Ventral surface densely covered by white or nearly white, broadly imbricated, oval to elongate-oval scales; no distinct rows of erect or subereet setae. Sternum five with median fovea, usually concealed by scales.

Femur with prominent, apical, ventral emargination; no minute tooth on proximal portion of emargination. Vestiture of dense, broad, elongate, usually parallel sided, truncate, or apically rounded scales, with elongate-oval, nonstrigose scales on basal portion.

Tibiae mucronate, mucro on protibia largest, about equal in length to tarsal claw. Vestiture of elongate, broad, strigose scales with very fine hairlike setae near apex.

Tarsi clothed dorsally with hairlike setae and broad, strigose scales; claws with basal processes parallel, nearly half as long as claw.

Male genitalia (Fig. 12) with apical portion of median lobe rounded; apical, dorsal, median membranous area round, extending proximad beyond middle of median lobe, strongly defined posteriorly; median struts and tegminal strut strongly clavate.

Female: rostrum slightly longer and narrower, antennal insertion near middle; mucrones slightly smaller.

Hosts. *Astragalus adsurgens* var. *robustior*, *A. bisulcatus* var. *heydenianus*, *A. scopulorum*, *A. tenellus*, *Oxytropis besseyi*, *O. campestris* var. *gracilis*, *O. lambertii* and *O. sericea*, *Hedysarum* sp. Also recorded from "vetch."

Distribution. (Fig. 19).

Alaska: Big Delta, VII-16-48, R. T. Sailer, 3 males, 1 female (USNM).

Alberta: Cardston, 9 mi. S., VIII-6-68, W. E. Clark, *Oxytropis campestris* var. *gracilis*, 4 males, 4 females (WEC); Edmonton, VII-14-20, F. S. Carr, 1 female (AMNH), VII-14-20, 1 male, 3 females (CAS), 2 males, 2 females (CU), 2 males, 1 female (MCZ), 3 males (PANS), 1 female (PA), 5 males, 5 females (UA), 3 males, 2 females (UK), 11 males, 5 females (USNM), 4 males, 1 female (OSU), VII-14-20, J. G. Shenafelt, 1 female (LA); Medicine Hat, VII-14-20, A. C. Davis coll., 1 male, 1 female (CNC).

British Columbia: Naramata, V-28-58, H. and A. Howden, "on vetch," 1 male, (CNC); Oliver, 2 mi. W., V-29-58, H. and A. Howden, "on vetch," 1 male, 1 female (CNC); Pentieton, 3 mi. E., VI-1-58, H. and A. Howden, "on vetch," 2 males (CNC); Ritcher Pass Road, 7 mi. W. Osoyoos, VI-2-58, H. and A. Howden, 2 males, 1 female (CNC).

Colorado: Buena Vista, VI, VII-15, 30, 1, 6-96, H. F. Wickham, 7900-8000'. 5 males, 2 females (MCZ), VII-1, 6- 1896, 5 males, 2 females (USNM), VIII-5, Liebeck Coll., 3 males, 1 female (MCZ), III-7, Hubbard and Schwarz Coll., 4 males, 3 females (USNM), H. F. Wickham, 4 males, 1 female (USNM), 6 males, 3 females, (AMNH), 4 males (CU), 1 male (CAS), 1 male, 1 female (UK), Boulder, VI-9-61, W. R. M. Mason, 5500'. 1 male (CNC); Colorado Springs, II-10; 2-4, H. Soltau Coll., 3 males, 10 females (USNM); Garland, 24 males, 14 females (USNM), 2 males (UK), VI-30, F. C. Bowditch, 1 male (MCZ), VI-29, 30, Horn Coll., 2

females (PANS); VI-29-30 Hubbard and Schwarz, 6 males, 5 females (USNM); Mancos, La Plata Co., 7 mi. N., VI-10-69, W. E. Clark, *Astragalus bisulcatus* var. *haydenianus*, 3 males, 2 females (WEC); Montrose, VIII-8-1885, F. C. Bowditch Coll. 6000', 2 males, 1 female (MCZ); Archuleta County, Pagosa Springs, 26 mi. S.E., V-31-69, W. E. Clark, *Astragalus bisulcatus* var. *haydenianus*, 15 males, 8 females (WEC); Poudre Canyon, Larimer Co., VI-12-68, W. E. Clark, *Oxytropis lambertii* and *O. sericea*, 57 males, 33 females (WEC); Ridgeway, Ouray Co., 2 mi. S.W., V-31-69, W. E. Clark, *Astragalus bisulcatus* var. *haydenianus*, 5 males, 5 females (WEC); Toponas, Routt Co., 3 mi. E., VI-4-69, W. E. Clark, *Astragalus tenellus*, 9 males, 5 females (WEC); 19 mi. E., VI-5-69, W. E. Clark, *Astragalus corpulorum*, 7 males, 3 females (WEC).

Manitoba: Aweme, VII-4-03, N. Criddle, 1 male (CNC); VI-4-29, R. M. White, *Oxytropis lambertii*, 2 males, (CNC); Treebank, 5-18-27, N. Criddle, *Astragalus*, 1 male (CNC); VI-11-27, R. M. White, 2 males, 2 females (CNC).

Montana: Powder River Co., Ashland, 7 mi. E., VI-8-69, W. E. Clark, *Oxytropis*, 3 males, 1 female (WEC); Big Horn Co., Bushby, 4 mi. W., VI-8-69, W.E. Clark, *Oxytropis sericea*, 25 males, 16 females (WEC); Kalispell, VI-13-20, Wickham, 1 male (USNM); Custer Co., Miles City, 17 mi. N.E., VI-8-69, W. E. Clark, *Oxytropis lambertii*, 3 males, 2 females (WEC); Missoula, Lieberk Coll., 3 males, 3 females (USNM); Silver Bow Co., Nissler, 5 mi. N., VIII-6-68, W. E. Clark, *Astragalus adsurgens* ssp. *robustior*, 1 male, 2 females (WEC); Glacier Co., Piegan, 1 mi. S., VIII-6-68, W. E. Clark, *Oxytropis campestris* var. *gracilis*, 1 male, 2 females (WEC); 1 mi. S., 1 female (WEC).

Nebraska: McCook, Hubbard and Schwarz, 1 female (USNM); F. C. Bowditch Coll., 1 male (MCZ), Wickham Coll., 2 males, (USNM); R. Hopping Coll., 1 male, 1 female (CAS); War Bonnet Canyon, 1 male (USNM).

Nevada: Elko Co., east slope Spruce Mtn., VI-26-56, W. C. Russell, 1 male (CIS).

New Mexico: Rio Arriba Co., Chama, 17 mi. N.W., V-31-69, W. E. Clark, *Astragalus bisulcatus* var. *haydenianus*, 12 males, 8 females (WEC); Jemez Mts., VI, VIII-IX-21, 8-21-27, J. Woodgate, 4 males, 5 females (CAS).

North Dakota: Golden Valley Co., Beach, 12 mi. E., VI-9-69, W. E. Clark, *Oxytropis lambertii*, 1 male, 2 females (WEC); Dunn Co., Killdeer, 1 mi. S., VI-10-69, W. E. Clark, *Oxytropis lambertii*, 1 male (WEC); McKenzie Co., Newtown, 17 mi. W., VI-10-69, W. E. Clark, *Astragalus tenellus*, 10 males, 10 females (WEC); Mountrail Co., Parshall, 3 mi. N.W., VI-10-69, W. E. Clark, *Oxytropis*, 10 males, 10 females (WEC); Theodore Roosevelt National Park, South Unit, VI-9, 10-69, W. E. Clark, *Oxytropis sericea*, 19 males, 4 females (WEC); Williams Co., Williston, 33 mi. N., VI-11-69, W. E. Clark, *Oxytropis*, 2 males (WEC), 31 mi. N., VI-11-69, W. E. Clark, *Oxytropis*, 1 male, 1 female (WEC).

Ontario: Kamela, VI-10-25, M. C. Lane, 2 males, 3 females (USNM).

Saskatchewan: Loch Creek, VII-18-23, K. M. King, 1 male (CNC); Forta a LaCorne, VII-17-25, K. M. King, 1 female (CNC); Moose Jaw, 16 mi. E., VI-12-[illegible], E. Clark, 1 male, 2 females (WEC).

South Dakota: Lawrence Co., Brownsville, 1 mi. S., [illegible] W. E. Clark, *O. campestris* var. *gracilis*, 11 [illegible] (WEC); Lawrence Co., Cheyenne Crossing, 2 mi. E., VI-18-68, W. E. Clark, *O. campestris* var. *gracilis*, 5 males, 3 females (WEC); Todd Co., Mission, 15 mi. S., VI-11-50, Hicks, Slater, Laffoon, 1 male, 2 females (ISU); Pennington Co., Pactola Reservoir, VI-17-68, W. E. Clark, 1 female (WEC).

Wyoming: Horn Coll., 1 male (PANS); Albany Co., Albany, 5 mi. N.E., VI-5-69, W. E. Clark, *Oxytropis sericea*, 3 males (WEC); Johnson Co., Bulfalo, 5 mi. W., VI-7, 14-69, W. E. Clark, *Astragalus adsurgens* ssp. *robustior*, 15 males, 4 females (WEC), 8 mi. S.W., VI-20-69, W. E. Clark, *Oxytropis sericea*, 19 males, 10 females (WEC); Campbell Co., Gillette, 22 mi. W., VI-20-68, W. E. Clark, *Oxytropis lambertii*, 1 male, 1 female (WEC); Johnson Co., Kaycee, 1 mi. N., VI-7-69, W. E. Clark, *Oxytropis besseyi*, 5 males, 2 females (WEC); Fremont Co., Lander, 14 mi. S., VI-14-69, W. E. Clark, 1 female (WEC); Albany Co., Laramie, 4 mi. N.W., VI-6-69, W. E. Clark, *Oxytropis lambertii*, 5 males, 3 females (WEC); Niobrara Co., Lusk, 11 mi. S., VI-15-68, W. E. Clark, *Oxytropis besseyi*, 4 males, 1 female (WEC); Carbon Co., Medicine Bow, 3 mi. N., VI-6-69, W. E. Clark, *Oxytropis sericea*, 5 males, 4 females (WEC); Shoshoni, Fremont Co., 11 mi. N., VI-21-68, W. E. Clark, *Oxytropis lagopus*, 14 males, 11 females (WEC); Hot Springs Co., Thermopillis, 10 mi. N., VI-21-68, W. E. Clark, *Oxytropis lagopus*, 7 males, 5 females (WEC); Washakie Co., Worland, 7 mi. E., VI-14-69, W. E. Clark, *Oxytropis lagopus*, 6 males, 6 females (WEC).

Yukon Territory: Ross River, 132°3', 61°56', 3,000 ft., VI-20-60, *Hedysarum*, J. E. H. Martin, 22 males, 23 females (CNC), VI-19-60, E. W. Rockburne, 27 males, 26 females (CNC).

Total specimens examined: 816.

Discussion. Geographic variation is evident in scale shape, size, and color, as well as in the average size of specimens. Individual variation is evident in size, distribution of white scales, and color of the dense, elongate scales which impart the general color to the specimens. In a given series, specimens usually agree closely in the coloration and distribution of scales, but often range from very light to a few very dark colored specimens. Usually a number of gray or silvery gray specimens can be observed.

Some specimens from southwestern Colorado and northern New Mexico have very dark yellowish brown scales. These were associated with *Astragalus bisulcatus*. Specimens labeled "Jemez Mts.," New Mexico, have a very light red integument. The scales on these are light to very dark reddish brown providing a marked contrast with the white scales.

Specimens from Alaska and the Yukon Territory of Canada have a lighter, yellowish to grayish vestiture. Individual scales are narrow, leaving the integument broadly exposed.

A single female specimen from northeastern Nevada was examined which is unique in several characters. It is small, 2.5 mm in length, with scales very broad, elongate-oval, and relatively sparse, and integument broadly visible. The pedi-

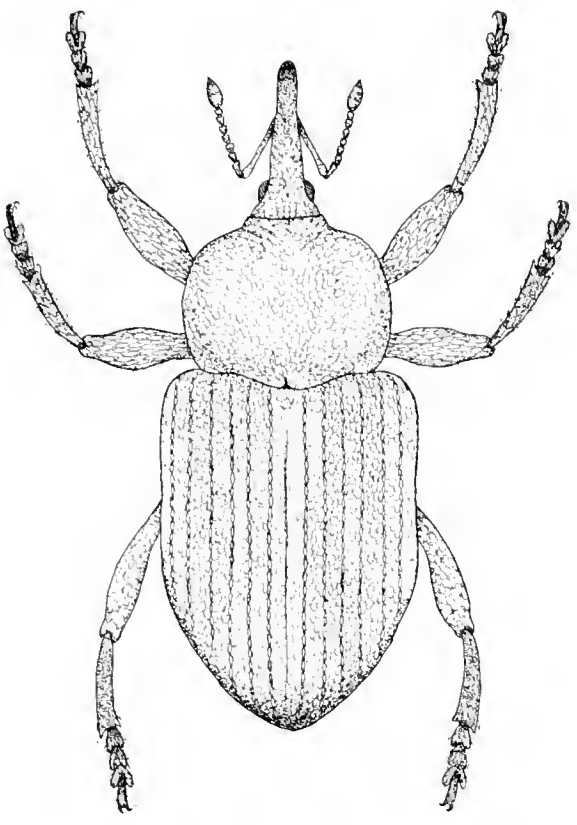


Fig. 1. Dorsal view of *Tychius tectus*.

cel of the antenna is longer than the next four segments combined.

Five specimens examined from Kamela, Oregon, average 3.9 mm in length and have very elongate, narrow rostra which in both sexes are silghtly longer than the prothorax. In these the rostra are finely tapered from the base to the apex and ammminate distad of the antennal insertion, but the distal portions are deeply rugulose.

The specimens from Nevada, Oregon, Alaska, and the Yukon Territory have extralimital distributions (Fig. 19).

Tychius semisquamosus LeConte

(Figs. 9, 21)

Tychius semisquamosus LeConte (not Fause, 1893), 1876, Proc. Amer. Philos. Soc., 15:217-218 (Lectotype here designated; female, Fort Tejon, California, MCZ type 5229; Paralectotype, female, same locality, MCZ, type 52292); Casey, 1892, Ann. New York Acad. Sci. 6:418.

Miccotrogus semisquamosus: Klima, 1934 Coleopterorum Catalogus, 29(138):32.

This species may be distinguished from other North American representatives of the genus by the multiple, confused, as opposed to single, uniform, median rows of long, narrow, light to dark reddish brown scales on the elytral interspaces; by the absence of fine, erect setae on the abdomen; and by the asymmetrical apical portion of the median lobe of the male genitalia (Fig. 9). It is doubtfully distinct from *T. lamellosus* Casey but can be distinguished by the following characters: the elongate-oval, white scales on the elytral interspaces are very sparse and rarely imbricated, and the rostrum is not finely acuminate and the average size is smaller.

Description. Male: length 2.5 mm, width 1.1 mm; integument black to piceous, appendages light to dark reddish brown; vestiture of white to dark reddish brown scales.

Rostrum shorter than prothorax, antennal insertion on distal fourth; moderately evenly arcuate in dorsal profile; in dorsal aspect strongly, evenly tapered from base to apex, frons 2.9 times wider between dorsal margin of eyes than rostrum at apex; distal portion strongly tapered, smooth, shining, pits and rugae shallow. Vestiture of elongate, broad, strigose, recumbent, apically rounded scales of uniform shape; distal portion glabrous except for sparse, fine setae around apical portion of scrobe.

Antennal funicle seven-segmented; pedicel as long or longer than next three segments combined; setae broad, elongate, apically rounded.

Pronotum wider than long, about 1.5 times wider at base than at apical constriction; sides evenly, prominently arcuate. Vestiture complex, consisting of long, narrow, apically rounded or pointed, recumbent, dark reddish brown, strigose scales covering dorsum and extending about half way down sides; integument broadly visible on dorsum, scales on lower portion of sides oval to elongate-oval, nonstrigose, light reddish brown, extending dorsally intermingled with long, narrow scales forming broad lateral vittae on dorsum; sparse oval scales scattered throughout on dorsum, also forming small, median, dorsal, basal patch.

Elytra nearly parallel-sided in basal two thirds, broadly rounded to apices; in dorsal profile nearly flat in basal half, declivity broadly, evenly rounded. Vestiture on interspaces of sparse, scattered, round to elongate-oval, sometimes slightly imbricated, recumbent, nonstrigose white to very light reddish brown scales, much denser, darker, and more broadly imbricated on interspace one. Each interspace with confused, multiseriate rows of long, narrow, apically rounded or pointed, dark reddish brown, usually suberect, strigose scales; scales not denser on intervals two through four. Strial setae narrow,

about half as wide as long, narrow scales on interspaces usually lighter in color.

Ventral surface with round to elongate-oval, recumbent, slightly imbricated, nonstrigose, white to light reddish brown scales; some scales slightly narrower and suberect, especially on sterna four and five, no discrete transverse rows of elongate, fine, hairlike setae. Sternum five with deep median fovea.

Femur elongate, apical half slightly swollen, apical ventral emarginations prominently developed, metafemur lacking minute tooth on proximal portion of apical ventral emargination. Vestiture of elongate-oval, recumbent, white to light reddish brown, nonstrigose scales, and long, narrow, strigose, white or light reddish brown, apically truncate or rounded, strigose scales; no fine, erect, hairlike setae.

Tibiae mucronate, mucrones shorter than tarsal claws, protibia with larger mucro; vestiture of long, narrow, strigose scales, and fine, erect, light brown setae on apical portion, rarely with sparse elongate-oval scales.

Tarsi dorsally with long, narrow scales and fine hairlike setae, basal process of claw about two thirds as long as claw.

Male genitalia (Fig. 9) with apical portion of median lobe strongly asymmetrical, apical, dorsal, median membranous area elongate, weakly defined posteriorly, median struts clavate.

Female: length 2.3-2.7 mm, rostrum narrower, slightly more acuminate in distal half, antennal insertion near middle. Tibial mucrones slightly smaller.

Host. Unknown.

Distribution. (Fig. 21).

California: T. L. Casey, coll., 1 male (USNM); Argus Mts., V-1891, 1 female (USNM).

Total specimens examined: 4

Discussion. The structure of the male genitalia (Fig. 9) is similar to that of *T. lamellosus* (Fig. 8). Examination of more material may indicate synonymy between these two. The LeConte specimens and the male in the Casey collection are small and have very sparse elongate-oval scales on the elytra. The female from the Argus Mountains of California has denser elongate-oval scales and is somewhat larger.

Tychius lamellosus Casey

(Figs. 8, 21)

T. lamellosus Casey, 1892. Ann. New York Acad. [illegible] 458-459 [illegible]. Holotype male, Utah, USNM, T. L. Casey collection.

[illegible] *lamellosus*: Klima, 1934. *Coleopterorum* [illegible] 29 138:50.

This species is distinguished from other North American representatives of the genus by the multiple, confused, as opposed to single, uniform median rows of long, narrow scales on the elytral interspaces; by the absence of fine, erect setae on the abdomen; by the finely acuminate rostrum; and by the asymmetrical apical portion of the median lobe of the male genitalia (Fig. 8). It is doubtfully distinct from *T. semisquamosus* LeConte but can be distinguished by the characters enumerated in the diagnosis of that species.

Description. Male: length 2.4-3.3 mm, width 1.2-1.5 mm; integument black on pronotum, black to piceous on elytra, appendages light to dark reddish brown; vestiture of white to dark reddish brown scales.

Rostrum shorter than prothorax, antennal insertion on distal fourth; in lateral aspect moderately to slightly, evenly, arcuate in dorsal profile; in dorsal aspect strongly tapered from base to tip, frons 1.8-2.5 times as wide between dorsal margin of eyes as rostrum at extreme apex; distal portion finely acuminate, smooth, shining, pits very shallow or absent. Vestiture of long, narrow, recumbent, or suberect, pointed or wedge shaped, strigose, light to dark reddish brown scales; distal portion glabrous except for sparse, fine setae around apical portion of scrobe.

Antennal funicle seven-segmented, pedicel nearly as long as next three segments combined, setae very fine, hairlike.

Pronotum wider than long, 1.5 times wider at base than at apical constriction; sides evenly, prominently arcuate. Vestiture complex, consisting of narrow, dorsal, median vitta of long, narrow, strigose, and round to oval nonstrigose, white scales, usually extending to anterior margin but often confined to basal portion; long, narrow to broad, recumbent, strigose, apically pointed to truncate, light to very dark reddish brown scales covering dorsum and dorsal half of lateral surface; lower portion of sides with round to elongate-oval, white to reddish brown, nonstrigose scales which extend dorsally forming broad, lateral, vittae in dorsal aspect; usually several nonstrigose scales intermingled with long, narrow scales on dorsum.

Elytra parallel sided in basal two thirds, broadly rounded to apices, widest just behind humeri; in dorsal profile nearly flat in basal half to two-thirds, declivity broadly, evenly rounded. Vestiture on interspaces of nearly uniform biseriate to triseriate rows of round to elongate-oval, slightly imbricated, recumbent, nonstrigose, white to very light reddish brown scales, usually

more broadly imbricated on intervals one and five through seven, darker in color and denser on interspace one; each interspace with confused uniseriate or multiseriate rows of long, narrow, apically truncate or pointed, light to dark reddish brown, suberect, strigose scales which are usually denser on interspaces two through four; setae arising from strial punctures narrow, light colored, hairlike.

Ventral surface densely clothed with round to elongate-oval, recumbent, broadly imbricated, nonstrigose white scales, often some scales slightly narrower and suberect, especially on sterna four and five; no discrete transverse rows of elongate, fine, hairlike setae. Sternum five with deep median fovea.

Femur elongate, narrow, apical half slightly swollen. Apical, ventral, emargination weakly developed; metafemur often with minute tooth or spine on proximal portion of emargination. Vestiture of elongate-oval, recumbent, white scales and long, narrow, white or very light reddish brown apically truncate or rounded, strigose scales; no fine, erect, hairlike setae.

Tibiae mucronate, mucrones usually shorter than tarsal claws, lacking obtuse tooth on dorsal portion, usually largest mucro on protibia. Vestiture of long, narrow, strigose scales, and fine, erect, light brown setae on apical portion, rarely with sparse elongate-oval scales.

Tarsi dorsally with long, narrow scales, and hairlike white setae, claw with basal process about two-thirds as long as claw.

Male genitalia (Fig. 8) with apical portion of median lobe asymmetrical; apical, dorsal, median mebranous area elongate, strongly defined posteriorly; median struts weakly clavate.

Female: similar to male except rostrum longer, more slender, antennal insertion median, distal portion very smooth, long, finely acuminate; slightly larger, length 2.4-3.4 mm; mucrones on tibiae slightly smaller.

Hosts. *Astragalus beckwithii*, *A. drummondii*, *A. lentiginosus* var. *palens*, and *A. lonchocarpus*.

Distribution. (Fig. 21).

British Columbia: Oliver, 2 mi. W., V-29-58, H. and A. Howden, "on vetch," 4 males, 3 females (CNC).

Colorado: Boulder, VI-13-61, J. R. Stainer, 1 female (CNC); Garfield Co., Grand Valley, 8mi. W., VI-4-69, W. E. Clark, *A. lonchocarpus*, 1 male, 3 females (WEC); San Miguel Co., Placerville, 4 and 6 mi. N.W. and 1 mi. N.E., VI-3-69, W. E. Clark, *A. lonchocarpus*, 16 males, 29 females (WEC); LaPlata Co., Bayfield, 16 mi. E., V-31-69, W. E. Clark, *A. lonchocarpus*, 29 males, 30 females (WEC); Archuleta Co., Pagosa Springs, 21 mi. W., V-31-69 W. E. Clark, *A lonchocarpus*, 7 males, 11 females (WEC).

New Mexico: Rio Arriba Co. Chama, 17 mi. N.W., V-31-69, W. E. Clark, *A. lonchocarpus*, 7 males, 19 females (WEC); Rio Arriba Co., Cebolla, 2 mi. S. and 15 mi. S.W., V-31-69, W. E. Clark, *A. lonchocarpus*, 60 males, 65 females (WEC); Rio Arriba Co., Coyote, 8 mi. W., VI-1-69, W. E. Clark, *A. lonchocarpus*, 7 females (WEC); Sandoval Co., Jemez Springs, 3 mi. N.E., VI-1-69, W. E. Clark, *A. lonchocarpus*, 12 males, 5 females (WEC); 1923, Edith W. Mark, 4 females (CI); Jemez Mts., VI-4, and VI-26, J. Woodgate, 6 males, 8 females (CAS), VI-4, Shoemaker, 2 males (USNM); Ft. Wingate, VI-VII, 5 females (USNM).

Utah: Utah Co., Provo, 1 mi. S.E., V-15, 22, 24-66, 67, 68, W. E. Clark, *A. beckwithii*, 71 males, 50 females (WEC); Utah Co., Provo, Mouth Rock Canyon, V-3, 10, 21, 69, W. E. Clark, *A. beckwithii*, 113 males, 110 females (WEC); Utah Co., Lehi, 13 mi. W., V-10-69, W. E. Clark, *A. beckwithii*, 3 males, 1 female (WEC); Utah Co., Provo Canyon, VI-1-68, W. E. Clark, 1 male (WEC); Arches National Monument, V-10-68, W. E. Clark, *A. lentiginosus* var. *palens*, 9 males 6 females (WEC).

Wyoming: Fremont Co., Lander, 14 mi. S., VI-14-69, W. E. Clark, *A. drummondii*, 12 males, 10 females (WEC).

Total specimens examined: 677.

Discussion. Specimens examined from Utah have the antennal insertion very near the tip of the rostrum as do specimens from British Columbia. The most noticable variation is in the color, shape, and density of the long, narrow, reddish brown scales on the pronotum and elytral interspaces. In specimens from Provo, Utah, these scales range from nearly the color of the round nonstrigose scales to very dark reddish brown with a corresponding darkening of the round, nonstrigose scales. In all specimens examined these scales have bluntly pointed apices. Specimens from southwestern Colorado and northwestern New Mexico have the elongate scales rather light orangish brown and very broad and rounded at the apices. Specimens taken on *A. drummondii* near Lander, Wyoming, are very light in color, with the long, narrow scales barely darker than the round, nonstrigose scales. Specimens from British Columbia are very similar to the Wyoming specimens. Specimens from Arches National Monument, Utah, average smaller in size than Provo specimens and more nearly resemble *T. semisquamosus* in distribution of scales and size.

Color and shape of the long, narrow scales vary in a cline from British Columbia, where they are narrow and light in color, to New Mexico, where they are broad, darker, and orangish brown.

Tychius badius, n. sp.

(Figs. 5, 21)

This species is probably closely related to *T. lamellosus* Casey, but differs by the following

[illegible]ters the median lobe of the male genitalia has lateral prominences on the apical portion (Fig. 5); the long, narrow, scales on the elytral interspaces are nearly always in single, uniform median rows while in *T. lamellosus* they are usually in multiseriate rows, the basal portion of the rostrum is wider in lateral aspect; and the scales on the elytra are broader and more densely imbricate.

Description. Male: length 3.1 mm, width 1.5 mm, integument black to piceous, appendages light reddish brown. Vestiture of creamy white to reddish brown scales.

Rostrum slightly shorter than prothorax; swollen in basal fourth then slightly arcuate in apical two-thirds; antennal insertion in apical third; distad of antennal insertion smooth, shining, with sparse, shallow, lateral impressions; finely acuminate to apex, in dorsal aspect prominently tapered from base to apex, frons 1.7 times as wide between dorsal margin of eyes as rostrum at apex. Scales above antennal insertion of uniform size and shape, long, narrow, recumbent, apically rounded, no erect hairlike setae. Scrobe with elongate, suberect setae around anterior margin; extreme apical portion with sparse, very fine setae.

Antennal funiculus seven-segmented, pedicel nearly twice as long as next two segments combined.

Pronotum 1.2 times as wide as long, sides prominently arcuate, 1.6 times wider at base than at apical constriction. Scales of two distinct types, long, narrow, pointed, light reddish brown scales on dorsum and halfway down sides; median dorsal vitta of broad, oval, white scales; lower portion of sides with oval, white scales which extend dorsally and are densely intermingled with the long, narrow scales on dorsum.

Elytra 1.6 times as long as wide, sides parallel to apical fourth then evenly rounded to apices, nearly flat in basal two-thirds in dorsal profile. Each interspace with double or triple rows of round to elongate-oval, light brown, densely imbricate, recumbent scales, scales on interspace one denser and more broadly imbricate. Each interspace with single median row of long narrow recumbent light reddish scales, single rows breaking up into irregular clusters laterally on interspace two, around humeri, and scattered places all over elytra. Strial setae narrow, hairlike, white.

Ventral surface with round to oval, white [illegible] on median surface of venter with [illegible] some scales on apical portion [illegible] elongate and suberect, no distinct transverse rows of erect, fine setae. Sternum five with shallow median fovea.

Femur with prominent, apical, ventral emargination; sometimes with minute tooth on proximal portion of emargination. Vestiture of round to oval, nonstrigose and long, narrow, strigose scales.

Tibiae mucronate, mucrones shorter than trasal claws; vestiture of long, narrow scales and suberect fine setae.

Tarsi clothed with elongate setae; claws with broad, connate basal processes.

Male genitalia (Fig. 5) with prominent lateral prominences on apical portion of median lobe; apical, dorsal, median membranous area nearly round, sharply defined posteriorly, median struts very stout, not clavate.

Female: slightly longer, rostrum longer, more finely tapered, 1.9 times as wide at apex as frons between dorsal margins of eyes, antennal insertion median.

Type Locality. COLORADO: LaPlata Co., Mancos , 7 mi. E.

Type Material. Male holotype, female allotype, 15 males and 11 females, paratypes taken at the type locality, May 30, 1969, by W. E. Clark, sweeping *Astragalus scopulorum*. The holotype and allotype are deposited in the U.S. National Museum, Washington, D.C.; two male and two female paratypes are deposited in the Brigham Young University collection, Provo, Utah; the remaining 23 paratypes are retained in the author's collection.

Distribution. (Fig. 21).

Colorado: Archuleta Co., Pagosa Springs, 15 mi. S.E., V-31-69, W. E. Clark 2 males, 19 females, *Astragalus bisulcatus* var. *haydenianus*, (WEC); "Colo.," Wickham collection, 1 male (USNM).

Total specimens examined: 50.

Discussion. There is a conspicuous difference in the size of the Mancos and Pagosa Springs specimens. Males from Mancos range from 3.0-3.1 mm, and females range from 3.2-3.4 mm in length, males from Pagosa Springs range in length from 2.5-2.8 mm, females from 2.6-3.0 mm. Males from Pagosa Springs average 0.52 mm, and females 0.55 mm shorter than specimens from Mancos.

Tychius prolixus Casey

(Figs. 6, 21)

Tychius prolixus Casey, 1892, Ann. New York Acad. Sci. 6:119-120 (Holotype: male, Nevada, USNM 36756, T. L. Casey collection). Tanner, 1966, BYU Sci. Bull. Biological series, 8(2):26. Klima, 1934, *Coleopterorum Catalogus*, 29(138):21.

Tychius (*Paratychius*) *prolixus* Casey, 1910, Can. Entomol., 42:135 (established *prolixus* as type of subgenus *Paratychius*).

Tychius (*Paratychius*) *imbricatus* Casey, 1910, Can. Entomol., 42:135-136 (Holotype: female, San Diego, California, USNM 36757, T. L. Casey collection).

This species most closely resembles *T. lamellosus* but can be easily distinguished by the six rather than seven antennal funicular segments, by the denser, more broadly imbricated scales on the elytra, and by the symmetrical apical portion of the median lobe of the male genitalia (Fig. 6).

Description. Male: length 2.6-4.0 mm; integument piceous to black, rostrum and appendages light to dark reddish brown; vestiture of white to dark reddish brown scales.

Rostrum nearly as long or slightly longer than prothorax; antennal insertion in distal third; nearly straight distally; from dorsal aspect strongly, evenly tapered from base to apex, frons 2.0-2.5 times wider between dorsal margin of eyes than rostrum at extreme apex, distal portion tapered, not finely acuminate, smooth, shining, pits dense, shallow. Vestiture of stout, broad, to long, narrow, wedge-shaped to apically rounded, decumbent, strigose, white to dark reddish brown scales; no distinct, erect, hairlike setae; distal portion glabrous except for sparse, small scales around apical portion of scrobe.

Antennal funiculus six-segmented; pedicel about equal in length to next three segments combined; setae long, hairlike to clavate.

Prontum wider than long, about 1.6-2.0 times wider at base than at apical construction; sides slightly arcuate in basal third, strongly arcuate indistal third. Vestiture complex, dorsal median, vitta, of long, narrow, strigose, and round to oval, nonstrigose white scales; long narrow, recumbent, strigose, apically truncate to rounded, light to very dark reddish brown, strigose scales covering dorsum and upper half of sides; lower portion of sides with round to elongate-oval, white to light reddish brown, nonstrigose scales which extend dorsally, forming broad lateral vittae from dorsal aspect; usually several nonstrigose scales intermingled with long, narrow scales on dorsum.

Elytra parallel sided on basal two-thirds, broadly rounded to apices; in dorsal profile nearly flat in basal half to two-thirds; declivity broadly, evenly rounded. Vestiture on interspaces of nearly uniform biseriate to triseriate rows of round to oval, broadly imbricated, recumbent, nonstrigose, white to reddish brown scales, denser and darker on interspace one, usually darker in color on interspaces two through four. Each interspace with uniform median rows of long, narrow, recumbent, apically truncate or rounded, light to dark reddish brown, strigose scales, usually in uniseriate rows on intervals one, three and five to seven; multiseriate rows on interspaces two and four. Strial setae narrow, white, hairlike.

Ventral surface with round to elongate-oval, recumbent, broadly imbricated, nonstrigose white scales; often several scales suberect, especially on sterna four and five; sometimes with discrete transverse rows of elongate, fine hairlike setae. Sternum five with deep median fovea.

Femur elongate, apical half moderately swollen; apical, ventral emargination usually prominent; metafemur often with minute tooth or spine on proximal portion of emargination. Vestiture of elongate-oval, recumbent, white scales and long, narrow, strigose, light, reddish brown, apically truncated or rounded, strigose scales; no fine, erect, hairlike setae.

Tibiae mucronate, mucro usually shorter than tarsal claw; lacking obtuse tooth on dorsal portion; usually mucro on protibia largest. Vestiture of long, narrow, strigose, white to light reddish brown scales, elongate-oval, white nonstrigose scales, and fine, erect, light brown setae on apical portions.

Tarsi dorsally with long, narrow scales and hairlike, white setae; claw with basal process about two-thirds as long as claw.

Male genitalia (Fig. 6) with apical portion of median lobe rounded; apical dorsal, median membranous area nearly round, strongly defined posteriorly; median struts fine, clavate.

Female: length 2.7-4.1 mm; rostrum longer, more slender, often straighter; antennal insertion median; tibial mucrones slightly smaller.

Hosts. *Astragalus amphioxys*, *A. douglasii*, *A. utahensis*, and *A. lentiginosus* (Tanner, 1966).

Distribution. Fig. 21).

Arizona: Morrison, Hubbard and Schwarz, 1 male (USNM); (Sta. Rita, N.F.), M. Chrisman, *Juniperus*, 1 male (USNM); Snowflake VIII-1-30 Ballantyne, *Astragalus diphysus*, 1 female (UA), V-27-32, E. F. Russell, "swept from loco weed," 1 female (USNM); St. John, VI-7-32, E. F. Russell, "reared from loco plants," 2 males (USNM).

California: 2 males (UK); Liebeck, 2 females (PANS), Aguanga, V-12-29, 1 male (CNC); Antioch, V-18-36, 1 female (CNC); Chino, VII-20-08, 1 female (USL), Elsinore, III, A. Feynes Coll., 2 males, 1 female (CAS); Hemet Reservoir, San Jacinto Mts., V-22-40 1 female (CIS); Jacumba, IV-17-16, J. O. Martin, 2 males, 1 female (CAS); Riverside Co., Keen Camp, VI-6, 12-17, E. P. Van Duzee, 1 male (CAS); 4 mi. E. Keen Camp, Hemet Res. 4500', VII-1-65, C. D. Johnson,

[illegible] 7 males, 5 females (CWO); Laguna [illegible] VII-6-29, R. H. Beamer, 2 females (UK); San Diego Co., La Mesa, III-20-28, H. G. Barber, 3 males (USNM); Lebec, IV-15-28, A. C. Davis, 2 males (CNC), 1 male (CNC); Los Angeles Co., Coquillett Coll., 3 males, 2 females (USNM); Van Dyke Coll., 2 males (USNM); San Diego Co., Pacific Beach, VI-23-?, C. Cannon, "reared from loco weed," 1 female (CAS); Riverside, III-18-10, C. Bammeres "flowers of loco weed," 1 male, 3 females (LA); 2 males, 2 females (USNM); San Diego Co., IV-8-25, E. C. Van Dyke, 1 male, 5 females (CAS); F. E. Blaisdell, 1 male, 2 females (CAS); F. H. Parker Coll., 1 males, 2 females (CA); D. K. Duncan, 2 males, 2 females (CA); IV-23-20, E. P. Van Duzee, 1 female (CAS); Riverside Co., San Jacinto Mts., VII-20-29, 1 male (UK); San Luis Obispo, III-11-08, L. J. Condit, *Astragalus*, 2 males, 3 females (USNM); S. Bernardino Co., 2 males, 4 females (USNM); Buena Ventura, Liebeck Coll., 8 males, 4 females (MCZ); Upland, IV-5-20, A. Fennes Coll., 2 males, 2 females (CAS); IV, Wickham Coll., 1 male, 2 females (USNM); 1 female (MCZ); Monterey Co., King City, IV-2-60, C. A. Toschi, one male (CWO).

New Mexico: W. G. Dietz, 1 male (MCZ); Sandoval Co., San Ysidro, 13 mi. N.W., VI-1-69, W. E. Clark, *Astragalus amphioxys*, 9 males, 4 females (WEC).

Texas: Brewster Co., 17 mi. S. Alpine, 4000', VI-6-70, L. and C. W. O'Brien, 1 male, 1 female (CWO); Davis Co., 10 mi. S. Toyahvale, V-31-70, R. M. Murray, 1 female (WEC).

Utah: Utah Co., Provo, Mouth Rock Canyon, V-19-69, W. E. Clark, *Astragalus utahensis*, 10 males, 9 females (WEC); Utah Co., Provo, V-9-67, V-27-67, D. R. Harris, *Astragalus utahensis*, 7 males, 1 female (WEC).

Total specimens examined: 153.

Discussion. Specimens from Utah and New Mexico have longer and straighter rostra in both sexes than do specimens from California. The possession of six rather than seven antennal funicular segments does not justify giving this taxon the rank of subgenus because of its apparent close relationship to other members of the *T. semisquamosus* species group, especially *T. lamellosus*.

Tychius soltani Casey

(Figs. 11, 20)

Tychius soltani Casey, 1892, Ann. New York Acad. Sci., 6:416. Holotype: male, Laramie, Wyoming, USNM 36754 (E. L. Casey collection).

Micrelytrogus soltani: Klima, 1934, *Coleopterorum Catalogus*, 29(138):32.

This is the most widely distributed species group of very closely related species within the *T. semisquamosus* species group. This species is distinguished from other members of the *T. semisquamosus* species group by the possession of dark, bristlelike setae on the abdominal [illegible] (Fig. 11), which lack [illegible] and pronotum of *T. badius* (Fig. 5) and *T. hirsutus* (Fig. 14) and have the apical median membranous area sharply defined posteriorly rather than not sharply defined as in *T. plalarus* (Fig. 7), serve to distinguish *T. soltani* from other members of the group.

Description. Male length, 2.6-3.8 mm, width 1.2-1.8 mm, integument piceous to black, appendages piceous to light reddish brown. Vestiture complex, of white to dark reddish brown scales.

Rostrum shorter than prothorax, length of rostrum 20 to 25 percent of total body length; antennal insertion in apical fourth; usually strongly arcuate in basal half, nearly straight apically, but often evenly arcuate or straight entire length; from dorsal aspect tapered evenly from base to apex, frons 1.7-2.5 times wider between dorsal margin of eyes at extreme apex, distal portion tapered but not strongly acuminate, smooth and shining, large, shallow pits especially dense laterally. Vestiture of long, narrow, apically truncate or rounded, strigose scales, usually scales on lower portion of sides smaller, lighter colored, white to light reddish brown, scales on dorsal portion dark reddish brown with several lighter colored, narrow, erect or suberect setae especially dense distally.

Antennal funiculus seven-segmented; pedicel as long or longer than next three segments combined; setae broad, elongate.

Pronotum wider than long 1.6-1.8 times wider at base than at apical constriction, sides in dorsal aspect evenly, broadly rounded. Vestiture of narrow, dorsal, median vitta of long, narrow, strigose, and round to oval white scales; long, narrow, light to very dark reddish brown, strigose scales covering most of dorsum and upper portion of sides; lower portion of sides with round to elongate-oval, white or light reddish brown, nonstrigose scales which extend dorsally forming broad, lateral vittae from dorsal aspect, nonstrigose scales usually intermingled with long, narrow scales on dorsum.

Elytra parallel-sided in basal two-thirds, broadly rounded to apices; in dorsal profile nearly flat on disc, declivity broadly evenly rounded. Vestiture on interspaces of round to oval, broadly imbricated, recumbent, nonstrigose, white to dark reddish brown scales, lighter in color on interspaces five to eight; each interspace with uniform row of scales similar to long, narrow scales of pronotum. Strial setae narrower than scales on interspaces.

Ventral surface with round to elongate-oval, white to light reddish brown, recumbent, imbricated scales; each abdominal sternum with dis-

crete transverse row of erect, narrow, hairlike setae; metasternum with some elongate, recumbent, narrow setae; sternum five with deep median fovea.

Femora long, narrow to stout, apical portion swollen, ventral emargination well developed in specimens with stout apical portion; metafemur often with minute tooth or spine on proximal portion of apical, ventral emargination. Vestiture of elongate-oval, recumbent, usually light to dark reddish brown scales, and long, narrow, strigose, suberect, usually white or very light reddish brown scales.

Tibiae mucronate, mucrones usually as long as tarsal claws, often with obtuse tooth on dorsal portion, usually largest on protibia. Vestiture of elongate, oval, and long, narrow scales, and fine, hairlike setae.

Tarsi dorsally with long, narrow scales; claws with basal process short, about half as long as claw.

Male genitalia (Fig. 11) with apex of median lobe obtusely rounded; apical, dorsal, median membranous are a small, transversely oval, strongly defined posteriorly; median struts slightly clavate.

Female: length 2.6-3.9 mm; rostrum more finely tapered distad of antennal insertion; mucrones on tibiae usually smaller.

Hosts. *Astragalus flavus* var. *flavus* and *A. flexuosus.*

Distribution. (Fig. 20).

Arizona: C. V. Riley, 1 male (USNM); Peach Springs, VIII-25, C. W. Leng, 1 female (BYU).

Colorado: Denver, IV-2, H Soltau, 1 male (USNM); Platte Can., X-27-1889, H. Soltau, 1 male (USNM).

Manitoba: Aweme, VI-26-30, R. M. White, *Astragalus flexuosus*, 1 female (CNC).

Montana: 1 male (INHS), 1 male (USNM), 1 female (PANS); Helena, Hubbard and Schwarz, 1 female (USNM).

Nebraska: Indianola, H. Soltau, 2 males (USNM).

New Mexico: Sandoval Co., San Ysidro, 13 mi. N.W., V-1-69, W. E. Clark, 1 male (WEC).

North Dakota: Tower City, VI-3-05, G. I. Reeves, 1 female (USNM).

Saskatchewan: Last Mtn. Lake, VI-5-33, Wickham Coll., 1 male (USNM).

South Dakota: Pennington Co., Pactola Reservoir, VI-17-68, W. E. Clark, 1 female (WEC).

Texas: Davis Mts., IV-26-24, J. O. Martin, 1 male, 1 female (CAS); Upton Co., Rankin, VI-3-70, C. W. Neeb, 1 male (TAM).

Utah: Cache Co., Logan, V-24-51, H. G. Egoscue, 2 females (BYU); Uintah Co., Vernal, 14 mi. S.W., V-17-69, W. E. Clark, *Astragalus flavus*, 10 males, 8 females (WEC).

Wyoming: Albany Co., Laramie, 20 mi. N.W., V-6-69, W. E. Clark, *Astragalus flavus*, 13 males, 8 females (WEC); Fremont Co., Lander, 14 mi. S., VI-14-69, W. E. Clark, 1 male, 1 female (WEC); Carbon Co., Medicine Bow, 32 mi. N., VI-6-69, W. E. Clark, 1 male, 1 female (WEC).

Total specimens examined: 63.

Discussion. The holotype is small, 3.0 mm in length, unusually narrow, and dark in color. Specimens taken in New Mexico, Arizona, and Colorado are often somewhat larger in size but agree in characters of the male genitalia. Most of the specimens at hand are single or at best pairs of specimens from widely separated areas.

I have examined a female from Montana in the Casey collection identified as *T. aralus*, but it is actually *T. soltaui*. This specimen is fairly large and the erect setae on the intervals are finer than those of the type of *T. soltaui*.

Tychius montanus n.sp.

(Figs. 18, 20)

This species appears closely related to *T. soltaui* Casey. The most reliable character for separating the two species is the structure of the apical portion of the median lobe of the male genitalia (Fig. 18) which possesses weakly developed lateral, apical, prominences in *T. montanus* but not in *T. soltaui*. The rostrum is generally as long or slightly longer than the prothorax, nearly straight or very slightly arcuate, and usually expanded at the extreme apex. The pits on the distal portion of the rostrum are slightly deeper than in *T. soltaui*. The median dorsal patch of white scales does not extend the entire length of the pronotum, as in *T. soltaui*, but forms a small, basal patch. The absence of erect hairlike setae or recumbent, long, narrow, white scales on the metasternum and the first visible abdominal sterna is also diagnostic.

Description. Male: length 3.4 mm, width 1.5 mm; integument light reddish brown, darker on dorsal surfaces. Vestiture complex, of white to dark reddish brown scales.

Rostrum slightly-shorter than prothorax, rostrum length about 28 percent of total body length; antennal insertion in apical third, evenly, slightly arcuate from base to apex in dorsal profile; slightly tapered from base to apex, sometimes slightly expanded at apex, frons about 1.5 times wider between dorsal margin of eyes than rostrum at apex; distal portion stout, not more strongly tapered than proximal two-thirds; distal third densely, deeply rugulose. Vestiture of long, narrow, apically, rounded, strigose scales; scales on dorsal portion dark reddish brown, several lighter colored, slightly narrower, suberect scales especially dense distally.

Antennal funicle seven-segmented, pedicel as long as next three segments combined, setae long, narrow.

Pronotum about 1.2 times wider than long, 1.6-1.8 times wider at base than at apical constriction, sides prominently, evenly arcuate. Vestiture complex, dorsum with small basal patch of round and long, narrow, white scales; long, narrow, often suberect, light to very dark reddish brown, apically truncate or pointed, strigose scales covering most of dorsum and upper half of sides; lower portion of sides with round to elongate-oval, white to light reddish brown, nonstrigose scales which extend dorsally forming broad, lateral, light colored vittae from dorsal aspect.

Elytra parallel sided in basal two-thirds, broadly rounded to apices; in dorsal profile nearly flat to very slightly rounded in basal half; declivity broadly, evenly rounded. Vestiture on interspaces of nearly uniform biseriate or triseriate rows of round to oval, broadly imbricated, recumbent, nonstrigose, white to dark reddish brown scales, slightly darker on intervals two through four lighter and denser on interspace one; each interspace with uniform row of long, narrow, usually apically pointed, suberect, light to dark reddish brown, strigose scales, each scale shorter than width of interspace. Strial setae lighter in color and slightly narrower than long narrow scales on interspaces.

Ventral surface with round to elongate-oval, white, recumbent, nonstrigose scales; abdominal sterna three and five each with discrete transverse row of erect, hairlike setae, which are absent from metathorax and abdominal segments one and usually two. Sternum five with deep median lovea.

Femora long, narrow or swollen apically; apical, ventral emargination usually well developed, metafemur often with minute tooth or spine on proximal portion of emargination. Vestiture of elongate-oval, recumbent, usually light reddish brown, nonstrigose scales and long, narrow strigose, usually suberect, lighter colored, often white scales.

Tibiae mucronate, mucro on protibia about as long as tarsal claw, mucrones on mesofemur and metafemur smaller, usually mucrones with obtuse dorsal tooth. Vestiture of elongate-oval, [illegible] light reddish brown scales, long, narrow [illegible] scales and very fine, hairlike suberect setae [illegible] dense on apical and ventral portions. [illegible] apically with long, narrow scales; claw [illegible] process about half as long as claw.

[illegible] Fig. 18) with weakly developed [illegible] prominences on median lobe; apical, dorsal, median membranous area nearly round, strongly defined posteriorly; median struts very fine, strongly clavate.

Female: rostrum length 27 percent to 29 percent of total body length; total body length 3.1-3.5 mm; antennal insertion median.

Type Locality. MONTANA: Helena.

Type Material. Male holotype, female allotype, one male and one female paratype taken at the type locality by Hubbard and Schwarz; on 1-5, all but the male paratype are deposited in USNM, the male paratype is in my personal collection.

Host. Unknown.

Distribution. (Fig. 20).

In addition to the type material, two specimens from the following localities were examined:

Alberta: Medicine Hat, VI-1-34, J. Carr, 1 female (BYU).

North Dakota: Mandan, F. E. Cobb, 1 female (USNM).

Total specimens examined: 6.

Tychius hirsutus, new name

(Figs. 14, 20).

Tychius hirtellus LeConte (not Tournier, 1873), 1876, Proc. Amer. Philos. Soc., 15:218 (Lecotype here designated: female, Texas, MCZ type 52282).

Miccotrogus hirtellus: Klima, 1934, *Coleopterorum Catalogus*, 29(138):30.

This species can be distinguished from its North American relatives by the very fine, elongate, hairlike setae on the interspaces of the elytra, rostrum and appendages. It closely resembles *T. soltani* Casey but can be distinguished from that species by the apical, lateral, projections of the median lobe of the male genitalia (Fig. 14). The rostrum is more finely acuminate in the distal portion, the scales on the pronotum are narrow, leaving the integument broadly visible, and the variation in color between interspaces two to three and four to seven apparent in *T. soltani* is absent.

Description. Male: length 2.6-2.9 mm; integument piceous to black, appendages piceous to light reddish brown. Vestiture complex, of white to dark reddish brown scales.

Rostrum shorter than prothorax, antennal insertion in apical fourth, usually evenly, slightly to moderately arcuate in dorsal profile but sometimes prominently arcuate in basal half, nearly straight in distal half; in dorsal aspect tapered evenly from base to apex, frons 2.0-2.5 times

wider between dorsal margin of eyes than rostrum at apex; distal portion strongly tapered, often finely acuminate, pits and rugae shallow. Vestiture of elongate, very narrow, apically pointed or finely acuminate, light to dark reddish brown scales on dorsum and upper portion of sides, usually with smaller lighter colored narrow scales and several light colored round to oval, nonstrigose scales on lower portion of sides; suberect, elongate, hairlike white setae proximad and distad of antennal insertion.

Antennal funicle seven-segmented; pedicel about equal in length to or longer than next three segments combined; setae very fine, elongate.

Pronotum wider than long, 1.6-1.7 times wider at base than at apical constriction; sides evenly, broadly rounded, or nearly parallel in basal half, rounded acutely in distal portion. Vestiture complex, of narrow, dorsal, median vitta of long, narrow, and oval to elongate-oval white scales; elongate, narrow, often semierect, light to dark reddish brown, strigose, scales covering most of dorsum and upper half of sides; integument visible between scales; lower portion of sides with round to elongate-oval, white to dark reddish brown nonstrigose scales which extend dorsally forming broad, lateral vittae from dorsal aspect; usually with several oval scales intermingled with long, narrow scales on dorsum.

Elytra usually broadest at humeri, tapering slightly to apices; in dorsal profile nearly flat on disc; declivity broadly, evenly rounded. Vestiture on interspaces of round to oval, broadly imbricated, recumbent, nonstrigose, white to dark reddish brown scales, slightly denser, and often of different color on interspace one, no obivous color differences on other interspaces; each interspace with uniform median row of narrow, elongate, pointed, erect, white to dark reddish brown, setae.

Ventral surface with round, to elongate-oval recumbent, imbricated, white to light reddish brown, usually plumose margined scales; each abdominal sternum with discrete transverse row of erect, fine, white, hairlike setae; metasternum usually with some elongate, recumbent or suberect, narrow setae, but often with erect very fine setae. Sternum five with deep median fovea.

Femora long, narrow, apical portion not prominently swollen, apical ventral emargination weakly developed; metafemur often with minute tooth on proximal portion of apical ventral emargination. Vestiture of elongate-oval, recumbent, light to dark reddish brown scales, and elongate, pointed, hairlike, erect, white setae, no long, narrow, strigose scales.

Tibiae mucronate, mucro usually as long as tarsal claw, often with obtuse tooth on dorsal portion, mucrones usually of uniform size on all tibiae but often largest on protibia. Vestiture of elongate-oval, recumbent scales and fine, hairlike, erect setae.

Tarsi dorsally with long, narrow, pointed, scales; claw with basal process about two-thirds as long as claw.

Male genitalia (Fig. 14) with apical portion of median lobe bearing prominent lateral projections; apical, dorsal, median membraneous area nearly round, strongly defined posteriorly; median lobe very long in comparison to median struts, very heavily sclerotized; median struts clavate.

Female: length 2.7-3.0 mm; antennal insertion median, finely acuminate distally; tibial mucrones slightly smaller.

Hosts. Specimens bearing the following host data have been examined: *Astragalus nuttallianus*, beating *Quercus*, and *Prosopis juliflora*.

Distribution. (Fig. 20).

New Mexico: Albuquerque, VI-27-33, Wickham and Bowditch, 1 male (USNM), 1 female (MCZ).

Texas: 2 females (PANS); Belfrage, Hubbard and Schwarz, 2 males (USNM); C. V. Riley, 1 male, 2 females (USNM); Bastrop Co., VI-31-58, H. R. Burke, 1 female (TAM); Brazos Co., VI-20-60, H. R. Burke, 1 female (TAM); Collinsworth Co., V-1859, 1 female (TAM; Corpus Christi, III-30-54, D. J. and J. N. Knull, 1 female (OSC); Dallas, V-11-50, E. E. Gilbert, 2 males, 1 female (CIS); Dallas Co., IV-18-40, Knutson, 1 female (CAS); Gillespie Co., VI-1-58, S. Burke, 1 female (TAM); Kerrville, IV, V, VI-4, 5, 18-52, 55, L. J. Bottimer, *Astragalus*, V-4-52, 3 males, 7 females (CNC), IV-4, 13, 20-59, Becker and Howden, beating *Quercus*, 2 males, 1 female (CNC); Llano, IV-21-06, F. C. Pratt, 1 female (USNM); Marfa, VII-11-12, J. W. Green, 1 female (USNM); San Antonio, V-31-03, A. C. Morgan, *Prosopis juliflora*, 1 female (USNM); Jim Wells Co., 7 mi. W, Alice, III-29-70, W. E. Clark, *Astragalus nuttallianus*, 5 males, 4 females (WEC).

Total specimens examined: 46.

Discussion. The range of this species and *T. soltani* overlap in western Texas and New Mexico. Some specimens examined from the area have weakly developed lateral apical prominences on the median lobe of the male genitalia which suggests possible intergradation between the two. More study is necessary to determine accurately the relationship between them.

Tychius phalarus, n.sp.

(Figs. 2, 7, 20)

This species closely resembles *T. soltani* Casey. The most reliable character for separating the two is the apical portion of the median lobe

of the male genitalia (Fig. 7). The apical, median membranous area extends proximad for the greater portion of the length and does not have a distinct posterior limit as in *T. soltani* (Fig. 11). The white scales on the median portion of the dorsum of the pronotum are restricted to a prominent basal patch (Fig. 2) instead of forming a median vitta the length of the pronotum. In most specimens the rostrum is slightly expanded in the extreme distal portion, scales on the rostrum are elongate-oval and pointed rather than parallel sided, scales on the pronotum are narrow and dark in color, oval scales on the femur are white, and the long, narrow scales are dark in color.

Description. Male: length 2.8-3.5 mm; integument black to piceous appendages light to dark reddish brown. Vestiture of white to dark reddish brown scales.

Rostrum slightly shorter or about same length as prothorax, length 20 to 28 percent of total body length, antennal insertion on apical fourth; evenly, prominently arcuate from base to apex in dorsal profile. In dorsal aspect prominently, evenly tapered from base to apex, frons 1.8-2.2 times wider between dorsal margin of eyes than rostrum at extreme apex; distad of antennal insertion oblong in cross section, not finely acuminate; smooth, shining, lateral pits shallow; often slightly expanded at antennal insertion and at extreme apex. Vestiture of elongate-oval, apically pointed, white, recumbent scales, and long, narrow, strigose, suberect scales; no fine erect setae, some round, nonstrigose scales on lower portion of sides.

Antennal funicle seven-segmented; pedicel as long or longer than next three segments combined.

Pronotum wider than long, base about 1.7 times wider than apex at apical constriction; sides evenly, prominently rounded; punctures large, evenly spaced, broadly visible on disc. Vestiture complex, large, median basal, patch of oval, nonstrigose and long, narrow, strigose, white scales; remainder of dorsum and upper portion of sides with long, narrow, pointed, dark reddish brown, strigose scales, lower portion of sides with oval to elongate-oval, white to light reddish brown, nonstrigose scales, some extending to dorsum.

Elytra nearly parallel in basal fourth, broadly rounded to apices, in dorsal profile nearly flat to [illegible] declivity evenly, broadly rounded. Vestiture on interspaces of biseriate to triseriate round oval, recumbent white to light reddish brown, nonstrigose, broadly imbricated scales; [illegible] interspace one slightly denser, more broadly imbricated. Each interspace with median, uniseriate row of long, narrow, strigose, suberect to erect, usually dark reddish brown, apically pointed scales. Strial scales elongate, pointed, white.

Ventral surface with oval, or elongate-oval, imbricated white, plumose margined, nonstrigose scales. Metasternum and abdominal sterna with discrete, transverse rows of suberect to erect, hairlike setae; sternum five with deep median fovea.

Femur long, narrow, apical ventral emargination well developed, often metafemur with minute spine on proximal portion of emargination. Vestiture of elongate-oval, recumbent, nonstrigose scales, and long, narrow, suberect, strigose, white to light reddish brown scales.

Tibiae mucronate, mucro on mesofemur and metafemur usually shorter than tarsal claw; mucro on protibia about equal in length to tarsal claw. Vestiture of elongate-oval, nonstrigose and long, narrow strigose scales, and fine, hairlike, usually darker colored setae near apex.

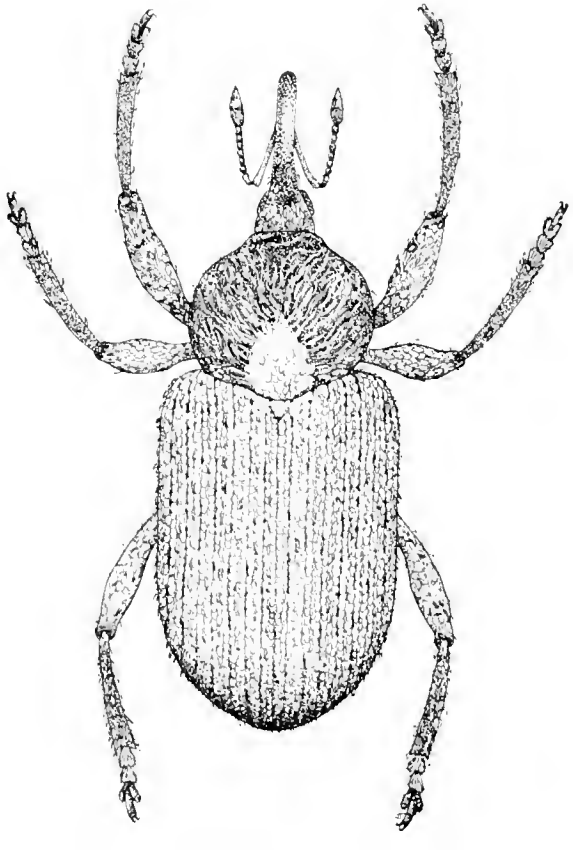


Fig. 2. Dorsal view of *Tychius phalarus*.

Tarsi dorsally with long, narrow scales; claw with short basal process, usually only half as long as claw.

Male genitalia (Fig. 7) with apical portion of median lobe broadly rounded; apical, dorsal, median membranous area not sharply defined, posterior sclerotized margin absent; median struts fine, clavate.

Female: length 2.8-3.6 mm; rostrum usually equal in length to pronotum, narrower, more slender; tibial mucrones generally smaller.

Type Locality. ARIZONA: Organ Pipe Cactus National Monument, Dripping Springs.

Type Material. Male holotype, female allotype, 16 male and 15 female paratypes taken at the type locality on April 5, 1969, by W. E. Clark, sweeping the host plant. One female paratype was taken at the type locality on April 24, 1953, by A. and H. Dietrich. Deposition of the type material is a follows: holotype and allotype (USNM), 1 male, 1 female paratype (BYU), one female paratype (CAS); the remaining 29 paratypes are retained in the authors collection.

Host. *Lotus rigidus.*

Distribution. (Fig. 20).

One specimen not included in the type material that was examined.

California: Poway, 1 female (CAS).
Total specimens examined: 35.

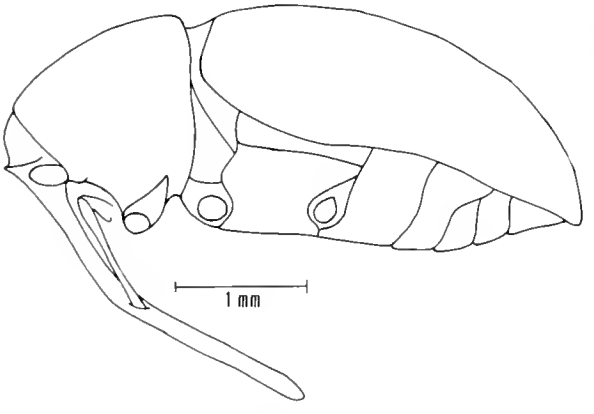


Fig. 3 Lateral view of *Tychius aratus*, female.

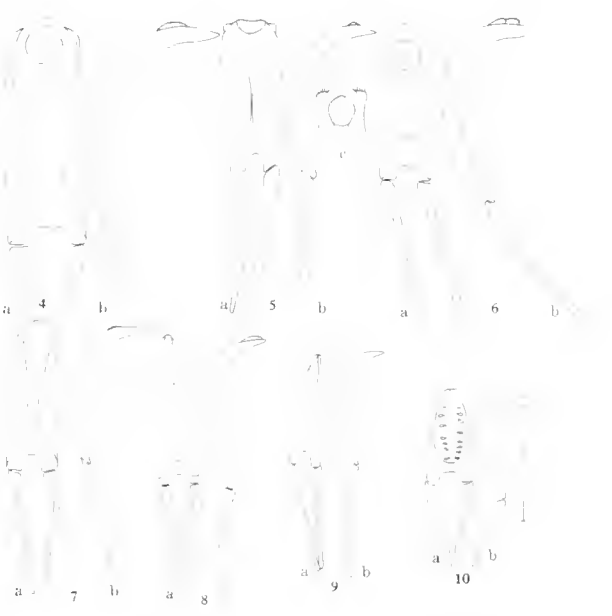
Tychius aratus Say

(Figs. 3, 4, 19)

Tychius aratus Say, 1831, Descriptions of North American curculionides, . . . , p. 26, (reprinted *In*: LeConte, 1859, The complete writings of Thomas Say, . . . , 1:294) (Male holotype of *Tychius arator* Gyllenhal here designated as neotype of *Tychius aratus* Say; Missouri, Naturhistoriska Riksmuseum, Stockholm); LeConte, 1876, Proc. Amer. Philos. Soc., 15:432; Gemminger and Harold, 1871, *Catalogus Coleopterorum* 8:2514 (=*arator* Gyllenhal).

Tychius arator Gyllenhal, 1836, *In*: Schoenherr, Genera et species curculionidum, . . . , 3(1):414-415 (Holotype: male, Missouri ,Naturhistoriska Riksmuseum, Stockholm).

Miecotrogus aratus Klima, 1934, *Coleopterorum Catalogus*, 29(138):29.



Figs. 4-10. *Tychius* spp., median lobe of male genitalia; 4. *T. aratus;* 5, *T. badius;* 6, *T. prolixus;* 7, *T. phalarus;* 8, *T. lamellosus;* 9, *T. semisquamosus;* 10, *T. stephensi;* a - dorsal view, b - lateral view, c - dorsal view of apex. Line at right of Fig. 10 represents 1 mm.

This species differs from other members of the *T. semisquamosus* species group by the unicolorous scales and larger size. The long rostrum in the female (Fig. 3) is unique among known North American *Tychius.*

Description. Male: length 4.0-4.4 mm, width 1.8-2.1 mm; integument dark reddish brown to black on body, appendages dark reddish brown; covered by unicolorous, light, tawny scales.

Rostrum longer than prothorax, slightly, evenly arcuate or nearly straight in basal two-thirds in dorsal profile; slightly wider at antennal insertion in lateral aspect; in dorsal aspect slightly, evenly tapered from base to tip, frons 1.4 times wider between dorsal margin of eyes than rostrum at apex; antennal insertion in apical third, evenly tapered to tip in lateral aspect, lateral portion with very deep rugae, dorsal portion with median shiny, smooth area. Vestiture of uniform shape, size and color; distad of an-

[illegible] insertion long, narrow, suberect setae extending two thirds distance to apex, scales above insertion stouter, no distinct erect hairlike setae.

Antennal funicle seven-segmented, pedicel as long as next two segments combined.

Pronotum 1.0-1.2 times wider than long, sides prominently arcuate, 1.8-2.0 times wider at base than at apical constriction. Scales of two types; long, narrow, recumbent, apically pointed scales on dorsum; sides with broad, oval, recumbent scales extending dorsally, intermingled with elongate scales halfway up sides, extending to dorsum forming broad lateral vittae from dorsal aspect.

Figs. 11-18. *Tychius* spp., median lobe of male genitalia; 11, *T. soltani*, 12, *T. tectus*; 13, *T. liljebladi*; 14, *T. hirsutus*, 15, *T. caesius*, 16 *T. lineellus*; 17, *T. sordidus*, 18, *T. montanus*, a - dorsal view, b - lateral view. Line at right of Fig. 18 represents 1 mm.

Elytra 1.4-1.5 times longer than wide; in dorsal profile nearly flat in basal fourth to one-half, broadly rounded to apices. Sides in dorsal aspect slightly rounded in basal two-thirds, broadly rounded to apices. Each interspace with three or four rows of broad, oval, sometimes pointed, densely imbricated, nonstrigose scales and with setae alternate to multiseriate rows of long, narrow, suberect, strigose scales. Strial scales [illegible] punctate.

Ventral surface densely clothed with broad oval, recumbent, densely imbricated scales and [illegible] rows of erect, setiform scales, these often absent from visible abdominal sternum one. Sternum five with broad, deep, median fovea.

Femur stout, apical, ventral emargination well developed, metafemur with minute tooth on proximal portion of emargination. Vestiture of round, and long, narrow, suberect, strigose scales.

Tibiae with short, stout, mucrones, mucro on protibia largest. Vestiture of sparse round scales and long, narrow, apically pointed, suberect, strigose scales. Tarsi with fine setae and long, narrow, strigose scales dorsally, tarsal claw divergent, basal processes parallel.

Male genitalia (Fig. 4) with apical portion of median lobe bearing lateral prominences, apex rounded; apical, dorsal, median membranous area nearly round, strongly defined posteriorly; median struts clavate.

Female: rostrum extremely long, narrow, nearly half body length. Antennal insertion near middle, apical portion slightly expanded, nearly glabrous entire length. Tibial mucrones slightly smaller than in male.

Host. *Astragalus crassicarpus*.

Distribution. (Fig. 19).

Minnesota: Duluth, Daggett, 1 male (LA).

Montana: Mason 1 female (USNM); Bozeman, VI-4-38, D. R. Lindsay, 1 male, (ISU).

Wyoming: Johnson Co., Buffalo, 5 mi. W., VI-20-68, W. E. Clark, *Astragalus crassicarpus*, 2 males (WEC).

Total specimens examined: 6.

Discussion. The "type of *T. aratus* Say was apparently destroyed (LeConte, 1859:vi). A specimen from the Gyllenhal collection in the Stockholm Museum labeled *Tychius aratus* Say was examined. Gyllenhal (1836:414-415) states that this specimen was sent to him by Say and cites *Tychius aratus* Say as a synonym of *T. arator*. LeConte (1876:216) says of *T. arator* that "Say apparently confounded this species with one described by him as *T. aratus;* and Major Gyllenhal suspecting perhaps the existence of some error has, while quoting Say in synonymy, given a different name to the insect received from that author." I have examined the specimen in the LeConte collection labeled *T. arator* and determine it to be *T. liljebladi* Blatchley. The specimen in the Gyllenhal collection sent by Say to Gyllenhal is probably the only authentic Say specimen of *T. aratus* in existence; therefore, it is here designated as the neotype.

The relationship of *T. aratus* to the other members of the *semisquamosus* group is not clear. It appears rather isolated in several features.

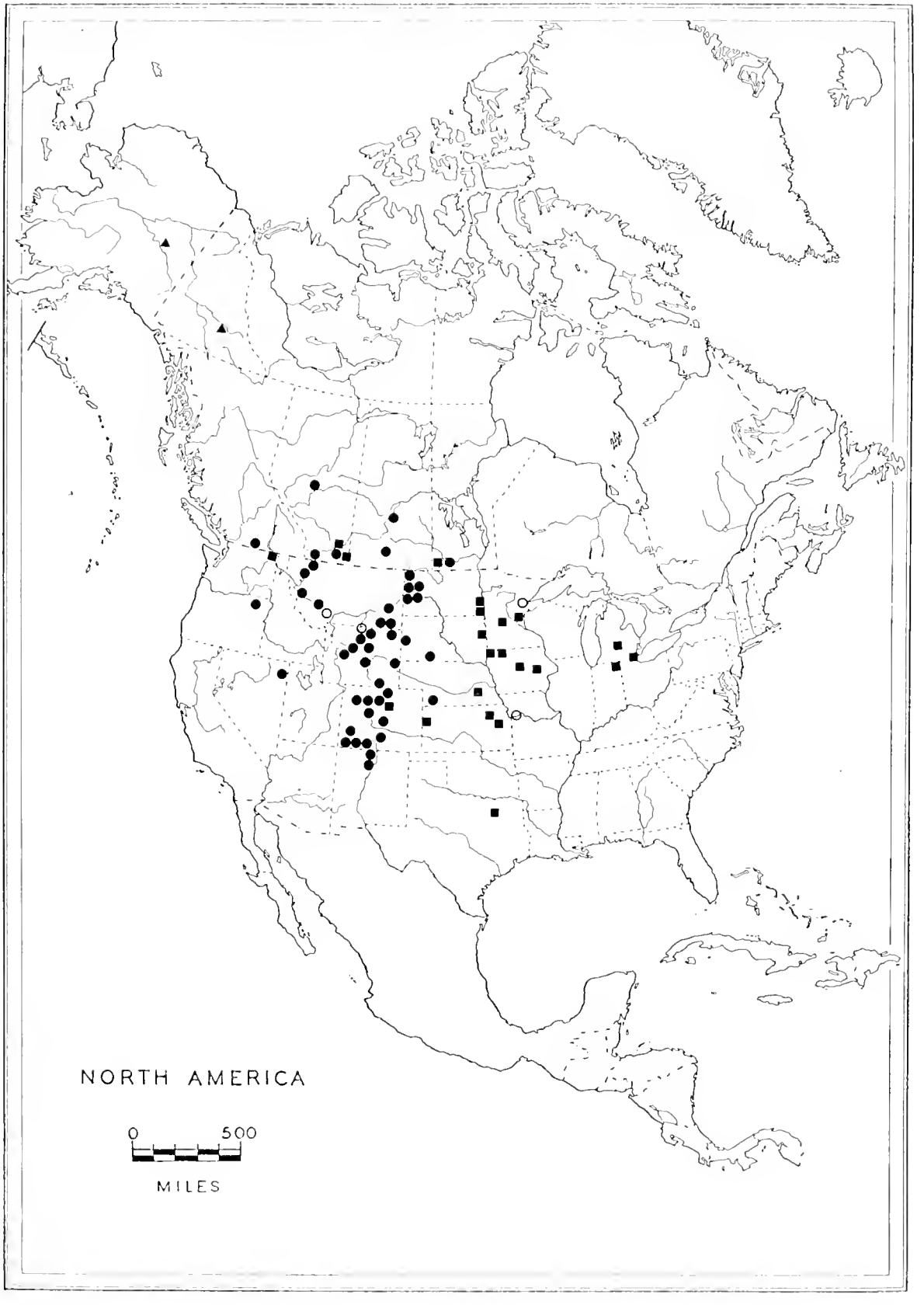


Fig. 19. Map of North America showing distributions of *Tychius liljebladi* ■, *T. tectus* ●, and *T. aratus* ○.

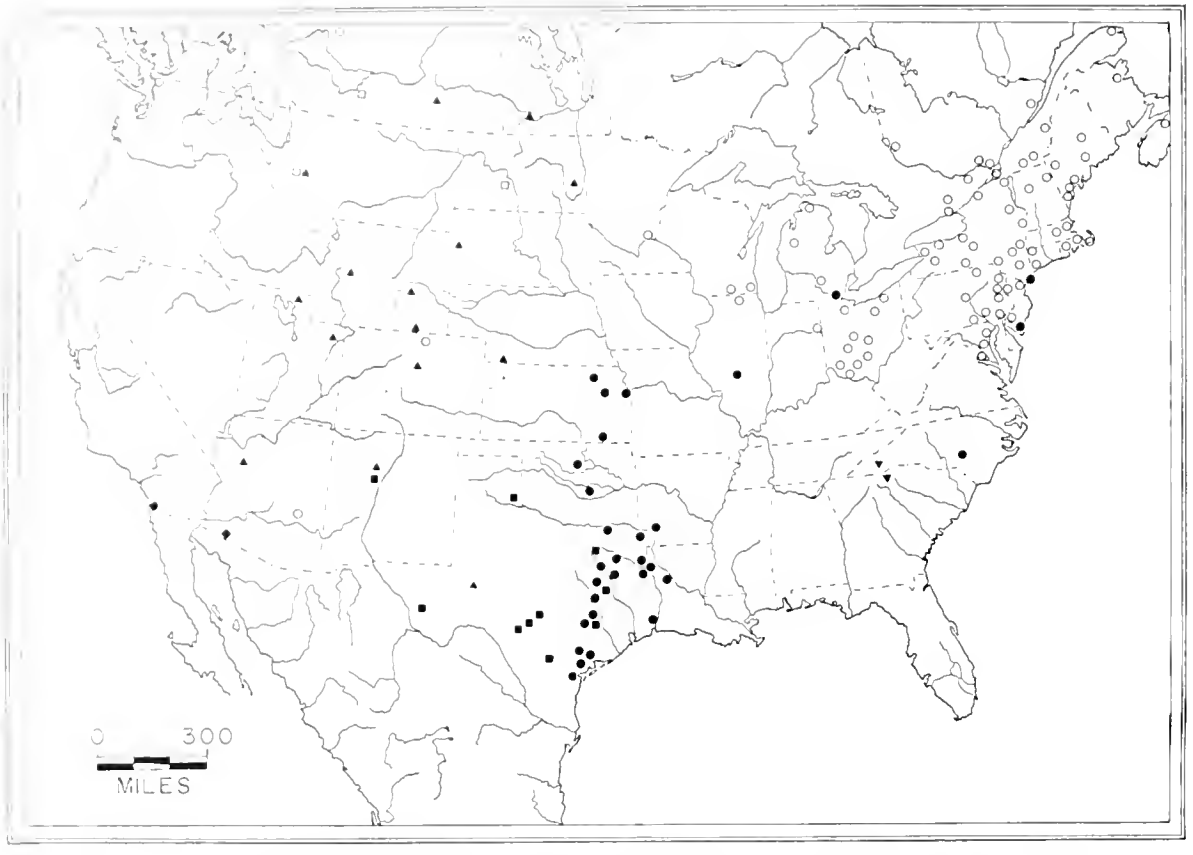


Fig. 20. Map of the United States showing the distributions of *Tychius stephensi* ○, *T. sordidus* ●, *T. caesius* ▼, *T. soltani* ▲, *T. montanus* □, *T. hirsutus* ■, and *T. phalarus* ◆.

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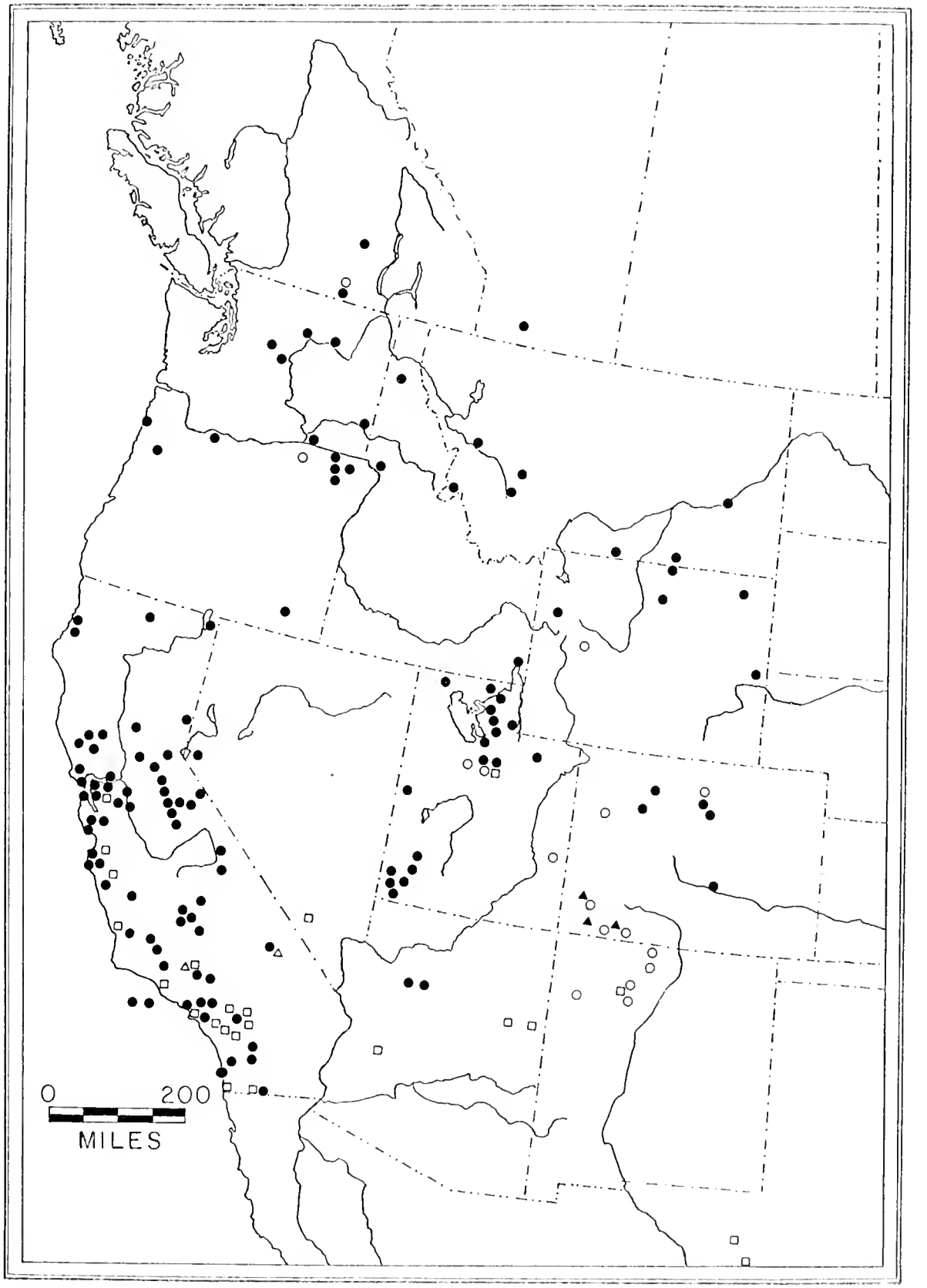

Fig. 21 Map of western United States showing the distributions of *Tychius lamellosus* ○, *T. semisquamosus* △, *T. lineellus* ●, *T. badius* ▲, *and T. prolixus* □

of *Tychius armatus* Green. Per Inga Persson, Department of Entomology, Swedish Museum of Natural History, Stockholm, for sending the types of *Tychius arator* Gyllenhal and *T. posticus* Gyllenhal, specimens from the Paykull collection and for information regarding type material of *T. stephensi* Schoenherr, and *Curculio fusciro-stris* Paykull. Dr. F. Heike, Zoologisches Museum, Berlin, for sending the type series of *C. tomentosus* Herbst. Dr. Lars Hedstrom, University of Uppsala, Uppsala, Sweden, for sending the type material of *Rhynchaenus picirostris* Gyllenhal. Dr. R. T. Thompson, British Museum (Natural History), for sending specimens from the Stephens collection and for information on the types of *C. cinerascens* Marsham, *C. villosus* Marsham, and *C. picirostris* Fabricius, and for information pertaining to the nomenclature of *Tychius stephensi* Schoenherr.

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A REVISION OF CRYPTANTHA SUBGENUS OREOCARYA

by

Larry C. Higgins

BIOLOGICAL SERIES — VOLUME XIII, NUMBER 4

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Larry C. Higgins[1]

ABSTRACT

This study is a taxonomic revision of *Cryptantha* subgenus Oreocarya (Boraginaceae), together with descriptions of species, synonyms, distribution maps, and discussions. The present treatment recognizes fifty-seven species and fourteen varieties, all separated by means of a comprehensive key. A history of the group, along with a discussion of distribution, ecology, and phylogeny is presented. As a basis for the comparison of taxa much of the research has been concentrated on morphological variation in herbarium specimens. Particular attention has been directed to a study of pubescence types, branching patterns, flowers, calyces, and fruit. The herbarium research has been correlated with extensive field observations and collections made throughout most of western North America.

INTRODUCTION

The genus *Cryptantha* subgenus Oreocarya consists of perennial or biennial herbs centered in western North America and belongs to the tribe Eritrichieae of the subfamily Boraginoideae of the family Boraginaceae. The subgenus has long been recognized for its taxonomic difficulty. This is due to the variability of the species and the lack of distinctive vegetative characters. Experience has shown that characters of the fruiting and floral structure provide the only satisfactory basis for precise specific differentation. The complexity of this subgenus plus the large number of species described since Payson's monograph (1927), have made a thorough study of the group necessary. It is hoped that the present revision of the North American species of this subgenus will partially meet this need.

The author first became interested in Oreocarya while doing fieldwork preliminary to the preparation of a thesis on the flora of the Beaverdam Mountains. Because of the difficulty encountered in classifying the plants of this group and at the suggestion of Dr. Stanley L. Welsh, the present study was undertaken.

Materials and Methods

The materials used in this study are largely dried and pressed specimens from a number of institutional herbaria in the western hemisphere, together with my collections from sites within the western United States. Because of the large number of specimens examined during the course of this investigation, citation of all specimens has been omitted, and only a few representative ones for each taxon are included. Type specimens of most taxa were received on loan and were subsequently photographed and all photographs were deposited in the Brigham Young University Herbarium.

Collections were made during the spring and summer months of 1967 in Utah and northern Arizona. Additional collections were made in Wyoming, Colorado, Montana, Washington, Oregon, Idaho, Nevada, California, Texas, New Mexico, Mexico, Arizona, and Utah during the spring and summer months of 1968, 1969, and 1970.

The measurements of a 15 cm ruler were used to measure leaves, stems, and inflorescences. Plant height was measured from the base of the stem to the tip of the inflorescence. Stem length was measured from the base of the stem to the first flower. The measurements of calyces, flowers, and nutlets were facilitated by the use of an ocular micrometer fitted to a binocular microscope.

The taxonomic presentation in this revision follows a conventional pattern. The number in Arabic numerals following the description of each species or variety denotes the total number of collections studied in preparation of the text. The figure in small Roman numerals immediately following in parentheses denotes the number of these collections made

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Herbaria in which specimens have been seen, with the standard abbreviations by which they are cited in the text (Lanjow and Stafleu, 1964) are as follows:

ARIZ University of Arizona Herbarium, Tucson, Arizona.

ASC Arizona State College, Flagstaff, Arizona.

BRY Brigham Young University, Provo, Utah.

CAS California Academy of Sciences, San Francisco, California.

COLO University of Colorado, Boulder, Colorado.

CS Colorado State University, Fort Collins, Colorado.

DIX Dixie Junior College, St. George, Utah.

GH Gray Herbarium, Harvard University, Cambridge, Mass.

IDS Idaho State College Herbarium, Pocatello, Idaho.

LA University of California, Los Angeles, California.

LL Lundell Herbarium, Renner, Texas.

MNA Museum of Northern Arizona, Flagstaff, Arizona.

MONT Montana State University, Bozeman, Montana.

ND-G Greene Herbarium, University of Notre Dame, Indiana.

ND University of Notre Dame, Notre Dame, Indiana.

NY New York Botanical Garden, New York, New York.

ORE University of Oregon Herbarium, Eugene, Oregon.

PH Philadelphia Academy of Natural Sciences, Phila., Penn.

POM Pomona College Herbarium, Claremont, California.

RM Rocky Mountain Herbarium, Laramie, Wyoming.

RSA Rancho Santa Ana Botanic Garden, Claremont, California.

TTC Texas Tech University, Lubbock, Texas.

UC University of California, Berkeley, California.

US United States National Museum, Washington, D.C.

UT University of Utah Herbarium, Salt Lake City, Utah.

UTC Intermountain Herbarium, Logan, Utah.

WTU University of Washington Herbarium, Seattle, Washington.

WTSU West Texas State University, Canyon, Texas.

History of the Subgenus Oreocarya

The species belonging to this group to be named first was *Cynoglossum glomeratum* Nutt. in Fras., nom. nud. (*Cryptantha celosioides*), the type of the subgenus. This was collected by Bradbury in "Upper Louisiana" in 1810, and was described by Pursh (1814), at which time he cited the Fraser Brothers Catalogue as the source of his name. The citation should thus read: *C. glomeratum* Nutt. ex Pursh, Fl. Am. Sept. 2:729. 1814. It was transferred to *Myosotis* by Nuttall (1818). Torrey (1828), described a second species, *Myosotis suffruticosa* (*C. jamesii*). A third species was described (*M. leucophaea*), and also assigned to *Myosotis* by Douglas in Lehmann (1830).

With the appearance of the tenth volume of de Candolle's *Prodromus* (1846), *C. glomeratum* and *M. leucophaea* were placed in the genus *Eritrichium* and this treatment stood until 1885.

Asa Gray (1875), published the results of his first study of the eritrichioid borages of western America. Following de Candolle he referred all the species to *Eritrichium* section Pseudo-myosotis. Four species and three varieties were recognized in Gray's revision.

Bentham and Hooker (1876), published that part of their *Genera Plantarum* treating the Boraginaceae. These authors accepted the interpretations of de Candolle and Gray and added still more diverse elements to the already overburdened genus *Eritrichium*. The species of *Cryptantha* were placed under that genus and considered generically indistinguishable from plants now classified under *Plagiobothrys* and *Eritrichium*.

The genus *Eritrichium* became so heterogenous and varied that its breakup was inevitable. This began with Gray's notable paper (1885), *A Revision of some Boraginous Genera*, in which the species of *Cryptantha* were transferred to the section Pseudo-krynitzkia of *Krynitzkia* with the exception of *K. setosissima* which was placed in the section Pterygium. Eight species were recognized by Gray that now are placed in the subgenus Oreocarya.

In a series of papers published by Greene (1887), the American representatives of de Candolle's *Eritrichium* were segregated in detail. First, the genus *Allocarya* was formed to include the species Gray had treated as *Krynitzkia* section Myosotidea. Then *Piptocalyx* was reinstated to include the species with circumscissile calyces, also two new genera, *Eremocarya* and *Oreocarya*, were formed. The first, *Eremocarya*, was based upon the plant of southwestern United States described as *E. micranthum* by Torrey (1859), and the second, *Oreocarya*, upon nine species of *Eritrichium* section Pseudo-krynitzkia and part of *Krynitzkia* section Pterygium, described by Gray (1885).

Greene (1896), described eight new species and redescribed several old ones. Later Greene (1899), described two new species and still later two more (1901).

In the period from 1896 to 1916 some 35 species were proposed as new, mainly by Marcus Jones (1891, 1895, 1910), Alice Eastwood (1903, 1913), and Per Axel Rydberg (1905, 1906, 1909, 1913).

Macbride (1916), wrote the first comprehensive revision of the subgenus Oreocarya which included 45 species. A dichotomous key was provided, specimens were cited, and a short discussion of each species was included.

Ivan M. Johnston (1924), questioned the status of the genus *Oreocarya*, and was of the opinion that both *Oreocarya* and *Cryptantha* should be combined under *Cryptantha*. Payson (1927), transferred all species previously known within *Oreocarya* to *Cryptantha*. His treatment included 45 species and contained keys to the species and a list of synonymy for each species plus descriptions, specimen citations, and discussions.

Brand (1927) proposed the new genus *Hemisphaerocarya*, which included all those species of the subgenus Oreocarya in which the fruit is hemispherical. *Cryptantha jamesii* and four of its close relatives formed the basis for this genus.

Since 1927 most of the new species which have appeared in the literature have been proposed by Johnston (1932, 1937, 1939, 1940), and Higgins (1968, 1969).

General Morphology

The plant consists of a taproot, varying in degree of branching, and a simple or branched caudex, the apex of which bears a rosette of leaves and gives rise to the flowering stem. The stem pattern may differ considerably between species, but fundamentally it consists of an axis, usually foliate (or bracteate), with branches bearing several helicoid cymes.

The majority of species live for several years and are classified as perennials. In *C. setosissima* and *C. virgata*, however, the plants are biennial with one prominent rosette giving rise to a central flowering stem.

Stems:

The stems are herbaceous, usually arising from a much branched woody caudex. However, in some species such as *C. virgata* and *C. setosissima* the stems are simple and erect. Most species are very similar with respect to the character of the stem, and so stems can be used only to a limited extent in the differentation of species.

Leaves:

The leaves are very similar in all species, varying only in length and width. They range from linear in *C. jamesii* var. *laxa* and *C. shackletteana*, to spatulate, or as is most common, oblanceolate. In all species the margins are entire, and the apices acute, obtuse, or subretuse. The blade is most often gradually narrowed into a long, slender, ciliate-margined petiole.

Inflorescence:

The inflorescence is an open, rounded leafy-bracteate thyrsus or a helicoid cyme. The individual cymules are prevailingly scorpioid, but sometimes glomerate or loosely racemose. In some species the inflorescence is characteristically narrow, while in others as *C. thyrsiflora*, it is very broad and open. In one species, *C. virgata*, the floral bracts are extremely long and greatly exceed the individual glomerate cymules.

Sepals:

The calyx is five-parted to the base, with the lobes all equal and linear, lanceolate, or ovate. In the more primitive species of this subgenus the lobes are only slightly accrescent in fruit, and in the advanced species greatly enlarged. The pedicel of the mature calyx may be nearly sessile or very short, or up to 10 mm long in the case of *C. fulvocanescens* var. *echinoides*.

Trichomes:

The hairs of *Cryptantha* are all simple, unicellular, and more or less silicious. The more silicious hairs are either smooth and somewhat transparent, or more or less roughened by encrustations and then somewhat opaque. The bristles vary notably in attitude (whether appressed, retrorse, or ascending), length, and rigidity. Some species are characteristically setose or hispid and others conspicuously silky-strigose, but most of the different forms are so much alike in pubescence that the differences are unnoticed by one unfamiliar with the group.

Associated with the bristlelike trichomes on the stem and leaves are the pale, blistery structures called pustules. These are composed of a circle of slightly elevated silicified, opaque, tessellately arranged epidermal cells surrounding the base of the trichome. They show much variety in frequency and size, varying from totally absent to decidedly abundant, and up to a diameter of 4 mm.

The terms used in botanical literature to describe the many diverse types of pubescence are employed by various authors in different contexts. The following list of terms is presented to allow precision in interpretation of pubescence types.

Hirsute:	with long, moderately stiff hairs.
Hispid:	with long, very stiff hairs.
Setose:	with short, rather stiff hairs.
Strigose:	with short, appressed hairs usually in one direction.
Tomentose:	hairs medium to short, curled and interwoven.

Corolla

The corolla limb is nearly always white and rotate-salverform or campanulate, but is distinctly yellow in two species. However, in many of the white-flowered plants the tube is light-yellow. The relative length of the corolla tube to the calyx lobes is an important diagnostic character. The corollas vary from 2-20 mm in length, but are quite constant for any given species. The tube bears at its apex five rounded or emarginate fornices, 0.5-1.5 mm long, that are conspicuously papillose to nearly glabrous. Near the base of the tube a ring of crests is usually present, but may be lacking, especially in the long-flowered species.

Style

The length of the style as well as the position of the stamens in the corolla tube is of little specific value in most of the long-flowered species, since most of them are distinctly dimorphic in these characters. However, in *C. oblata*, a long-flowered species, the stamens are always located at the middle of the tube, and the style exceeds the mature fruit by 3 to 5 mm. In the short-flowered species the distance by which the style exceeds the fruit is of some value in distinguishing species.

Fruit and nutlets:

The fruit of *Cryptantha* consists of four or fewer elongate, ventrally grooved nutlets affixed to a usually elongate gynobase. In shape the nutlets vary from broadly ovate or triangular-ovate to narrowly lanceolate. The dorsal surface occasionally is somewhat flattened, but is commonly more or less convex, although in *C. virgulensis* it is somewhat obtuse with a medial dorsal ridge. The sides of the nutlets in most species are acute, but can be quite obtusely angled, or as in *C. setosissima* the margin is drawn out into a broad, greatly developed wing. Surface characteristics of the nutlets are also of diagnostic value. The surface of the nutlet may be smooth and shiny as in *C. confertiflora*, *C. flava*, *C. barnebyi*, *C. semiglabra*, or may be variously roughened. In species such as *C. brevriflora*, *C. cana*, and *C. fulvocanescens* the roughenings consist of small, numerous, low, rounded, or sharp projections, a condition here described as muricate. Other species, such as *C. stricta*, *C. flavoculata*, and *C. echinoides* have the surface covered with long or short, irregular or transverse ridges called rugae.

Although four nutlets are commonly produced, one or more of them may fail to develop. This abortion can prevail throughout a plant or be restricted largely to either its younger or older parts. This suggest that abortions might be partially connected to the nutrition of the plant as influenced by seasonal conditions.

The nutlets are all homomorphic in contrast to those of the dimorphic species of the subgenus Krynitzkia, although its many species possessing heteromorphic nutlets. The ventral groove or scar of the nutlet is open or closed and can be simple or forked below. The margin surrounding the scar is entirely lacking or is greatly elevated as in *C. flavoculata* and *C. bakeri*.

Distribution and Ecology

Oreocarya, as circumscribed in the present treatment, is principally western North American in distribution. Only one taxon (*C. gnaphalodes*), or possibly two others, namely *C. argentea* and *C. amplexicaulis*, are found in South America (Chile), while all others occur in western North America. Payson (1927) stated,

> It would seem reasonable to suppose that the genus originated in the southwestern part of North America and in its perennial primitive form spread to the desert regions of Chile and Argentina. In that region it became differentiated into three main groups. The most primitive of these invaded North America as *Cryptantha* in the limited sense of recent American floras.

With this opinion the present author cannot entirely agree. A more reasonable hypothesis is that the group had its origin in southwestern North America. In its primitive form (probably similar to *C. jamesii* var. *multicaulis*), it spread to the desert regions of Chile and Argentina. In that region it became differentiated into Geocarya, an advanced group with highly specialized, cleistogamous flowers. The majority of the group that remained in western North America became specialized and gave rise to the subgenus Krynitzkia. The subgenus Krynitzkia in turn spread to South America and the specialized subgenus Cryptantha developed from it.

The center of distribution in North America is eastern Utah and western Colorado, with the greatest concentration of species extending from southwestern Wyoming and northwestern Colorado to southeastern California.

Members of the subgenus Oreocarya occupy for the most part xerophytic habitats at middle elevations. The species of Oreocarya grow in widely different ecological situations and in a wide elevational range. Few species are able to tolerate direct competition with other herbs or endure the shade of overhanging trees or shrubs. The prairie species *C. cana* and *C. caespitosa*, appear unable to tolerate the sod-grass climax vegetation, but flourish only on the shaly ridges or gravelly outcrops which here and there break through the prairie sod. Some species are found growing on sandy deserts, e.g. *C. jamesii* var. *disticha*, on alpine talus slopes, e.g. *C. weberi*, *C. crymophila*, *C. thompsonii*, and some on clay knolls or desert playa, e.g. *C. virgulensis*, *C. rugulosa*, and *C. semiglabra* which are associated with *Atriplex*. Apparently

no species is able to tolerate a moist, undrained soil. The ability to grow and reproduce in difficult environments has enabled members of the group to colonize a wide variety of raw and newly exposed, often unpromising habitats. It is perhaps this ability, together with the selective action of the environment upon pioneer populations, that has produced the large number of species and at the same time the patterns of narrow endemism which are a feature of the subgenus.

The species are commonly found on almost any barren hillside. Many are restricted to soils that are so strongly impregnated with mineral salts that few other plants are able to compete with them. They are particularly at home on loose hillsides, talus slopes, shale outcrops, and heavy, detrital, clay soils.

Over 50 percent of the species are narrowly restricted in some specific ecological niche or edaphic situation. Some of them are limited to a single hillside, others to a particular mountain range, and still others are restricted to some isloated basin.

The greatest number of endemics are found in the cold desert regions of Utah and Colorado. *C. grahamii* and *C. barnebyi* are restricted to the Green River Shales of the lower Uintah Basin, being the most conspicuous plants on the shales. *C. stricta* is a very narrow endemic, also of the Uintah Basin, but it is limited to heavy clay habitats on the north rim of the basin. Other endemics such as *C. elata*, *C. aperta*, *C. breviflora*, *C. wetherillii*, *C. longiflora*, and *C. rugulosa* grow on highly saline soils. Gypsiferous soils of western Colorado and eastern Utah are the home of *C. paradoxa*, while in this same general region *C. tenuis* and *C. osterhoutii* are almost always confined to sandy soil.

Endemic species also occur in mesic environments. For example, the Wasatch Formation of western Garfield County, Utah, is the habitat of the narrowly endemic *C. ochroleuca*. The volcanic talus slopes along the Salmon River in central Idaho is the habitat of *C. salmonensis*. Montane and warm desert regions include the habitats of other endemics.

Dispersal mechanisms within the subgenus are almost entirely unknown. One species, *C. setosissima*, has broadly winged nutlets, but the size of the wing in relation to nutlet size is such that it may have little or no value in dispersal. It seems probable that long distance dispersal by means of some animal vector is the most reasonable answer to dispersal of propagules in this group. However, the species of *Cryptantha* are not known to be grazed or eaten by animals, and thus the potential of animals in their dispersal is unknown. It is apparent that much additional information must be obtained to account for the broad distribution of members of this group of plants.

Seasonal differences in the flowering period are highly variable in the subgenus and have probably served in the isolation of species within the group. For example, *C. jonesiana* is closely related to *C. fulvocanescens* but flowers much earlier. By early May *C. jonesiana* has completed flowering and produced fruit, while *C. fulvocanescens* has only started to flower. Seasonal isolation between other closely related species is known (e.g. *C. virginensis* and *C. hoffmannii*, *C. spiculifera* and *C. interrupta*, and between *C. humilis* and *C. propria*).

Heterostyly, (regularly associated with outbreeding populations), has been developed in several groups in the evolution of the subgenus. Some of the widely distributed species such as *C. flavoculata* and *C. fulvocanescens* are distinctly heterostyled. On the other hand some of the very narrow endemics such as *C. ochroleuca*, *C. compacta*, and *C. jonesiana* are homostyled and possibly self-pollinated. Outbreeding in the subgenus is probably also facilitated by various insects. Butterflies and beetles have been noted visiting several of the species and undoubtedly serve as pollinating agents.

Generic Relations and Phylogeny

The genus *Cryptantha* is a member of the tribe Eritrichieae and is apparently derived from the Lithospermeae through some form similar to the North American species of *Antiphytum*, Johnston (1925).

The primitive fruit was probably similar to that of the Hydrophyllaceae, being two or imperfectly four-loculed, capsular, and terminated by a lobed style. The lobed style consistently occurs in those subfamilies of the Boraginaceae which are considered primitive, i.e. the Heliotropioideae, Ehretioideae, and Cordioideae. Within the subfamily Boraginoideae, the style is lobed or bears geminate stigmas only in the tribe Lithospermeae.

The nutlets have resulted from a pinching in of the pericarp walls to form lobes of the fruit each containing one ovule. The stages of this development may be appreciated by a comparative study of the fruit of *Heliotropium* or better still, of *Coldenia*. *Coldenia canescens* has an unlobed fruit bearing a decidedly terminal style; *Coldenia nuttallii* has the lobing evident and the style attached to the pericarp between and below the apices of the nutlets. In *Coldenia litoralis* the lobing is almost complete and the style is affixed almost upon the receptacle. Evidently the development of nutlets has proceeded by the deepening downward of the lobing from the apex and inward from the sides by the pinching in of the pericarp between the carpels. This finally results in an apparent basal attachment of the nutlets and a gradual lowering of the style base between the nutlets until it is at last directly and firmly affixed upon the receptacle, Johnston (1925).

The nutlets of the annual as well as the perennial species of *Cryptantha* are characterized by the presence of a medial ventral groove, which is caused by

the consolidation of the pericarp walls. This development appears to have been brought about by the gradual encroachment of the pericarp over the surface of the sharply cut triangular attachment scar such as those in the Lithospermeae. This encroachment gradually narrows the attachment surface of the nutlet and forms a groove which is usually somewhat forked at the base. In *Cryptantha* the groove may be narrow but not completely closed. In *Amsinckia*, *Plagiobothrys*, etc. the groove is entirely closed and its location is marked by a ridge of fused pericarpel tissue which bears the scar, Johnston (1925).

According to Johnston (1925), it seems quite probable that the subgenus Oreocarya has been derived from some form of *Antiphytum*, a genus of Lithospermeae evidently derived from some ancestral plant similar to *Lithospermum*. The subgenus Oreocarya is the most primitive in the genus, probably having given rise to the other subgenera of Krynitzkia, Cryptantha, and Geocarya, of which the latter two possess cleistogamous flowers. Oreocarya seems also to have given rise to *Plagiobothrys*, a genus which appears then to have evolved *Amsinckia*. The principal derivative of Oreocarya, however, appears to be *Hackelia*, for Oreocarya appears to be connected with *Cynoglossum* through *Hackelia*.

According to Johnston (1925) and Payson (1927), the subgenus Krynitzkia is a specialized offshoot of Oreocarya. Oreocarya consists of rather coarse perennials or sometimes biennials with usually persistent calyces and homomorphic nutlets. However, in the subgenus Krynitzkia, composed mostly of annuals, the calyces are deciduous and the nutlets somewhat heteromorphic. In the present group the question of primitive or of advanced condition is of much interest. In the present work the species have been grouped together mainly on the basis of similar morphological characters. After reviewing the works by Johnston (1924, 1925) and Payson (1927), plus this current research a phylogenetic summary is presented below. These conclusions are not final and may be subject to change after additional research.

Nutlets:

In the hypothetical, primitive plant the nutlets evidently were smooth on both surfaces and ovate in outline. The scar of the nutlet was straight and narrow without an elevated margin. Nutlets also were attached at a very low position on the gynobase. As specialization took place the nutlets were roughened first on the dorsal and then on the ventral surface. The nutlets became more lanceolate, with the scar developing an elevated margin and becoming open and contorted. The nutlet of the supposedly advanced plant also became attached at a higher point on the gynobase style.

Corolla:

The primitive plant had corollas which were short and never exceeded the lobes of the calyx. This primitive corolla had low, rounded fornices and crests at the base of the tube. As specialization took place the corolla became longer until it greatly exceeded the lobes of the calyx. This long tube apparently developed along several different lines in the evolution of the group. Styles of various lengths (heterostyly), are regularly associated with long tubes. This is also an advanced characteristic, styles of uniform length being primitive.

Calyx segments:

Broadly ovate or lanceolate sepals that were slightly accrescent were primitive, while those which are narrowly lanceolate or linear and conspicuously accrescent in fruit are advanced.

Inflorescence:

The primitive inflorescence was confined to the upper part of the stem and was composed of a few, conspicuously elongated, scorpioid cymules. As development proceeded the cymules became shorter and the inflorescence tended to cover more and more of the stem.

Stem:

The question of the primitive nature of the perennial or annual habit is of much interest. Morphologists, in general, seem to be of the opinion that the perennial habit is more primitive than the annual habit or biennial habit. The author is inclined to agree with this generalization. The primitive species in this group were perennial with slender unbranched stems, while the less enduring ones with very short branched stems are specialized.

Leaves and pubescence:

The linear oblanceolate leaf is more primitive than the broader ovate or spatulate types. An extremely setose indument on the leaf is considered to be a mark of specialization, and in like manner a conspicuously sericeous and uniform covering is a specialization in another direction.

Phylogenetic relationships:

The North American species of the subgenus Oreocarya are thought to be monophyletic, but showing several major lines of development. In the present treatment the species groups are not given any taxonomic rank, but are of the rank of sections. As a substitute for the section the term group is employed. The perennial species placed in the subgenus Oreocarya are evidently the most primitive in the genus. The most primitive of these is *C. jamesii* var. *multicaulis*. The variety *multicaulis* has so many primitive characteristics that it may be used to visualize the ancestor from which the other subgenera developed. The author tends to agree with Payson (1927) in his postulation that the primitive Oreocarya species evolved in four different directions. The species of the main section Oreocarya remained perennial and developed a tendency toward larger flowers and shorter cymes. This larger flowered group is probably monophyletic in the sense that a single primitive

ancestor gave rise to several basic types and these in turn produced species as we know them. Development in another direction produced annuals very early in the history of the genus. This group is recognized as the subgenus Krynitzkia, with its reduced flowers, heteromorphic nutlets, and elongate cymes. This subgenus is probably polyphyletic, the species in Krynitzkia apparently having arisen independently from several perennial ancestors. The other two subgenera, Geocarya and Cryptantha had primitive perennial ancestors and probably developed along the same lines as Krynitzkia, since the species in these subgenera are similar in appearance to Krynitzkia. Geocarya is probably monophyletic. Evidence for this is indicated in the peculiar morphology of the cleistogamous flowers. The subgenus Cryptantha, may have developed along several lines from Krynitzkia.

The groups that occur within the subgenus Oreocarya are characterized, discussed, and arranged in a phylogenetic scheme (Fig. 1).

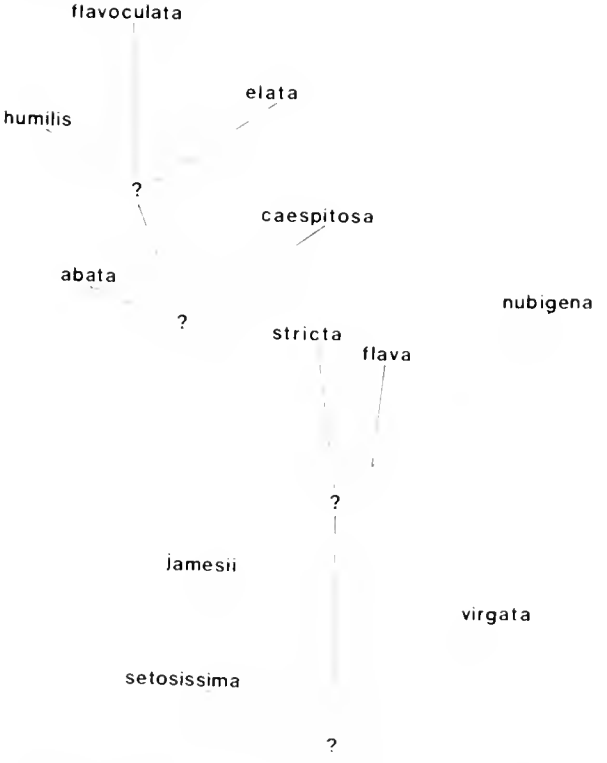


Fig. 1. A proposed phylogenetic arrangement of the groups within the subgenus Oreocarya.

The jamesii group: This group is composed of five species and seven varieties mostly confined to the eastern and southeastern section of the range of the subgenus (Fig. 2). It is characterized by the hemispherical fruit, with the nutlets smooth on all surfaces, or rugose and tuberculate, but not at all muricate on the dorsal surface. Ventral surface of the nutlet quite or nearly smooth, with the scar narrow, straight, and closed, and without an elevated margin. The species within the jamesii group form a natural unit. *Cryptantha jamesii* has more primitive characters (smooth hemispherical nutlets, short corolla tube with crests at the base, low fornices, oblanceolate leaves, strigose pubescence, and elongate cymes) than any other species in the subgenus and is probably similar to the hypothetical, ancestral form. *C. palmeri*, although very closely related to *C. jamesii*, shows the advanced characteristics of crests lacking at the base of the tube, accrescent sepals, and longer style. *C. crassipes* is to be considered more advanced than *C. palmeri* on the basis of the capitate inflorescence, roughened nutlets, and the longer style, which are all considered as specialized characters.

It seems probable that long corolla tubes are derived from shorter ones and that heterostyled flowers are derived from uniform flowers. On this basis *C. oblata* is more specialized than *C. jamesii*. *C. paysonii* probably very recently has evolved from *C. oblata*, but it is more specialized because of the strongly heterostyled flowers and the more capitate inflorescence.

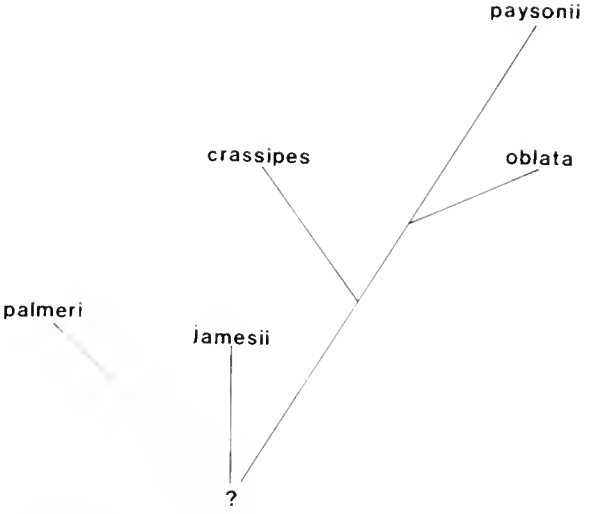


Fig. 2. A proposed phylogenetic arrangement of the species within the jamesii group.

The flava group: The flava group is composed of seven species, most of which are confined to Utah and northern Arizona (Fig. 3). The basic syndrome of characters includes the compressed nutlets which are smooth on both surfaces and the closed scar which lacks an elevated margin. This group is recognized as being closely related to the jamesii group primarily on the basis of the smooth nutlets. The species within this group, however, become more difficult to place because lines of development are more obscure. *C. salmonensis* is probably the most primitive in this group because of its short corolla and uniform style length. All other species within the group possess corollas that exceed the lobes of the calyx. *C. confertiflora* is a widely distributed species of the hot desert regions of Utah, Arizona, Nevada, and California and may have, through selective forces of the environment, given rise to most of the other species.

many of which are narrow endemics, confined to a particular kind of habitat. *C. semiglabra*, *C. capitata*, and *C. johnstonii* are closely related to *C. confertiflora*, but probably because of their ability to inhabit peculiar soil types, have been selected out and isolated from that species. *C. leucophaea*, a species of eastern Washington, which inhabits sand dunes along the Columbia River, was for a time included within the concept of *C. confertiflora* by Parish. It is believed, however, to be more advanced because of the longer inflorescence, conspicuous foliar bracts, and narrowly linear leaves. The author, at one time, was inclined to combine *C. flava* and *C. confertiflora* because of a few intermediates where the ranges of the two species overlap. However, with additional research the number of intermediates were found to be so few that the two taxa are best treated as separate species.

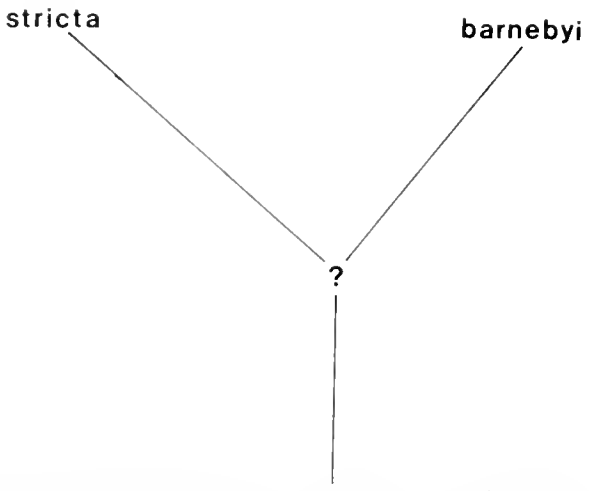


Fig. 4. A proposed phylogenetic arrangement of the species within the stricta group.

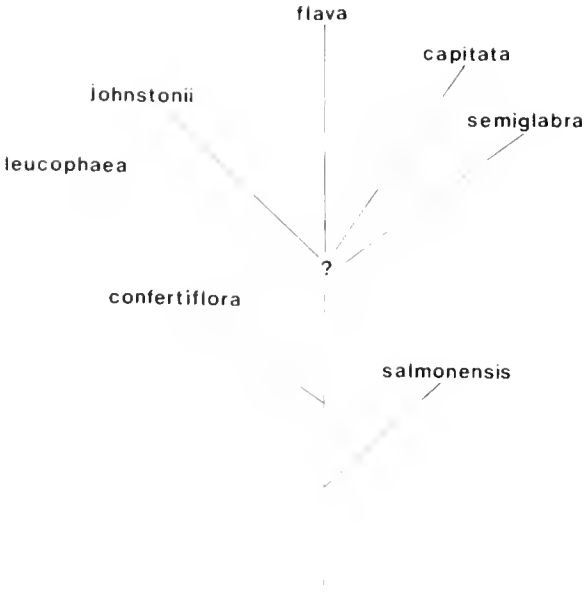


Fig. 3. A proposed phylogenetic arrangement of the species within the flava group.

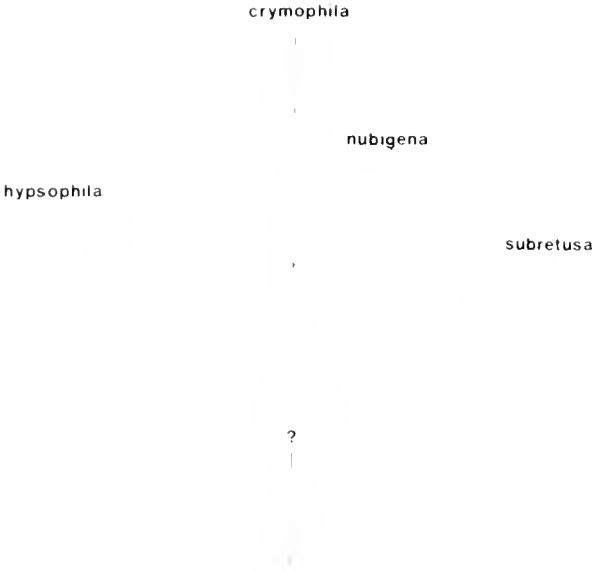


Fig. 5. A proposed phylogenetic arrangement of the species within the nubigena group.

The stricta group: The stricta group contains two species, *C. stricta* and *C. barnebyi*, both restricted to the Uintah Basin of Utah (Fig. 4). The stricta group probably had its origin from the flava group. The very setose or hispid indument, stout stems, and the smooth ventral surface of the nutlets separate this group from that of flava. *C. stricta* is considered more advanced than *C. barnebyi* because of the roughened dorsal surface of the nutlet.

The nubigena group: This group is composed of four species, all of high alpine or montane areas of California, Oregon, and Idaho (Fig. 5). The basic characteristics of the group involve the lanceolate nutlets, which are smooth on the ventral surface and roughened dorsally. This group probably had its origin from the flava group through some form similar to *C. confertiflora*. The three species, *C. nubigena*, *C. subretusa* and *C. hypsophila*, are so closely related that it is difficult to afford them complete specific rank; but because of the wide geographical separation and the slight differences in morphology, they are treated as distinct species. *C. crymophila* is probably more advanced than the other three species because of the larger nutlets, more accrescent sepals, and the longer foliar bracts. It was apparently derived from some form similar to *C. nubigena*.

The abata group: This group is mainly confined to the southwestern part of the range of the subgenus. It contains five species which are characterized by rugose or tuberculate nutlets, with the ventral scar open and triangular and usually surrounded by a slightly elevated margin (Fig. 6). These characters are all much more advanced than those displayed by the jamesii group; so it is probably not closely related to

that group. All the species in this group occur in the Sonoran Desert except for *C. abata*. *C. hoffmannii* is probably a recent derivative from *C. virginensis*. The two species appear to be distinct even though they are quite similar in general appearance. *C. hoffmannii* flowers much later and has nonfragrant flowers. The relationship of the other three species is not so obvious; however, they appear to have been derived from some common ancestor similar to *abata*.

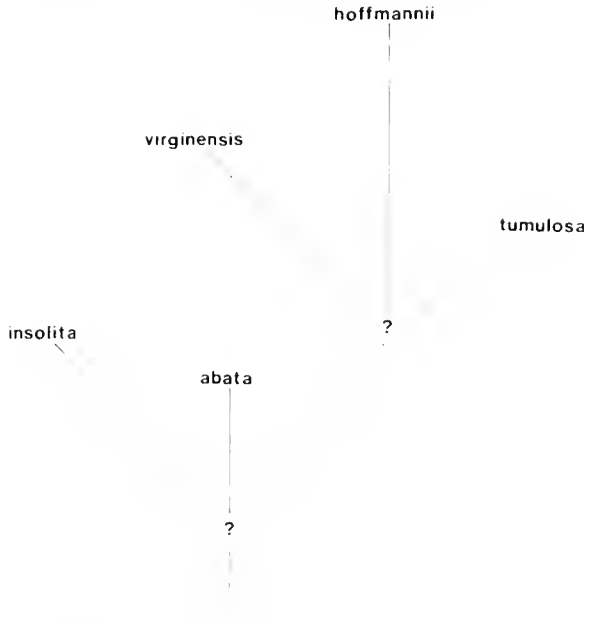


Fig. 6. A proposed phylogenetic arrangement of the species within the abata group.

The caespitosa group: This group contains two species, both of which are apparently derived from the abata or possibly the humilis group. The distribution of this group is bicentric. *C. caespitosa* is a very hummock forming species found throughout southern Wyoming growing on clay hillsides, while *C. ochroleuca* is a narrow endemic growing on gypsiferous soil in western Garfield County, Utah. The two species probably had a common ancestor similar to *C. caespitosa*.

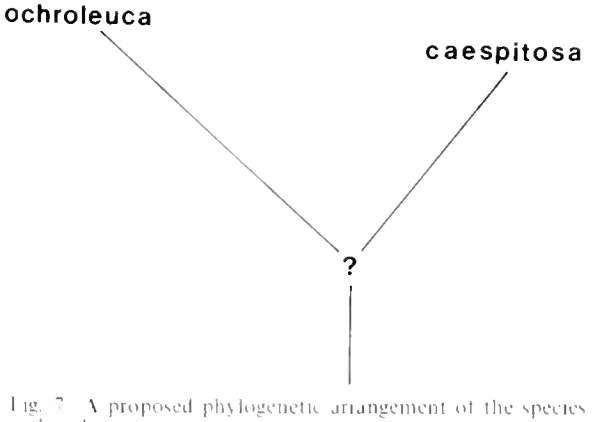


Fig. 7. A proposed phylogenetic arrangement of the species within the caespitosa group.

The humilis group: The humilis group is composed of eight species and five varieties (Fig. 8). The basic syndrome of characters in this group includes the conspicuously muricate nutlets and a scar with a tendency to be open and therefore triangular at the base. Two basic lines of development can be seen within this group; one in which the species possess two kinds of hairs and nutlets which have short rugae between the murications; the other line has leaves which are usually silky-strigose and only murications on the nutlets. *C. cana* and *C. breviflora* are members of this second group. *C. jonesiana* and *C. fulvocanescens* are considered advanced because of the long corolla tubes and more elongated nutlets.

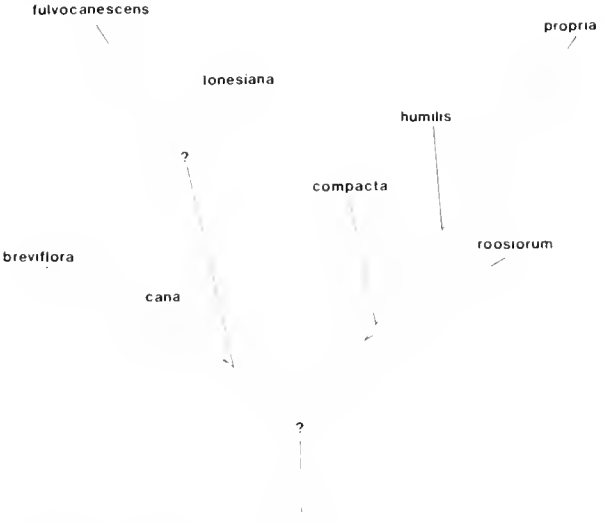


Fig. 8. A proposed phylogenetic arrangement of the species within the humilis group.

The elata group: The elata group is composed of thirteen species, covering a wide geographical and altitudinal range (Fig. 9). The basic syndrome of characters includes nutlets which are always roughened dorsally and distinctly rugose or tuberculate or both, and often muricate also; ventral surface smooth or variously roughened; scar straight, closed or nearly so, margins not elevated; corolla tubes never longer than the calyx lobes, except in *C. rollinsii*. The species in this group are so similar in overall appearance and characteristics that lines of development are obscured. *C. aperta* and *C. thyrsiflora* seem to form a natural unit which possess broad inflorescences and ovate tuberculate nutlets. *C. interrupta*, *C. spiculifera*, *C. shackletteana*, and also *C. rugulosa* seem to form a natural unit and are probably very closely related to each other. The lanceolate nutlets which have similar markings tend to substantiate this hypothesis. *C. celosioides*, a widespread and heteromorphic species, apparently gave rise to *C. sobolifera* and *C. thompsonii*. The other species in this group are more obscure in their evolutionary history; probably because they are very narrow endemics which have specialized out on peculiar soil types.

Fig. 9. A proposed phylogenetic arrangement of the species within the elata group.

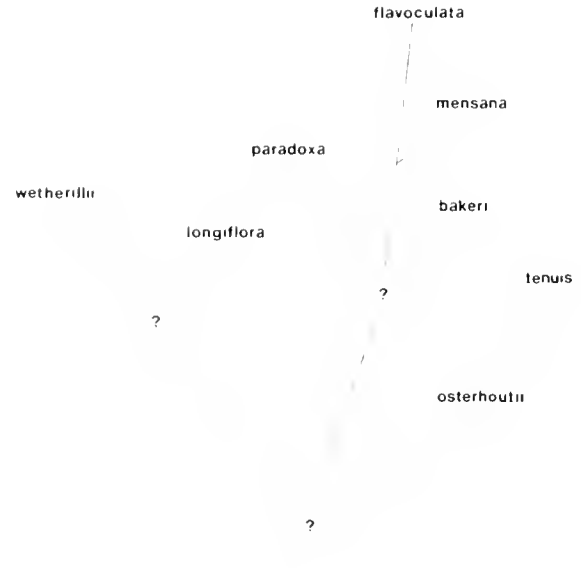


Fig. 10. A proposed phylogenetic arrangement of the species within the flavoculata group.

The flavoculata group: The flavoculata group is composed of eight species, most of which are confined to eastern Utah and western Colorado (Fig. 10). The basic syndrome of characters includes the deeply and conspicuously rugose and tuberculate, sometimes muricate or foveolate nutlets. Scar, except in *C. bakeri*, at least slightly open and then showing a tendency to be constricted above the base; margin usually elevated. The species of this highly developed group form so natural a unit that there is little doubt that they had a common origin. *C. osterhoutii* and *C. tenuis* are two very closely related species, but the longer corolla tube and style of *C. tenuis* evidently make it more advanced. *C. flavoculata* and the closely related species *C. paradoxa*, *C. bakeri*, and *C. mensana* are the most advanced in the subgenus and undoubtedly are very closely related. *C. wetherillii* and *C. longiflora* are somewhat intermediate between this group and the elata group, but seem to be more closely related to the flavoculata group on the basis of the nutlet characteristics.

The virgata group: This monotypic group is so different from the other basic groups that it is separated from them in this treatment. The characteristics which distinguish this distinctive group are the stout, erect, usually simple, fistulose stems and the long spicate inflorescence with the greatly elongated foliar bracts.

The setosissima group: This monotypic group is restricted to montane areas throughout southern Utah, Arizona, and southern Nevada. The basic syndrome of characters includes the simple erect stems, broadly winged nutlets, and ovate calyx segments.

Cytology

Very little cytological work has been done on the subgenus Oreocarya. Delbert Wiens at the University of Utah began a study of the morphology of the group, but because of the difficulty he had in being able to get seeds to germinate, the study was abandoned. He did, however, make chromosome counts on several of the species in this subgenus. The number in all species for which counts were made was n equals twelve. These species were *C. virgata*, *C. jamesii*, *C. thyrsiflora*, *C. flava*, *C. bakeri*, and *C. fulvocanescens*. Taylor and Brockman counted the chromosomes in *C. celosioides* (*C. maconnii*) and determined the number to be n equals nine. There are some discrepancies in the basic number of this subgenus, which points out the fact that much additional study is needed on the cytology of this group.

TAXONOMY

[illegible] subgenus Oreocarya (Greene) Higgins

Perennial herbs with a conspicuous [illegible] setose indument (except in *C. jamesii* var. *pustulosa* and *C. semiglabra*). Leaves entire, oblanceolate, spatulate or linear. Stems solitary from the root or caespitose, commonly unbranched below the inflorescence, 0.2-12 dm tall. Inflorescence a continuous or glomerate cluster of elongating or

reduced, simple or branched, bracteate or nearly ebracteate, two-ranked, unilateral, scorpioid cymes. Calyx segments distinct, usually conspicuously accrescent. Corollas white or yellow, salverform or campanulate; limb 4-17 mm broad; tube equalling or exceeding the calyx. Stamens included in the tube, anthers sessile or nearly so. Style shorter, equalling or much exceeding the mature fruit; stigma entire. Nutlets from nearly circular in outline to narrowly lanceolate, margined or winged, smooth or variously roughened on the different surfaces, attached to the gynobase at a point 1/3 to 4/5 of the distance from the base to the apex of the nutlet. Scar of nutlets various, open or closed, and margin elevated or plane. Subgeneric type: *C. celosioides* (Eastw.) Payson.

Key to the Species of Cryptantha Subgenus Oreocarya

1. Corolla tube elongate, distinctly surpassing the calyx; flowers usually heterostyled (2).
1. Corolla tube short, scarcely if at all surpassing the calyx; flowers not heterostyled (20).
   2. Nutlets smooth and shiny (3).
   2. Nutlets more or less roughened or wrinkled at least on the dorsal surface (9).
3. Corolla yellow (4).
3. Corolla white (5).
   4. Inflorescence an elongate, cylindrical thyrse; nutlets lanceolate, with acute margins, usually only one developing . . . . . 7. *C. flava*
   4. Inflorescence consisting of a large terminal cluster with one or more remote, at maturity frequently stalked, much smaller lateral clusters; nutlets broadly ovate, with winged margins, all four usually maturing . . . . 6. *C. confertiflora*
5. Inflorescence capitate, 0.1-0.4 dm long; corolla limb 6-8 mm broad, the tube little surpassing the calyx; nutlets lanceolate; native to northern Arizona and southern Utah . . . . . 8. *C. capitata*
5. Inflorescence elongate, 0.4-4 dm long; corolla limb 8-17 mm broad, the tube distinctly surpassing the calyx except in *C. barnebyi*; nutlets ovate (6).
   6. Ventral surface of the leaves glabrous; native to north-central Arizona and southwestern Utah . . . . . 10. *C. semiglabra*
   6. Ventral surface of the leaves strigose or setose-hispid (7).
7. Corolla limb 13-17 mm broad, crests at base of tube absent; nutlets 3-3.5 mm long; native to San Rafael Swell . . . . . 9. *C. johnstonii*
7. Corolla limb 8-11 mm broad, crests at base of tube conspicuous; nutlets 3.5-4.5 mm long (8).
   8. Corolla tube 5-7 mm long, the limb campanulate; leaves broadly oblanceolate, setose-hispid; stems stout; endemic to the Uintah Basin, Utah . . . . . 11. *C. barnebyi*
   8. Corolla tube 8-10 mm long, the limb spreading; leaves linear or narrowly lanceolate, strigose with few or no pustulate hairs, stems slender; native to Washington. . . . . 12. *C. leucophaea*
9. Nutlets uniformly muricate or papillose, or sometimes in *C. jonesiana* also with some inconspicuous ridges (10).
9. Nutlets more or less rugose or tuberculate, or sometimes with a few inconspicuous murications (11).
   10. Leaves oblanceolate, strigose with pustulate hairs small or lacking; corolla 7-10 mm long, fornices elongate; native to southeastern Utah, northwestern New Mexico, western Colorado, and northeastern Arizona . . . . . 34. *C. fulvocanescens*
   10. Leaves spatulate, hispid with pustulate bristles; corolla 10-15 mm long, fornices low and broad; native to the San Rafael Swell, Utah . . . . . 35. *C. jonesiana*
11. Ventral or inner surface of the nutlets smooth or nearly so (12).
11. Ventral surface of the nutlets distinctly roughened (15).
   12. Plants biennial; corolla campanulate, crests at base of tube evident; nutlets lanceolate; native to the Uintah Basin, Utah . . . . . 49. *C. rollinsii*
   12. Plants perennial; corolla salverform, crests at base of the tube lacking; plants of Texas and New Mexico (13).
13. Inflorescence capitate; nutlets 3.3-3.8 mm long; leaves densely white strigose or subtomentose; native to Brewster county, Texas . . 5. *C. crassipes*
13. Inflorescence elongate; nutlets 2.5-3.2 mm long; leaves strigose and setose-hispid (14).
   14. Corolla tube 7-10 mm long; calyx lobes 5-7 mm long in anthesis; plants not heterostyled; nutlets conspicuously tuberculate and short rugose; native to Texas . . . . . 3. *C. oblata*
   14. Corolla tube 12-14 mm long; calyx lobes 7-9 mm long in anthesis; plants strongly heterostyled; nutlets finely tuberculate or rugose, native to New Mexico and western Texas . . . . . 4. *C. paysonii*
15. Leaves conspicuously pustulate ventrally; corolla tube 12-16 mm long; calyx segments 7-10 mm long in anthesis; native to west-central Colorado and east-central Utah . . . . . 51. *C. longiflora*
15. Leaves sparsely if at all pustulate ventrally; corolla tube 5.5-12 mm long; calyx segments 3-5.7 mm long in anthesis (16).
   16. Inflorescence 0.1-0.4 dm long; corolla tube 10-12 mm long; margin of nutlets not in contact; plants less than 1.2 dm tall, eastern Utah and western Colorado. . 54. *C. paradoxa*
   16. Inflorescence 0.5-3 dm long; corolla tube 5-10 mm long; margin of nutlets in contact or nearly so; plants usually over 1.2 dm tall (17).

17. Scar of nutlets surrounded by an elevated margin but tightly closed; style 1-2 mm long; calyx 3.5-4 mm long in anthesis; native to southern Utah, southwestern Colorado, and northeastern Arizona . . . . . 55. *C. bakeri*

17. Scar of nutlets conspicuously open; style 3-8 mm long; calyx 4.5-7 mm long in anthesis (18).

18. Scar of nutlets conspicuously open and surrounded by a definite elevated margin; widespread . . . . . 57. *C. flavoculata*

18. Scar of nutlets slightly open and with only an inconspicuous elevated margin if any (19).

19. Leaves linear-spatulate; nutlets sharply and deeply rugose; corolla tube 5.5-7 mm long, fornices low and broad; native to southeastern Utah . . . . . 52. *C. tenuis*

19. Leaves obovate or broadly oblanceolate; nutlets with rounded ridges and tubercles; corolla tube 7-10 mm long, fornices long papillose; native to eastern Utah . . . . . 50. *C. wetherillii*

20. Nutlets smooth on their dorsal surface, not rugose, muricate or tuberculate (21).

20. Nutlets more or less roughened, muricate, rugose or tuberculate at least on the dorsal surface (26).

21. Fruit depressed globular, nutlets not in contact by their margins (22).

21. Fruit conical, ovoid or lanceolate, nutlets in contact by their margins or nearly so (23).

22. Crests at base of corolla tube conspicuous; calyx not conspicuously accrescent; widespread . . . . . 1. *C. jamesii*

22. Crests at base of corolla tube obsolete; calyx conspicuously accrescent; southwestern New Mexico, western Texas and northern Mexico . . . . . 2. *C. palmeri*

23. Stout, strictly erect plants with many elongated and conspicuous bracts in the inflorescence, southeastern Wyoming and central Colorado . . . . . 20. *C. virgata*

23. Smaller, usually caespitose plants with few or inconspicuous bracts in the inflorescence; native to west of the continental divide (24).

24. Corolla tube 5-7 mm long, style 5-6 mm long; calyx 5-7 mm long; endemic to the Uintah Basin, Utah . . . . . 11. *C. barnebyi*

24. Corolla tube 2-4 mm long; style 0.5-2 mm long; calyx 2.5-4 mm long (25).

25. Nutlets ovoid, corolla tube 3-4 mm long, limb 7-10 mm wide; plants of central Idaho . . . . . 13. *C. salmonensis*

25. Nutlets narrowly lanceolate, corolla tube 2-2.5 mm long, limb 3.5-5 mm wide; native to the high sierras in southern California . . . 15. *C. nubigena*

26. Ventral surface of the nutlets smooth or nearly so (27).

26. Ventral surface of the nutlets rugose or variously wrinkled (40).

27. Nutlets bordered by a conspicuous wing; robust plants 5-10 dm tall, with long ebracteate spikes . . . . . 19. *C. setosissima*

27. Nutlets never conspicuously winged, sometimes with an acute margin simulating a narrow wing; plants usually lower and caespitose; inflorescence bracteate (28).

28. Inflorescence a virgate spikelike thyrsus with all but the uppermost floral bracts much longer than the short cymes; nutlets broadly ovate, sparcely rugose or smooth; native to Wyoming and Colorado . . . . . 20. *C. virgata*

28. Inflorescence various but seldom if ever so spikelike, and at least the upper floral bracts reduced to short bracts which slightly if at all exceed the cymes or racemose branches (29).

29. Corolla tube 7-9 mm long; calyx 6-9 mm long in anthesis (30).

29. Corolla tube 2-6 mm long; calyx 2.5-6 mm long in anthesis (31).

30. Inflorescence capitate, 0.2-0.8 dm long; nutlets ovate; leaves densely white strigose or subtomentose; native to the Big Bend Region of Texas . . . . . 5. *C. crassipes*

30. Inflorescence elongate, 0.6-2 dm long; nutlets lanceolate; leaves setose-hispid; native to Utah . . . . . 49. *C. rollinsii*

31. Inflorescence very broad and rounded in outline; native to the eastern slope of the Rocky Mountains . . . . . 36. *C. thyrsiflora*

31. Inflorescence narrower; plants west of the continental divide (32).

32. Fruiting calyx 9-14 mm long; nutlets 4-6 mm long (33).

32. Fruiting calyx 4-9 mm long; nutlets 2.5-3.8 mm long (34).

33. Nutlets lanceolate, the scar narrowly subulate but open at the base; native to Alpine and Tuolumne Counties, California . . . . . 18. *C. crymophila*

33. Nutlets more ovate, the scar broader and cuneate at the base; plants of the high mountains in Kittitas and Chelan Counties, Washington . . . . . 46. *C. thompsonii*

34. Nutlets 2-2.3 mm long, the scar cuneate or narrowly triangular; plants of Saguache and Hinsdale Counties, Colorado . . 40. *C. weberi*

34. Nutlets 2.6-3.7 mm long, scar closed or narrowly linear and open only at the forked base (35).

35. Plants conspicuously setose-hispid; nutlets transversely rugose and tuberculate; plants of Colorado, Utah, and Nevada (36).

35. Plants strigose or setose, but not as above; nutlets usually tuberculate or short rugulose; plants of the high mountains in California, Oregon, Idaho, and Montana (37).

36. Nutlets scarcely or not at all muricate between the rugae; strictly erect, conspicuously

hispid perennials from northwestern Colorado and northeastern Utah . . .14. *C. stricta*

36. Nutlets distinctly muricate or tuberculate between the rugae and near the margins; erect perennials from western Utah and eastern Nevada . . . . . .41. *C. rugulosa*

37. Nutlets with tubercles but no conspicuous transverse ridges, or sometimes nearly smooth; native to California. . . . . .15. *C. rubigena*

37. Nutlets with evident ridges on the dorsal surface; plants of northern California, Oregon, Idaho, and Montana (38).

38. Style 1.8-2.5 mm long; soboliferous perennials from western Montana . . . . . .47. *C. sobolifera*

38. Style 0.5-1.5 mm long; plants of Idaho and Oregon (39).

39. Leaves oblanceolate, acute or obtuse, spreading bristly setose; style 1.2-1.5 mm long; central Idaho . . . . . .17. *C. hypsophila*

39. Leaves spatulate, subretuse or obtuse, subtomentose or strigose; style 0.5-1 mm long; Oregon, northern California, and northwestern Nevada . . . . . .16. *C. subretusa*

40. Nutlets conspicuously muricate, or in *C. humilis* also with a few irregular ridges (41).

40. Nutlets not exclusively muricate, but rugose or tuberculate, also with a few murications between the ridges (44).

41. Leaves distinctly subtomentose or tomentose, also setose in *C. humilis* (42).

41. Pubescence of the leaves silky-strigose or strigillose but not subtomentose or tomentose (43).

42. Plants 0.3-1 dm tall; leaves 0.5-2.5 cm long; calyx 2-2.5 mm long in anthesis; corolla tube 1.8-2.2 mm long; native to Millard County, Utah . . . . . .30. *C. compacta*

42. Plants 0.4-2.5 dm tall; leaves 2.5 cm or longer; calyx 3-5 mm long in anthesis; corolla tube 3-5 mm long; plants widespread, Colorado to California . . . . . .28. *C. humilis*

43. Plants densely caespitose, caudex multicipital; leaves linear oblanceolate; native to eastern Wyoming and adjacent Nebraska and Colorado . . . . . .31. *C. cana*

43. Plants scarcely or only moderately caespitose; leaves broadly oblanceolate or spatulate; native to the Uintah Basin in northeastern Utah . . . . . .32. *C. breviflora*

44. Scar of nutlets open some distance above the base (45).

44. Scar of nutlets closed or nearly so, without a conspicuous triangular opening toward the base (58).

45. Scar somewhat constricted some distance below the middle of the open portion (46).

45. Scar triangular and not constricted below the middle (47).

46. Elevated margin of the scar definitely limited; pustules present on both leaf surfaces; central Utah . . . . . .56. *C. mensana*

46. Elevated margin indefinitely limited; pustules present only on dorsal surface of the leaves; southeastern Utah . . . . . .53. *C. osterhoutii*

47. Some tendency to an elevated margin evident around the scar (48).

47. No tendency to an elevated margin around the scar (52).

48. Cymules elongating and so the inflorescence broad; biennial or short-lived perennials; nutlets usually with an evident dorsal ridge (49).

48. Cymules shorter and the inflorescence narrow; long-lived perennials; nutlets with only a slight dorsal ridge if any. (51).

49. Surface of the leaves with inconspicuous appressed bristles; inflorescence open, with only a few elongate cymules, 7-14 cm long terminating the stem; endemic to near Las Vegas, Nevada. . . . . .22. *C. insolita*

49. Surface of the leaves conspicuously setose-hispid with spreading bristles; inflorescence open, at least at maturity (50).

50. Calyx lobes 7-12 mm long in fruit; nutlets 3-4.5 mm long; prominently carinate on the dorsal side; southwestern Utah to southern California . . . . . .23. *C. virginensis*

50. Calyx lobes 5-7 mm long in fruit; nutlets 2.5-3 mm long, with only an indistinct central ridge toward the apex; eastern California and western Nevada . . . . .24. *C. hoffmannii*

51. Nutlets indefinitely tuberculate and rugose; California and southern Nevada . . . . 21. *C. tumulosa*

51. Nutlets definitely tuberculate or rugose; native to Utah and eastern Nevada . . . . . 25. *C. abata*

52. Style not exceeding the mature nutlets by more than 0.5 mm; plants usually less than 1.3 mm tall (53).

52. Style exceeding the mature nutlets by 1 mm or more; plants usually taller than 1.3 dm (56).

53. Corolla tube 3-4 mm long; nutlets 3-3.5 mm long (54).

53. Corolla tube 2-2.6 mm long; nutlets 2.3-3 mm long (55).

54. Ventral surface of nutlets deeply rugose and tuberculate; native to southern Utah and eastern Nevada . . . . . 25. *C. abata*

54. Ventral surface of nutlets indefinitely muricate; native to southern Wyoming . . . . . .26. *C. caespitosa*

55. Inflorescence less than 2 cm long; calyx segments 3-4 mm long in fruit; plants 0.1-0.3 dm tall; endemic to Inyo County, California . . . . . .29. *C. roosiorum*

55. Inflorescence 2.7 cm long or longer; calyx segments 4-6 mm long in fruit; plants 0.2-1.3 dm

tall; endemic to Garfield County, Utah . . . . . 27. *C. ochroleuca*

56. Leaves setose-pustulate and tomentose; nutlets muricate or with a few short rugae . . . . . 28. *C. humilis*

56. Leaves finely strigose and appressed setulose; pustulate hairs lacking or inconspicuous on the ventral surface of the leaves; densely caespitose perennials (57).

57. Leaves linear to narrowly oblanceolate; corolla tube 3-3.3 mm long; nutlets inconspicuously tuberculate and rugulose; native to Alaska . . . . . 44. *C. shackletteana*

57. Leaves oblanceolate to spatulate; corolla tube 3.5-4.5 mm long; nutlets muricate and irregularly rugose; native to Oregon and western Idaho . . . . . 33. *C. propria*

58. Upper surface of the leaves uniformly appressed strigose and without pustulate hairs (59).

58. Upper surface of the leaves with two distinct kinds of hairs, pustulate at base (63).

59. Nutlets sharply rugose and tuberculate, scar surrounded by an elevated margin . . . . 55. *C. bakeri*

59. Nutlets not so sharply rugose or tuberculate, scar not surrounded by an elevated margin (60).

60. Leaves linear or narrowly oblanceolate, 2-13 cm long, 0.1-0.5 cm wide; native to Alaska . . . . . 44. *C. shackletteana*

60. Leaves shorter and broader, plants from farther south (61).

61. Corolla tube 2-2.5 mm long; style exceeding nutlets by 1 mm or less; endemic to Garfield County, Utah . . . . . 27. *C. ochroleuca*

61. Corolla tube 3.5 mm long or longer; style exceeding nutlets by more than 1 mm (62).

62. Densely caespitose perennial from a multicipital caudex; native to eastern Oregon and western Idaho . . . . . 33. *C. propria*

62. Less evident or not at all caespitose; native to Utah, Colorado, and Wyoming . . . . . 38. *C. scricea*

63. Mature calyx exceeding the nutlets by 2-4 mm; inflorescence broadtopped; western Colorado and eastern Utah . . . . . 37. *C. clata*

63. Mature calyx exceeding the nutlets by 4-8 mm (64).

64. Nutlets tuberculate, scarcely if at all rugose (65).

64. Nutlets more or less rugose (69).

65. Ventral surface of the nutlets smooth or nearly so; native to high mountains in western Montana . . . . . 47. *C. soboliifera*

65. Ventral surface of the nutlets distinctly roughened (66).

66. Plant 1-2 dm tall; native to western Colorado and eastern Utah (67).

66. Plants 2 or more dm tall (68).

67. Corolla tube 2.6-3 mm long, calyx segments 2.8-3 mm long in anthesis; nutlets 2-2.6 mm long; endemic to Mesa County, Colorado . . . . . 39. *C. aperta*

67. Corolla tube 3.5-5 mm long; calyx segments 5-7 mm long in anthesis; nutlets 3-3.8 mm long; native to Uintah County, Utah . . 48. *C. grahamii*

68. Nutlets broadly lanceolate; muricications lacking or indefinite; inflorescence slightly open to very broad; widespread, from North Dakota to Washington and Oregon . . . . . 45. *C. celosioides*

68. Nutlets narrowly lanceolate; muricications or tuberculations very definite; Elko County, Nevada . . . . . 42. *C. interrupta*

69. Scar of the nutlets somewhat open at the base . . . . . 28. *C. humilis*

69. Scar of the nutlets closed or nearly so (70).

70. Inflorescence very broad and open; plants native on the eastern slope of the Rocky Mountains, from southern Wyoming to northern Texas . . . . . 36. *C. thyrsiflora*

70. Inflorescence narrower; plants more northerly in range (71).

71. Leaves narrowly oblanceolate, strongly setose-ciliate on the margins; stems slender; native to eastern Washington and Oregon, and Idaho . . . . . 43. *C. spiculifera*

71. Leaves usually broader, oblanceolate to spatulate, the margins not strongly setose-ciliate; stems more robust (72).

72. Inner surface of the nutlets conspicuously rugose or tuberculate; widespread . . . . . 45. *C. celosioides*

72. Inner surface of the nutlets smooth or nearly so (73).

73. Leaves soboliferous, oblanceolate to spatulate, setose; native to high mountains of western Montana . . . . . 47. *C. soboliifera*

73. Leaves not soboliferous, spatulate, subretuse, subtomentose; native to northern California and Oregon . . . . . 16. *C. subretusa*

1. *Cryptantha jamesii* (Torr.) Payson

Perennials, 1-6 dm tall; stems one-many, 0.4-4 dm long, glabrous to conspicuously hirsute; leaves linear to broadly oblanceolate, obtuse to acute, 2-15 cm long, 0.2-1.5 cm wide, glabrous to hirsute, usually pustulate dorsally, ventral surface lacking pustules or the pustules very inconspicuous; inflorescence open, cymules usually elongating, tomentose to setose-hirsute, floral bracts inconspicuous to very conspicuous; calyx segments ovate-lanceolate, acute, in anthesis 3-4 mm long, in fruit 5-7 mm long, subtomentose to setose-hirsute, (or sometimes nearly glabrous); pedicels 1-3 mm long; corolla white, the tube 2.5-3 mm long, crests at base of tube conspicuous, fornices

light-yellow, emarginate, 0.5-1 mm long, limb 5-8 mm broad; style exceeding mature fruit 1-3 mm; fruit oblate-ovoid, 1-4 nutlets maturing, ovate-lanceolate, margins acute, 2-2.5 mm long, 1.5-2 mm wide, the margins not in contact, both surfaces smooth and glossy, scar straight, closed, extending from the base to near the apex, elevated margin lacking.

Key to the varieties of *C. jamesii*

1. Ventral surface of the leaves glabrous, the petioles not ciliate-margined, nor tufted at the base . . . . . .lg. var. *pustulosa*
1. Ventral surface of the leaves strigose or setose, the petioles ciliate-margined; leaves tufted at the base (2).
   2. Stems simple, not branched above the base (3).
   2. Stems branched from the base as well as above (5).
3. Stems 1-4.4 dm long, usually twice as long as the basal tuft of leaves . . . . . 1a. var. *multicaulis*
3. Stems 0.2-0.9 dm long, usually not exceeding the basal tuft of leaves (4).
   4. Floral bracts exceeding the cymules; stems low, decumbent; Nevada and California . . . . . .ld. var. *abortiva*
   4. Floral bracts not exceeding the cymules; stems erect or nearly so . . . . . 1c. var. *setosa*
5. Stems decumbent; plants of the Great Plains . . . . . .1f. var. *jamesii*
5. Stems erect; plants west of the continental divide (6).
   6. Leaves linear; cymules 8 cm long or longer, very lax; native to southern New Mexico, Texas, and Mexico . . . . . .1b. var. *laxa*
   6. Leaves oblanceolate; cymules usually much shorter than 8 cm long, and more congested . . . . . .1e. var. *disticha*

1a. var. *multicaulis* (Torr.) Payson

Cryptantha jamesii (Torr.) Payson var. *multicaulis* (Torr.) Payson, Ann. Mo. Bot. Gard. 14:244. 1927.

Eritrichium multicaule Torr. in Marcy, Exploration Red River. 262. 1854

Oreocarya multicaulis (Torr.) Greene, Pitt. 3:114. 1896.

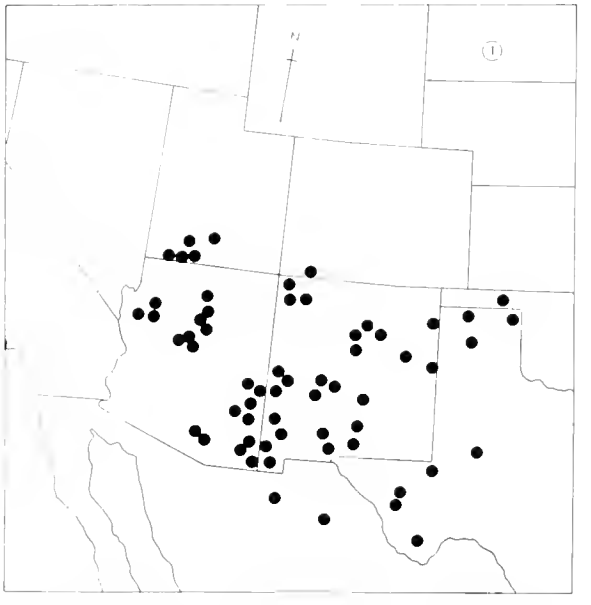
Oreocarya suffruticosa (Torr.) Payson var. *multicaulis* (Torr.) Payson, Univ. Wyo. Publ. Bot. 1:171. 1926.

Hemisphaerocarya suffruticosa (Torr.) Brand var. *multicaulis* (Torr.) Brand, Fedde, Rep. Spec. Nov. 24:60. 1927.

Perennial, 2-5.5 dm tall, branched from the base, simple above; stems slender, 1-4.4 dm long, weakly strigose-setose; leaves mostly basal, oblanceolate, 5-15 cm long, 0.4-1 cm wide, dorsal surface strigose and appressed setose, or sometimes setose-hirsute, pustulate, ventral surface uniformly strigose or subtomentose, without pustules, or the pustules small and inconspicuous, the petioles conspicuously ciliate on the margins; inflorescence open, 0.5-1.5 dm long, bracts inconspicuous. Collections: 387 (x); representative: Jones 4007 (ARIZ, GH, US, UTC); J. M. Tucker 2771 (GH, ORE); R. C. Rollins 2429 (GH, US, UTC); B. Maguire 11975 (ARIZ, UTC); O. B. Metcalfe 70 (ARIZ, GH, ND-G, US); E. C. Higgins 3136, 3169, 3595 (BRY, WTSU).

Holotype: Fendler 636, collected in New Mexico near Santa Fe, 1847, NY. Isotypes at GH, US.

Distribution: Southern Colorado and eastern New Mexico, south to western Oklahoma and Texas into northern Mexico, north through central Arizona to southern Utah. Growing on a wide variety of soils, 4,500 to 8,000 feet. Map No. 1a. April to September.



Map No. 1a. Parts of southwestern United States. Range of *C. jamesii* (Torr.) Payson var. *multicaulis* (Torr.) Payson.

The original description of *E. multicaule* Torr., was based on a collection from near Santa Fe with setose-hirsute pubescence. This same bristly form also occurs in the White Mountains and southward to the Santa Catalina Mountains of Arizona. A strigose or subtomentose form occurs about Flagstaff, also into southwestern New Mexico, and north into southern Utah. In northern Arizona var. *multicaulis* may be confused with var. *setosa*. It can be separated from var. *setosa* by the longer stems, becoming twice the length of the basal tuft of leaves, and the individual cymes which are longer and more perfectly developed. On its eastern boundary it may be confused with var. *jamesii*, but differs in the simple stem which is never branched above the base, more perfectly developed cymes, and the more dense strigose pubescence.

1b. var. *laxa* (Macbr.) Payson

Cryptantha jamesii (Torr.) Payson var. *laxa* (Macbr.) Payson, Ann. Mo. Bot. Gard. 14:246. 1927.

Oreocarya multicaulis var. *laxa* Macbr., Contr. Gray Herb. 48:35. 1916.

Hemisphaerocarya laxa (Macbr.) Brand, Fedde, Rep. Spec. Nov. 24:60. 1927.

Perennial, 2.5-4.5 dm tall, stems branched from the base and upward, stout, 1-3 dm long, strigose and spreading setose, leaves linear, 4-12 cm long, 0.2-0.5 cm wide, dorsal surface coarsely strigose and pustulate, ventral surface finely strigose, and with a few inconspicuous pustulate hairs, the petioles long ciliate margined; inflorescence very broad and open, lax, 0.7-2.5 dm long, the foliar bracts inconspicuous. Collections: 13 (0); representative: L. C. Hinckley 3480 (GH), V. Harvard s.n. (US), F. L. Reed 3450 (US); E. O. Wooton 401 (NY).

Holotype: Pringle 776, collected in Chihuahua, Mexico, on sand hills near Paso Del Norte, 20 September 1886, GH. Isotypes F.L., ND-G.

Distribution: Southern New Mexico, western Texas, and northern Mexico in the state of Chihuahua. Limited to sand dune areas. Map No. 1b. June to November.

This narrow-leaved variety is apparently confined to the sandy, dune areas of Mexico and southern New Mexico. It may be confused with var. *jamesii* in western Texas and southern New Mexico, but usually can be separated from that variety by the stout, erect stems, the narrower leaves, and the longer, more perfectly developed cymes. From variety *multicaulis* it differs in the stems, which are branched above the base, and the very narrow leaves scattered along the stems.

1c. var. *setosa* (Jones) Johnst. ex Tidestr.

Cryptantha jamesii (Torr.) Payson var. *setosa* (Jones) Johnst. ex Tidestr. Proc. Biol. Soc. Wash. 48:42. 1935.

Oreocarya cinerea Greene, Pitt. 3:113. 1896. (Type: Southern Colorado, on the plains near Pueblo, 1873, Greene s.n.)

Krynitzkia multicaulis var. *setosa* Jones, Contr. West. Bot. 13:4. 1910.

Oreocarya lemmonii Eastw., Bull. Torrey Bot. Club 30:239. 1903. (Type: Arizona, without definite locality, 1884, Lemmon.)

Oreocarya multicaulis var. *cinerea* (Greene) Macbr., Proc. Am. Acad. 51:54. 1916.

Oreocarya suffruticosa var. *cinerea* (Greene) Payson, Univ. Wyo. Publ. Bot. 1:171. 1926.

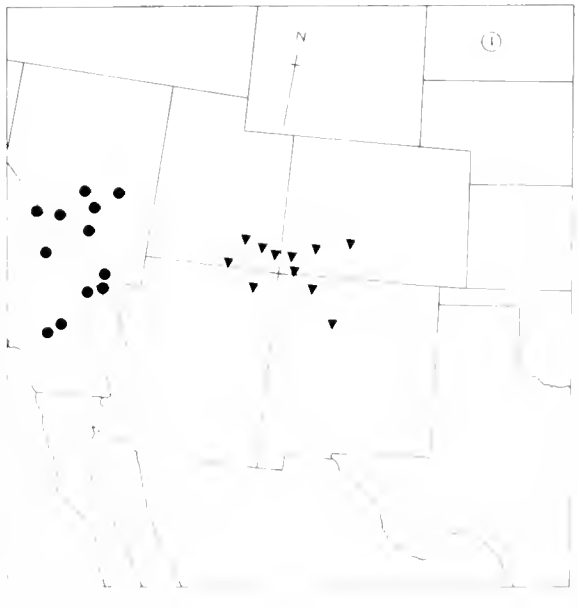
Hemisphaerocarya suffruticosa var. *setosa* (Jones) Brand, Fedde, Rep. Spec. Nov. 24:60. 1927.

Hemisphaerocarya cinerea (Greene) Brand, Fedde, Rep. Spec. Nov. 24:61. 1927.

Cryptantha jamesii (Torr.) Payson var. *cinerea* (Greene) Payson, Ann. Mo. Bot. Gard. 14:246. 1927.

Perennial, 1-3 dm tall, branched from the base, simple above; stems slender, 0.2-0.9 dm long, strigose and weakly setose; leaves mostly basal, oblanceolate, obtuse, 3.5-13 cm long, 0.4-1.5 cm wide, dorsal surface finely strigose, usually conspicuously pustulate, ventral surface uniformly and densely strigose, the petioles conspicuously ciliate on the margins; inflorescence open, 0.4-2 dm long, bracts evident especially near the base of the inflorescence. Collections: 163 (vii); representative: T. S. Brandegee B31 (NY, US); E. L. Greene s.n. (ND-G); Rydberg and Vreeland 5702 (NY, RM), D. T. Macdougal 204 (ARIZ, US); C.

Map No. 1b. Parts of southwestern United States. Range of *C. jamesii* (Torr.) Payson (Circles), var. *setosa* (Jones) Johnst. ex Tidestr. (Triangles); var. *laxa* (Macbr.) Payson



Map No. 1c. Parts of western United States. Range of *C. jamesii* (Torr.) Payson (Circles), var. *aborita* (Greene) Payson, (Triangles); var. *pustulosa* (Rydb.) Harrington

F. Baker 455 (GH, RM, US); L. C. Higgins 1009, 1443 (BRY).

Holotype: M. E. Jones s.n., collected near Fort Cove, Utah, growing under junipers, 27 June 1901, RSA. Photograph at BRY.

Distribution: South-central Colorado, northern New Mexico, northern Arizona, eastern Nevada, and southern Utah. Usually found on heavy clay soils. Map No. 1b. Late May to early September.

In southern Utah variety *setosa* reaches its best development. It is characterized by the short stems which never exceed the basal tuft of leaves. In the outlying areas on the margins of its range, it freely intergrades with variety *multicaulis* on the south, *abortiva* on the west, and variety *jamesii* on the eastern side. *Oreocarya lemmoni* was separated on the basis of a more setose indument which occurs on a population of this variety about Prescott, Arizona; however, I do not believe that it is worthy of any taxonomic rank. This variety has been recognized in the past as variety *cinerea*, but the older name of *setosa* must be used, at least at the variety level.

1d. var. *abortiva* (Greene) Payson

Cryptantha jamesii (Torr.) Payson var. *abortiva* (Greene) Payson, Ann. Mo. Bot. Gard. 14:250. 1927.

Oreocarya abortiva Greene, Pitt. 3:114. 1896.
Krynitzkia multicaulis var. *abortiva* (Greene) Jones, Contr. West. Bot. 13.5. 1910.
Oreocarya suffruticosa var. *abortiva* (Greene) Macbr. Proc. Am. Acad. 51 547. 1916.
Hemisphaerocarya abortiva (Greene) Brand, Fedde, Rep. Spec. Nov. 24 61. 1927.

Prostrate, caespitose perennials, branched from the base, 0.7-2 dm tall; stems slender, weak, decumbent, 0.3-0.7 dm long, strigose, and with some weak spreading setose hairs; leaves basal, as well as scattered along the stem, linear to narrowly oblanceolate, 1.5-9 cm long, 0.3-0.9 cm wide, dorsal surface finely strigose and setose pustulate, ventral surface finely strigose and without pustules, the petioles ciliate margined; inflorescence open, 0.2-1.3 dm long, floral bracts very evident, usually exceeding the cymules. Collections: 44 (i); representative: Clokey 7280 (BRY, ND, NY, ORE, UTC); Maguire and Holmgren 26119 (NY, UTC); Parish 1480 (US); Purpus 6068 (US).

Lectotype: S. B. Parish 3694, collected in the San Bernardino Mountains, Bear Valley, 6,500 feet, 16-20 June 1895, ND-G. Isolectotypes at GH, UC.

Distribution: Central and southern Nevada, west to the San Bernardino Mountains, north through Inyo and Mono Counties, California. Growing in sandy soils from 6,000 to 10,500 feet. Map No. 1c. Late May to October.

Variety *abortiva* is fairly well defined geographically, and is only to be confused on its eastern boundary with var. *setosa*. It may be separated from that variety by the long foliar bracts which exceed the individual cymules and the prostrate stems.

I have designated the plant in the Notre Dame Herbarium with Greene's handwritten notation *Oreocarya abortiva* to be the type specimen, as it agrees with the plant and the maturity of the fruit which he discusses in the original description.

1e. var. *disticha* (Eastw.) Payson

Cryptantha jamesii (Torr.) Payson var. *disticha* (Eastw.) Payson, Ann. Mo. Bot. Gard. 14:248. 1927.

Oreocarya disticha Eastw. Bull. Torrey Bot. Club 30 238. 1903.

Erect perennials, branched from the base as well as above; 2.5-4.2 dm tall; stems somewhat woody near the base, 1.2-2.9 dm long, strigose and weakly setose; leaves narrowly oblanceolate, 3-12 cm long, dorsal surface setose-pustulate and strigose, ventral surface strigose to setose or silky-strigose, without pustulate hairs or the pustules inconspicuous, the petioles ciliate-margined; inflorescence open, 0.5-2 dm long, the foliar bracts not conspicuous. Collections: 60 (iv); representative: A. H. Holmgren 3243 (ARIZ, BRY, UC, US, UTC); B. F. Harrison 10370 (BRY, UC); B. Maguire 18298 (UC, UTC); Eastwood and Howell 6674 (UTC); L. C. Higgins 1004 (BRY).

Holotype: A. Eastwood 90, collected in San Juan County, Utah, on Bartons Range, 13 July 1895, CAS. Isotypes at UC, GH, US.

Distribution: Wayne and Emery Counties, Utah, southeast through southwestern Colorado, northwestern New Mexico, northeastern Arizona in Apache, Navajo, and Coconino Counties, north to Garfield County, Utah. Usually found growing on sand dunes or sandy slopes and ridges, 4,000 to 7,500 feet. Map No. 1d. Late April to September.

The variety *disticha* seems to be intermediate between variety *multicaulis* and var. *jamesii*. It can be separated from the former by the more woody stems which are branched above the base, from var. *jamesii* by the erect stems, the leaves which are subglabrescent, and the more perfectly developed cymules. The character of a single nutlet is of no value; as one to four nutlets may be found on the same plant.

1f. var. *jamesii*

Cryptantha jamesii (Torr.) Payson var. *jamesii*.

Myosotis suffruticosa Torr. Ann. Lyc. N.Y. 2:225. 1827, not *Cryptantha suffruticosa* Piper, Proc. Biol. Soc. Wash. 32:42. 1919.
Eritrichium jamesii Torr. in Marcy, Expl. Red River, 262. 1854.
Krynitzkia jamesii (Torr.) Gray, Proc. Am. Acad. 20 278. 1885 in part.
Oreocarya suffruticosa (Torr.) Greene, Pitt. 1:57. 1887.
Hemisphaerocarya suffruticosa (Torr.) Brand, Fedde, Rep. Spec. Nov. 24 60. 1927.
Hemisphaerocarya suffruticosa var. *typica* Brand, Fedde, Rep. Spec. Nov. 24 60. 1927.

Decumbent perennials, 1.6-4 dm tall, branched from the base as well as above; stems decumbent,

stem 2 dm long, strigose and weakly setose, leaves linear to oblanceolate, 2.5-8 cm long, 0.3-0.9 cm wide, the dorsal surface coarsely strigose and appressed setose pustulate, ventral surface uniformly strigose and without pustules, the petioles ciliate-margined, inflorescence open, 0.4-1.4 dm long, floral bracts evident but not conspicuous. Collections: 217 (HD), representative: P. A. Rydberg 1514 (GH, ND-G, NY, US), A. Nelson 477 (GH, ND-G, NY, US), C. I. Porter 3951 (BRY, GH, RM), E. H. Christ 954 (CS, GH), E. C. Higgins 1527 (BRY).

Holotype: James s.n., barren deserts high upon the Platte, NY.

Distribution: Wyoming and South Dakota, south through Nebraska, Kansas, and western Oklahoma, west through northern Texas and western New Mexico, and north through Colorado east of the Continental Divide. Growing on sandy to clay soils. Map No. 1d. May to late August.

Variety *jamesii* is confined mainly to the area east of the Continental Divide, but with some overlap in central New Mexico and southern Colorado. In eastern New Mexico it may be confused with var. *multicaulis*, and very often it is quite difficult to separate the two. In south-central and southern Colorado var. *jamesii* may be confused with var. *setosa*, but can usually be separated from it by the shorter leaves which are scattered along the stem, rather than in a basal tuft.

1g. var. *pustulosa* (Rydb.) Harrington

Cryptantha jamesii (Torr.) Payson var. *pustulosa* (Rydb.) Harrington, Man. Pl. Colo. 466, 641. 1954.
Oreocarya pustulosa Rydb. Bull. Torrey Bot. Club 40:480. 1913.
Cryptantha pustulosa (Rydb.) Payson, Ann. Mo. Bot. Gard. 14:252. 1927.
Hemisphaerocarya suffruticosa var. *pustulosa* (Rydb.) Brand, Fedde, Rep. Spec. Nov. 24:60. 1927.

Erect perennials, 2-5.8 dm tall, branched from the base, simple above; stems slender, 1-3.9 dm long, glabrous or finely strigose; leaves linear to broadly oblanceolate, 2-9 cm long, 0.4-1.5 cm wide, the dorsal surface appressed setose-pustulate, ventral surface glabrous, the petioles not ciliate margined; inflorescence open, 0.4-2 dm long, floral bracts inconspicuous. Collections: 22 (HD), representative: A. H. Holmgren and S. Hansen 3489 (BRY, NY, UTC), P. A. Rydberg and A. O. Garrett 9569 (NY, RM, UT), A. Cronquist and N. Holmgren 9372 (NY, UTC), J. Reveal and G. Davidse 926 (BRY), Welsh, Higgins and Atwood 8933 (BRY).

Holotype: Rydberg and Garrett 9320, collected in San Juan County, Utah, on the Elk Mountains in Hammond Canyon, 31 July 1911, NY.

Distribution: Southeastern Utah in Garfield, Kane, and San Juan Counties, southwestern Colorado, northwestern New Mexico, and northeastern Arizona. Growing in a wide variety of soils, 4,500 to 8,500 feet. Map No. 1e. Late May to late August.

This variety is quite different in general appearance from any of the other varieties in this species complex. This is due to the slender weak stems, and the lack of any pubescence on the ventral surface of the leaves. The original description characterizes the leaves as being glabrous beneath, sparingly hairy above. However, with the specimens at hand it is the upper and not the lower surface that is glabrous. The var. *disticha* in some cases is nearly glabrous, but always has a few hairs on the ventral surface and is probably a connecting link between var. *setosa* and the present species.

2. *Cryptantha palmeri* (Gray) Payson

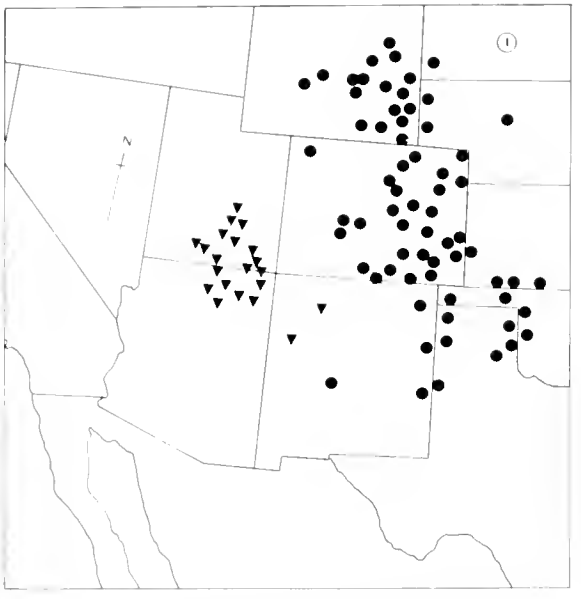
Cryptantha palmeri (Gray) Payson, Ann. Mo. Bot. Gard. 14:253. 1927.
Krynitzkia palmeri Gray, Proc. Am. Acad. 20:278. 1885.
Oreocarya palmeri (Gray) Greene, Pitt. 1:57. 1887.
Hemisphaerocarya palmeri (Gray) Brand, Fedde, Rep. Spec. Nov. 24:61. 1927.
Cryptantha corei Johnst. Journ. Arn. Arb. 20:396. 1939.

Plants biennial or short-lived perennials, 1.7-4 dm tall; stems 1-several, 0.7-3.5 dm long, spreading setose hirsute; leaves linear-lanceolate, acute, 3-16 cm long, 0.4-1 cm wide, strigose and subtomentose, pustulate hairs conspicuous on the dorsal surface, few and not evident on the ventral surface; inflorescence broad-topped due to the elongation of the cymules in age, 0.3-2.7 dm long, setose, the floral bracts inconspicuous; calyx segments lanceolate, in anthesis 4-6 mm long, in fruit becoming 7-10 mm long, setose or weakly hispid; corolla white, the tube 4-6 mm long, crests at base of tube lacking, fornices yellow, rounded, papillose, 0.5-1 mm long, limb 7-9 mm wide; style exceeding mature fruit by 2-3.5 mm; nutlets ovate, 2.5-2.8 mm long, 2-2.7 mm wide, the margins not in contact, acute, both surfaces of the nutlet smooth and glossy, scar tightly closed and without an elevated margin. Collections: 110 (HD); representative: D. S. Correll and I. M. Johnston 21243 (GH, LL), V. L. Cory 31547 (GH); D. S. Correll 16333 (GH, LL), J. Reverchon 2120 (GH, ND-G); M. E. Jones 18514 (ND), E. J. Palmer 34009 (GH), E. C. Higgins 3097 (BRY).

Holotype: Palmer 895, collected in Coahuila, Mexico, 40 miles south of Saltillo, March 1880, GH.

Distribution: Lower Sonoran life zone in western Texas and adjacent Mexico. Growing on limestone or gravelly to rocky hillsides, 1,000 to 4,000 feet. Map No. 2. April to late July.

The type of *C. palmeri* is very immature, and because of this immaturity some confusion has come about as to which plant should bear the name of *palmeri*. In observing the type specimen on loan from Gray Herbarium and the original description, which characterizes the nutlets as follows: "nuculis opacis



Map No. 1d. Parts of southwestern United States. Range of *C. jamesii* (Torr.) Payson: (Circles), var. *jamesii*, (Triangles), var. *disticha* (Eastw.) Payson.

rugosiusculis," the nutlets are subrugose only because they are immature. For this reason *C. coryi* is placed in synonymy. Immature specimens in all the smooth-fruited species have a tendency for the nutlets to appear subrugose until they are fully matured, which is no exception in the present species.

This species may be separated from its nearest relative *C. jamesii* var. *multicaulis*, by its lack of crests at the base of the corolla tube, the accressent sepals, and the longer style.

3. *Cryptantha oblata* (Jones) Payson

Cryptantha oblata (Jones) Payson, Ann. Mo. Bot. Gard. 14:254. 1927.

Krynitzkia oblata M. E. Jones, Contr. West. Bot. 13:4 1910.

Oreocarya hispidissima Wooton and Standley, Contr. U. S. Natl. Herb. 19:545. 1915, not *O. hispidissima* (Torr.) Rydb.

Oreocarya oblata (Jones) Macbr. Proc. Am. Acad. 51:548. 1916.

Hemisphaerocarya oblata (Jones) Brand, Fedde, Rep. Spec. Nov. 24:61. 1927.

Caespitose perennial, 1-3.5 dm tall; stems several, 0.4-1.5 dm long, retrorsely setose and spreading hirsute; leaves oblanceolate, acute, 3-10 cm long, 0.4-1.4 cm wide, coarsely strigose and appressed setose dorsally, pustules conspicuous, ventral surface weakly strigose-setose, and with fewer pustulate hairs, the petioles ciliate margined; inflorescence somewhat open, especially in age, 0.3-2 dm long, setose-hirsute; calyx segments linear-lanceolate, 5-7 mm long in anthesis, becoming 8-10 mm long in fruit, densely setose; corolla white, tube 7-10 mm long, crests at base of tube lacking, fornices yellow, broad, papillose, limb 8-12 mm wide; style 3-5 mm longer than mature fruit; nutlets ovoid, usually all four maturing, the margins narrowly separated, acute, 2.5-3 mm long, 2-2.5 mm wide, dorsal surface rugose-tuberculate, ventral surface smooth or slightly uneven, scar closed, straight, and without an elevated margin. Collections: 76 (VI); representative: D. S. Correll and I. M. Johnston 22036 (LL); C. L. and A. Lundell 14309 (GH, LL); G. R. Vasey s.n. (ND-G, US); W. P. Cottam 10228 (BRY, UT); G. C. Nealley 167 (ND-G, US); E. O. Wooton s.n. (ARIZ, RM, US).

Holotype: M. E. Jones 3759, collected at El Paso, Texas, 23 April 1884, POM. Photograph at BRY. Isotypes at RM, US.

Distribution: Southcentral New Mexico, western Texas and northern Mexico. Growing on sandy or gravelly limestone soil, 1,000 to 5,000 feet. Map No. 3. Late March to September.

This species is confined mainly to the western half of transpecos Texas and southern New Mexico. It may be distinguished from its nearest relatives, *C. palmeri* and *C. paysonii* on the basis of the floral and nutlet characters. From the former it may be distinguished by the nutlets which are roughened on the dorsal side and the corolla tube which definitely exceeds the calyx segments. It differs from the latter by the flowers which are not heterostyled, and the stamens which are always attached at the middle of the corolla tube, the fornices which are nearly glabrous, and the more open loosely thyrsoid inflorescence.

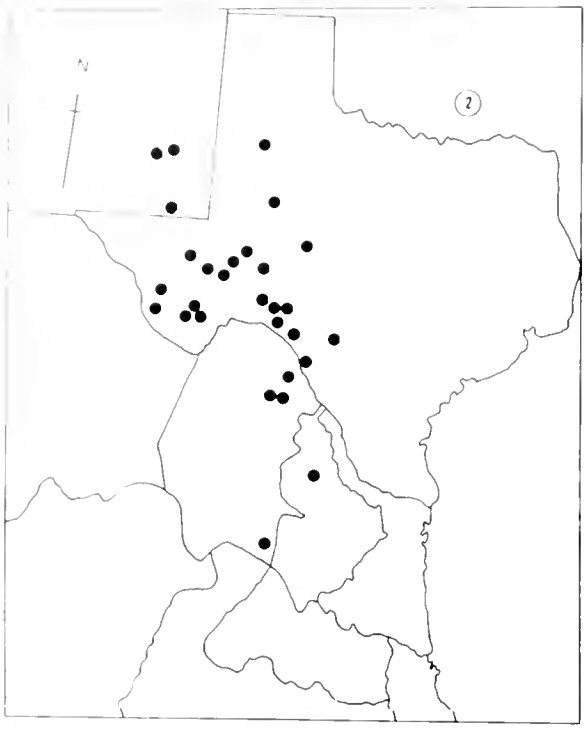
4. *Cryptantha paysonii* (Macbr.) Johnst.

Cryptantha paysonii (Macbr.) Johnst. Wrightia 2:160. 1961.

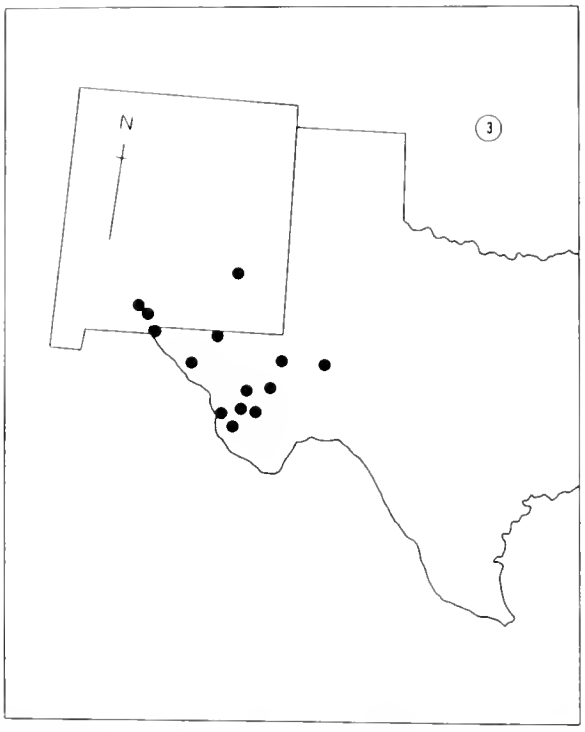
Oreocarya paysonii Macbr. Contr. Gray Herb. 48:36. 1916.

Hemisphaerocarya paysonii (Macbr.) Brand, Fedde, Rep. Spec. Nov. 24:61. 1927.

Caespitose perennials, 1.6-2.9 dm tall; stems erect, stout, 0.8-1.6 dm long, strigose and more or less spreading setose-hirsute; leaves oblanceolate, obtuse to acute, 3-9 cm long, 0.5-1.5 cm broad, dorsal surface finely strigose or subtomentose, also setose with pustulate hairs, ventral surface similar but with less conspicuous pustulate hairs; inflorescence subcapitate, consisting of four to six compact cymules, 0.5-1.2 dm long, setose; calyx segments linear-lanceolate, in anthesis 7-9 mm long, in fruit becoming 9-10 mm long, setose-hirsute; corolla white, the tube 12-14 mm long, crests at base of tube lacking, fornices yellow, rounded, densely papillose, 0.5-1 mm long, limb 10-13 mm wide; plants heterostyled; nutlets ovate, 2.7-3 mm long, 2-2.5 mm wide, usually all four nutlets maturing, margins narrowly winged, in contact, both surfaces finely rugulose or finely tuberculate, scar closed, straight, and lacking an elevated margin. Collections: 6 (III), representative: O. B. Metcalfe 1576 (POM, US); D. S. Correll and I. M.



Map No. 2. Western Texas and northern Mexico. Range of *C. palmeri* (Gray) Payson



Map No. 3. Parts of Texas and New Mexico. Range of *C. oblata* (Jones) Payson

Johnston 22003 (LL); L. C. Higgins 3151 (BRY, WTSU).

Holotype: O. B. Metcalfe 1576, collected in Sierra County, New Mexico, on limestone hills at Berendo Creek, 12 May 1905, GH. Isotypes at POM, US.

Distribution: New Mexico in Debaca, Otero, and Sierra Counties, south into Culberson County, Texas. Growing on limestone soil, 4,000 to 7,500 feet. Map No. 4. April to June.

This species has been confused in the past with *C. oblata*, but differs from it in the larger corollas which are strongly heterostyled, the more compact inflorescence, and the nutlets which are only finely rugulose or tuberculate.

More collections of this taxon are badly needed in order to determine its exact geographical range.

5. *Cryptantha crassipes* Johnst.

Cryptantha crassipes Johnst. Journ. Arn. Arb. 20:397. 1939.

Plants perennial, 1.5-2.4 dm tall, stems 1-several, 1.2-1.9 dm long, setose; leaves linear-lanceolate, obtuse to acute, mostly basal, reduced upward, 3-6 cm long, 0.2-0.6 cm wide, densely white strigose, also setose-pustulate on the dorsal surface; inflorescence capitate, 0.2-0.8 dm long, white strigose, floral bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 7-9 mm long, in fruit becoming 9-11 mm long, setose; corolla white, the tube 8-9 mm long, crests at base of tube lacking, fornices yellow, rounded, about 1 mm long, limb 9-11 mm wide; style exceeding mature fruit 4-7 mm; nutlets ovate or triangular-ovate, 3.3-3.8 mm long, 2.5-3 mm wide, dorsal surface finely rugulose, ventral surface smooth or only slightly uneven, margin acute or narrowly winged, scar closed, and without an elevated margin. Collections: 15 (iii); representative: V. L. Cory 18613 (GH); D. S. Correll and I. M. Johnston 21934 (GH, LL); D. S. Correll and R. C. Rollins 23604 (LL); V. L. Cory 31585 (GH); L. C. Higgins 2767, 2940 (BRY, WTSU).

Holotype: V. L. Cory 18613, collected in Brewster County, Texas, 6.5 miles east of Agua Fria Springs, 13 April 1936, GH. Photograph at BRY.

Distribution: Brewster County, Texas, in the Big Bend region. Growing on white limestone which is shaley or clayey, 1,500 to 4,500 feet. Map No. 5. Late March to early June.

This distinctive plant is closely related to *C. palmeri* and *C. paysonii*. From the former it can be distinguished by the compact capitate inflorescence, the thicker more woody caudex, and the shorter corolla tube. From *C. paysonii*, it differs in the shorter corolla tube, the monomorphic flowers, the nutlets which are more compressed or flattened, and the very woody caudex.

6. *Cryptantha confertiflora* (Greene) Payson

Cryptantha confertiflora (Greene) Payson, Ann. Mo. Bot. Gard. 14:256. 1927.

Krynitzkia leucophaca var. *alata* Jones, Proc. Calif. Acad. Sci. II. 5:710. 1895. (Type: Silver Reef, Utah, on sandstone cliffs, 4,500 feet, 3 May 1894, M. E. Jones 5144.)

Orecocarya contertiflora Greene, Pitt. 3:112. 1896.

Orecocarya lutea Greene, Muhlenbergia 2:240. 1906. Name only. Tedde, Rep. Spec. Nov. 19:72. 1923. Description. (Type: California, Inyo County, White Mountains, 9 May 1906, Heller 8211.)

Orecocarya alata (Jones) A. Nels. Coulter and Nelson, Man. Cent. Rocky Mts. 417. 1909; Rydb. Fl. Rocky Mts. 725. 1917.

Perennial herbs, 1.7-4.3 dm tall; stems 1-7, slender, 1.5-2.5 dm long, tomentose at the base, strigose and setose upward; leaves linear to oblanceolate, 3-12 cm long 0.2-1.6 cm wide, acute, dorsal surface densely strigose and appressed setose with pustulate bases, ventral surface uniformly strigose and with few or no pustules; inflorescence subcapitate, 0.3-2 dm long, strigose and with twisted setose hairs, bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 6-8 mm long, in fruit becoming 10-14 mm long, strigose and spreading setose; corolla yellow, the tube 9-13 mm long, fornices broad, emarginate, about 1 mm long, crests at base of tube evident or sometimes lacking, limb 8-10 mm wide; plants distinctly heterostyled; nutlets triangular or ovate, 3.5-4 mm long, 2.5-3 mm wide, usually all four maturing, margins narrowly winged, in contact, surfaces smooth and glossy, scar straight, closed, and lacking an elevated margin. Collections: 117 (vi); representative: I. W. Clokey 7659 (ARIZ, LL, ND, ORE, UTC); S. B. and W. F. Parish 1316 (ND-G, US); F. W. Gould 1550 (BRY, UT, UTC); P. Train s.n. (ARIZ, ORE); L. C. Higgins 1365, 1475, 1771 (BRY).

Holotype: S. B. Parish 1316, collected in San Bernardino County, California, at Cushenberry Springs on the north side of the San Bernardino Mountains, 1882, ND-G. Photograph at BRY. Isotype at US.

Distribution: Southwestern Utah, northern Arizona, southern Nevada, and west to southern and western California. Growing in a wide variety of soils, 2,000 to 8,500 feet. Map No. 6. April to July.

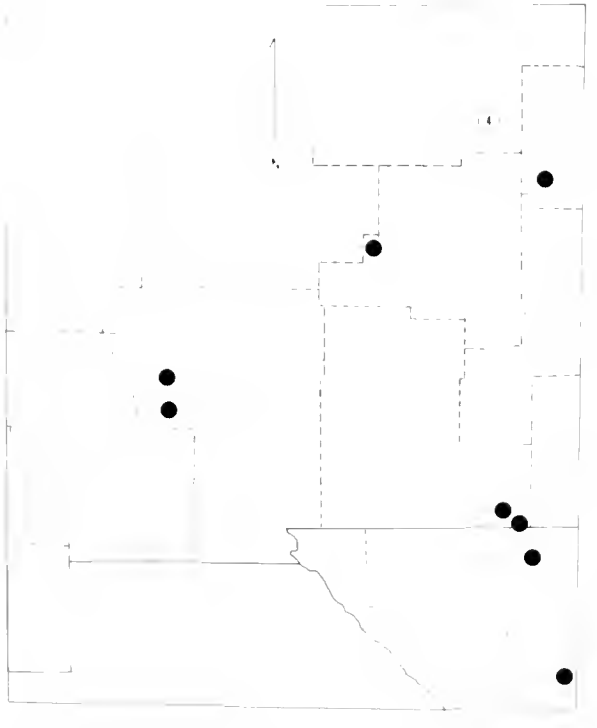
This distinctive, yellow-flowered species is one of the largest of the perennial species of *Cryptantha*, and is not common, but covers a wide distributional range. This species may be distinguished from its closest relative, *C. flava*, by the broader more ovate nutlets and the longer stems with a subcapitate inflorescence.

Brand legally published the nomen nudum *Orecocarya lutea* Greene. He did this on the basis that the stamens were in a different position in the corolla tube. However, this taxonomic criteria is of no value in the present species because the corolla is very dimorphic in regards to this character.

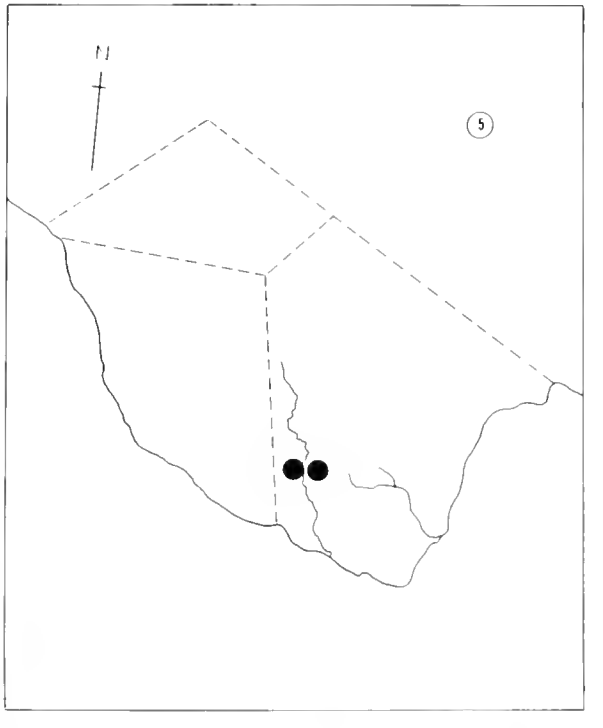
Jones described a narrow-leaved form from southern Utah as a new variety, but it is not worthy of any subspecific rank.

7. *Cryptantha flava* (A. Nels.) Payson

Cryptantha flava (A. Nels.) Payson, Ann. Mo. Bot. Gard. 14:259. 1927.



Map No. 4. Northwestern Texas and southern New Mexico. Range of *C. paysonii* (Macbride) Johnston



Map No. 5. Brewster Co., Texas. Range of *C. crassipes* Johnston

Oreocarya flava A. Nels. Bull. Torrey Bot. Club 25: 202. 1898.

Oreocarya lutescens Greene, Pitt. 4: 93. 1899. (Type: On hills about Aztec, New Mexico, 25 April 1899, C. F. Baker.)

Cryptantha confertiflora var. *flava* Brand, Pflanzenreich (Heft. 97) 4, fam. 252: 90. 1931.

Cryptantha confertiflora var. *lutescens* Brand, Pflanzenreich (Heft. 97) 4, fam. 252: 90. 1931.

Perennial, 1.3-4 dm tall; stems many, from a multiple caudex, 0.8-2.6 dm long, densely long white-hairy at the base, becoming setose and strigose upward; leaves narrowly oblanceolate to nearly linear, acute, 2-9 cm long, 0.3-0.8 cm wide, dorsal surface strigose and appressed setose with pustulate hairs, ventral surface almost uniformly strigose, and with the pustules less conspicuous; inflorescence narrow to somewhat open, 0.5-2.5 dm long, conspicuously yellow setose, the floral bracts inconspicuous; calyx segments linear, in anthesis 8-10 mm long, in fruit becoming 9-12 mm long, densely setose, with yellowish hairs, pedicels 3-5 mm long in fruit; corolla yellow, the tube 9-12 mm long, crests at base of tube absent or nearly so, fornices yellow, truncate, emarginate, 1-1.5 mm long, limb 8-10 mm broad; style exceeding mature fruit 3-7 mm (heterostyled); nutlets lanceolate, 3.4-4 mm long, 1.9-2.2 mm wide, 1-2 usually maturing, margins acute, in contact when more than 1 nutlet matures, both surfaces of nutlet smooth and glossy, scar straight, closed, elevated margin lacking. Collections: 193 (xi); representative: C. F. Baker 562 (ND-G); A. and R. Nelson 785 (ARIZ, ORE); W. A. Weber 3838 (ARIZ, COLO); W. P. Cottam 2050 (BRY); B. Maguire 18302 (UTC); L. C. Higgins 527, 998, 1057, 1073, 1082, 1105 (BRY).

Holotype: A. Nelson 3074, collected in Sweetwater County, Wyoming at Point of Rocks, 1 June 1897, RM.

Distribution: Southern Wyoming, south through western Colorado and eastern Utah to northern New Mexico and Arizona. Usually found growing in sandy soil, 4,000 to 7,500 feet. Map No. 7. April to August.

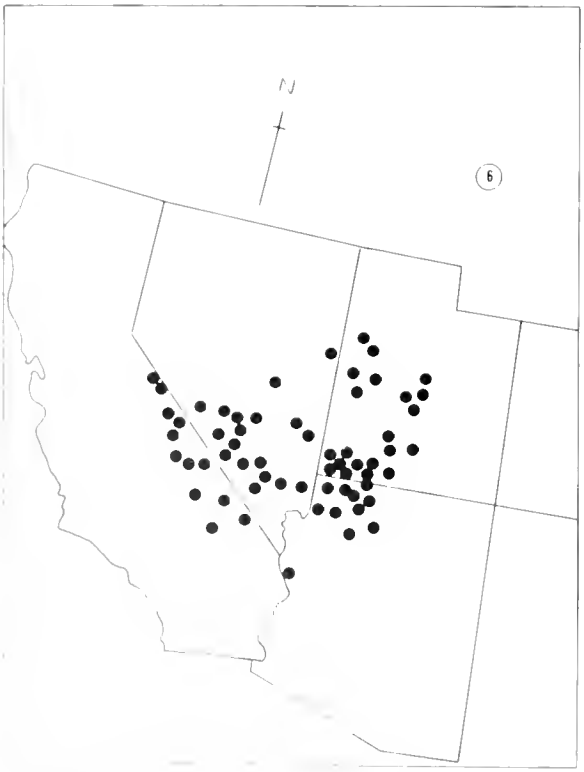
This yellow-flowered species is closely related to *C. confertiflora*, but may be separated from that species by the narrowly lanceolate nutlets and the longer thyrsoid inflorescence.

8. *Cryptantha capitata* (Eastw.) Johnst.

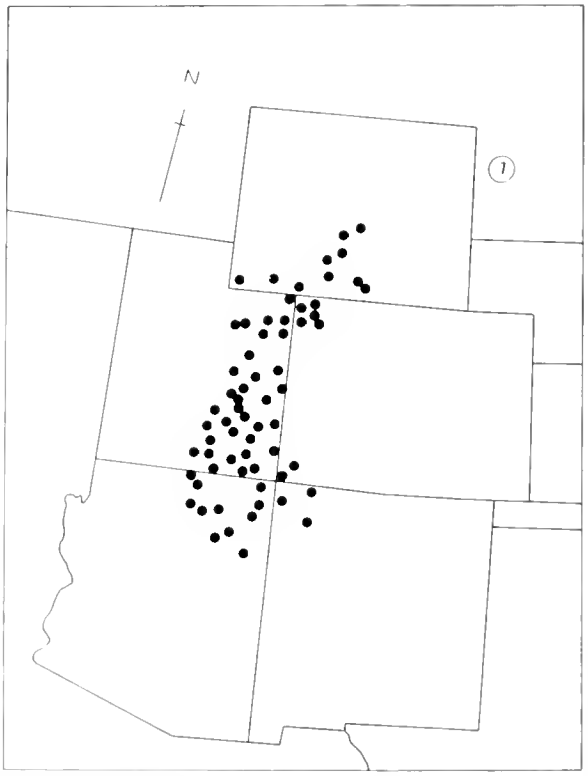
Cryptantha capitata (Eastw.) Johnst. Journ. Arn. Arb. 21:66. 1940.

Oreocarya capitata Eastw. Leaflets West. Bot. 1:9. 1937.

Perennial, 1.5-2.7 dm tall; stems weak, 1-several, 1.2-2.4 dm long, appressed setose; leaves linear, or very narrowly oblanceolate, 3-8 cm long, 0.3-0.5 cm wide, dorsal surface appressed setose-pustulate, ventral surface uniformly strigose and without pustules; inflorescence capitate, or with one or two glomerules below the terminal cluster, 0.1-0.4 dm long, spreading white-setose; calyx segments linear-lanceolate, 7-9



Map No. 6. Parts of western United States. Range of *C. confertiflora* (Greene) Payson.



Map No. 7. Parts of western United States. Range of *C. flava* (A. Nels.) Payson.

mm long in anthesis, in fruit becoming 11-16 mm long, conspicuously setose-pustulate; corolla white, the tube 9-12 mm long, crests at base of tube conspicuous, fornices yellow, emarginate, about 1 mm long, papillose, limb 6-8 mm wide; style exceeding mature fruit 4-5 mm; nutlets lanceolate, 4-5 mm long, 2-3 mm wide, two to four usually maturing, the margins in contact, knifelike, both surfaces glossy-smooth, scar closed, straight, and without an elevated margin. Collections: 11 (0); representative: A. Eastwood and J. T. Howell 1005 (CAS, GH); A. Eastwood 5832, 5969 (CAS, GH), L. White s.n. (MNA); R. F. Collom kt26 (ASC); F. W. Pennell 21575 (ARIZ).

Lectotype: A. Eastwood 5969, collected in Coconino County, Arizona, from Hermit Trail on the south rim of the Grand Canyon, 9 April 1917, CAS. Photograph at BRY. Isolectotype at GH.

Distribution: Southcentral Utah, and northcentral Arizona in the Colorado River drainage basin. Growing in sandy soil, 6,500 to 8,500 feet. Map No. 8. April to July.

C. capitata is probably most closely related to *C. confertiflora*, but differs from that species in the more capitate inflorescence, the narrower leaves, white flowers, with crests at the base of the tube, and usually smaller size.

Two collections by Cronquist and N. Holmgren 9299 and 9365, appear to be the same species, but the leaves are broader. These two collections came from the Henry Mountains and Aquarius Plateau in Utah.

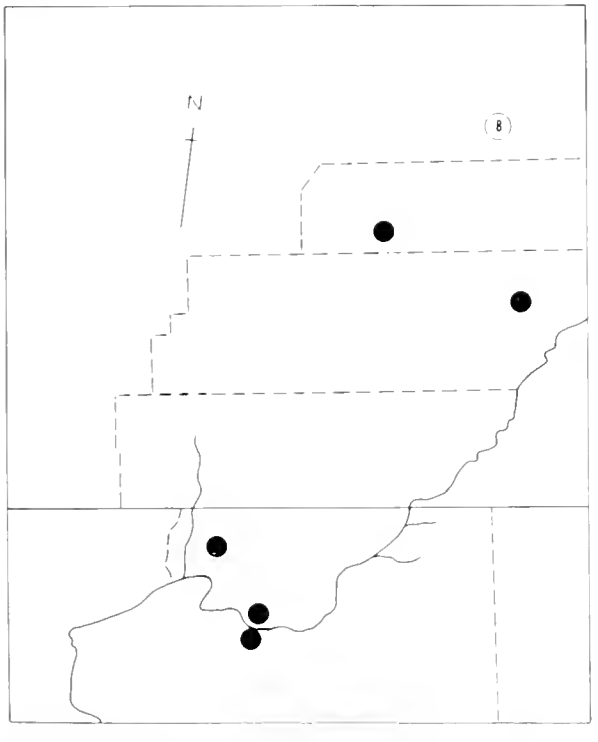
9. *Cryptantha johnstonii* Higgins

Cryptantha johnstonii Higgins, Great Basin Naturalist 28:195. 1968.

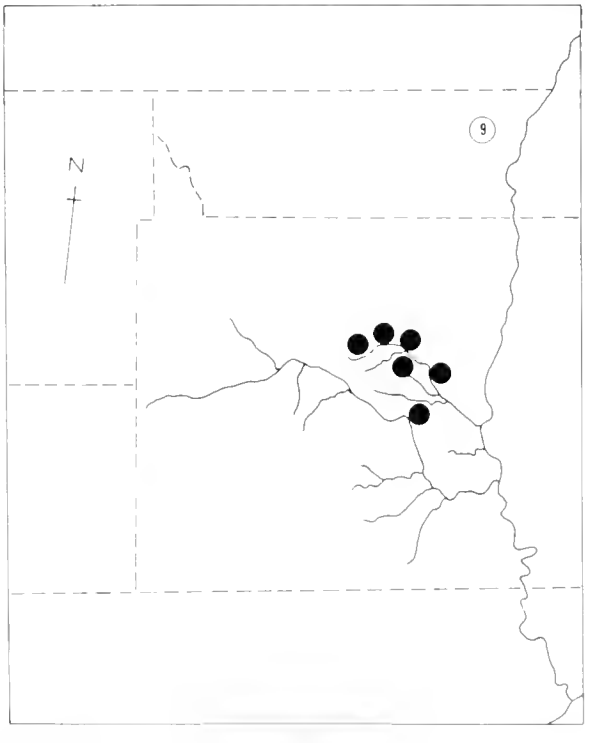
Caespitose perennial 1-2.5 dm tall; stems several, arising from the branched caudex, 0.6-1.3 dm long, very weakly strigose; leaves oblanceolate, the apices obtuse to acute, 2-6.5 cm long, 0.4-1 cm wide, dorsal surface strigose with conspicuous pustulate hairs; inflorescence somewhat open, 0.5-2 dm long; foliar bracts evident but not conspicuous, 1-2 cm long; calyx segments linear-lanceolate, in anthesis 5-6 mm long, in fruit becoming 8-10 mm long, strigose and spreading white setose; pedicels 0.5-1 mm long; corolla white, the tube 12-15 mm long, flaring in the throat, crests at base of tube lacking, fornices yellow, 1-1.5 mm long, emarginate, papillose, limb 13-17 mm broad; style exceeding mature fruit 3-8 mm (heterostyled); nutlets ovate, 3-3.5 mm long, 2.3-2.7 mm wide, usually all four maturing, the margins acute or knifelike, in contact, both surfaces smooth and glossy, scar straight, closed, elevated margin lacking. Collections: 5 (iii); representative: L. C. Higgins 1310 (BRY); B. F. Harrison 5628 (BRY).

Holotype: L. C. Higgins 1310, collected in Emery County, Utah, on low rolling hills about 15 miles west of hwy. 50-6 along the road from Woodside to Castle Dale, 25 May 1968, BRY. Isotypes at CAS, GH, NY, POM, RM, US, UTC.

Distribution: Known only from the type locality 15 miles west of hwy. 50-6 on the San Rafael Swell,



Map No. 8. Southern Utah and northern Arizona. Range of *C. capitata* (Eastw.) Johnston



Map. No. 9. Emery County, Utah. Range of *C. johnstonii* Higgins

Emery County, Utah. Growing on clayey to sandy soils, 5,000 to 5,500 feet. Map No. 9. May and June.

Cryptantha johnstonii is most closely related to *C. confertiflora* known from western Utah, northern Arizona, Nevada, and southwestern California. It can be distinguished from that species by its smaller size, longer and more open inflorescence, white flower color, larger corolla with longer fornices and no basal crest.

10. *Cryptantha semiglabra* Barneby

Cryptantha semiglabra Barneby, Leaflets West. Bot. 3:197. 1943.

Erect perennials, 2-3 dm tall; stems 1-several, 0.9-1.8 dm long, retrorsely strigose and weakly spreading setose; leaves oblanceolate, acute, 3-7 cm long, 0.3-0.6 cm wide, dorsal surface appressed setose-pustulate, ventral surface glabrous, the old leaf bases long white-hairy; inflorescence narrow, or somewhat open, 0.4-1.3 dm long, foliar bracts slightly surpassing the cymes, 1.5-2 cm long; calyx segments lanceolate, in anthesis 5-8 mm long, in fruit becoming 10-13 mm long, setose; pedicels 1-2 mm long; corolla white, the tube 10-12 mm long, crests at base of tube conspicuous, fornices yellow, rounded, 1-1.2 mm long, obscurely papillose, limb 8-10 mm wide; style surpassing the mature fruit 5-7 mm; nutlets ovate, 3.5-4 mm long, 2-2.5 mm wide, usually all four maturing, margins acute, in contact, both surfaces smooth and glossy, scar closed, elevated margin lacking. Collections: 5 (n); representative: J. W. Harrison s.n. (DFX); H. D. Ripley and R. C. Barneby 8519 (UTC); D. Atwood 1525 (BRY); L. C. Higgins 1357, 1364 (BRY).

Lectotype: Ripley and Barneby 8429, collected in Coconino County, Arizona, on detrital clay hills about 2 miles east of Fredonia, 4,900 feet, 5 June 1942, CAS.

Distribution: Apparently confined to near the type locality and north just across the state line into Washington and perhaps Kane County, Utah. Growing in clay soils, 4,500 to 5,000 feet. Map No. 10. Early May to July.

Cryptantha semiglabra is closely related to *C. caputata* and *C. confertiflora*. From the former it differs in several important aspects, the most immediate difference being the distribution of pubescence. The upper part of the caudex branches are densely clothed with long white hairs, the lower surface of the leaves are beset with stout appressed setose hairs with pustular bases, while the upper surface is glabrous. The inflorescence of a long narrow thyrsus also distinguishes it from *C. caputata*. From the latter it may be distinguished by the white flowers, the glabrous ventral surface of the leaves, crests at the base of the corolla tube, and the longer foliar bracts.

11. *Cryptantha barnebyi* Johnst.

Cryptantha barnebyi Johnst. Journ. Arn. Arb. 29:240. 1948.

Perennial, 1.5-3.5 dm tall; stems stout, erect, several, 0.8-1.2 dm long, conspicuously yellowish hispid; leaves oblanceolate, thick, acute, 5-9 cm long, 0.5-1.4 cm wide, coarsely appressed hispid pustulate on both surfaces, and with some finer hairs beneath, the petioles conspicuously ciliate; inflorescence narrow, 1-1.5 dm long, densely yellowish hispid, foliar bracts evident to conspicuous; calyx segments lanceolate, in anthesis 5-7 mm long, in fruit becoming 8-13 mm long, yellowish hirsute; corolla white or light yellow, the tube 5-7 mm long, crests at base of tube very conspicuous, fornices yellow, emarginate, distinctly papillose, 0.5 mm long, limb 8-11 mm wide; style exceeding mature fruit 5-6 mm; nutlets ovate, 3.5-4 mm long, 2.5-3 mm wide, all four maturing, margins of nutlets in contact, acute, smooth and glossy on both surfaces, scar closed, straight, and without an elevated margin. Collections: 10 (viii); representative: Ripley and Barneby 8748 (GH); D. Atwood 1562 (BRY); L. C. Higgins 1584, 1587, 1599, 1601 (BRY).

Holotype: Ripley and Barneby 8748, collected in Uintah County, Utah, 30 miles south of Ouray on white shale knolls, 5,500 feet, 17 June 1947, GH. Photograph at BRY.

Distribution: Confined to the lower part of the Uintah Basin, Uintah County, Utah. Growing on white barren shale knolls, 5,000 to 6,000 feet. Map No. 11. May to June.

This endemic species is confined to white shaley knolls, and is the only conspicuous plant on them. In the western part of its range it is found growing with *C. grahamii*, but still limited to white shale.

In the original description of this species the corolla was described as being long tubed and protruding beyond the sepals. In observing this plant in the field the corollas do not exceed the calyx, or if they do, it is by less than 1 mm.

C. barnebyi is a very distinctive species, and is probably most closely related to *C. confertiflora* or *C. johnstonii*, but may be distinguished from both of them by the thick stout stems, campanulate corolla, harsher hispid pubescence, and the more woody caudex.

12. *Cryptantha leucophaea* (Dougl.) Payson

Cryptantha leucophaea (Dougl.) Payson, Ann. Mo. Bot. Gard. 14:262. 1927.

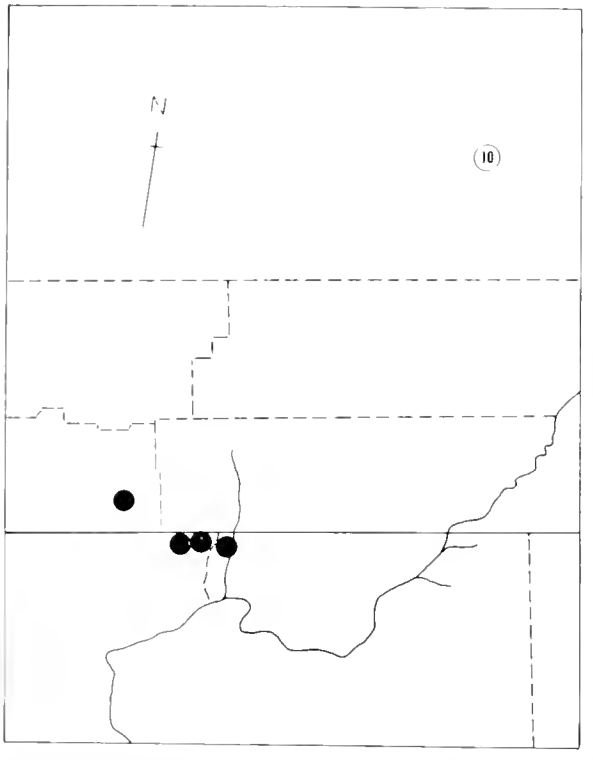
Myosotis leucophaea Dougl. in Lehm. Pug. 2:22. 1830.

Eritrichium leucophaeum (Dougl.) A. DC. Prod. 10:129. 1846.

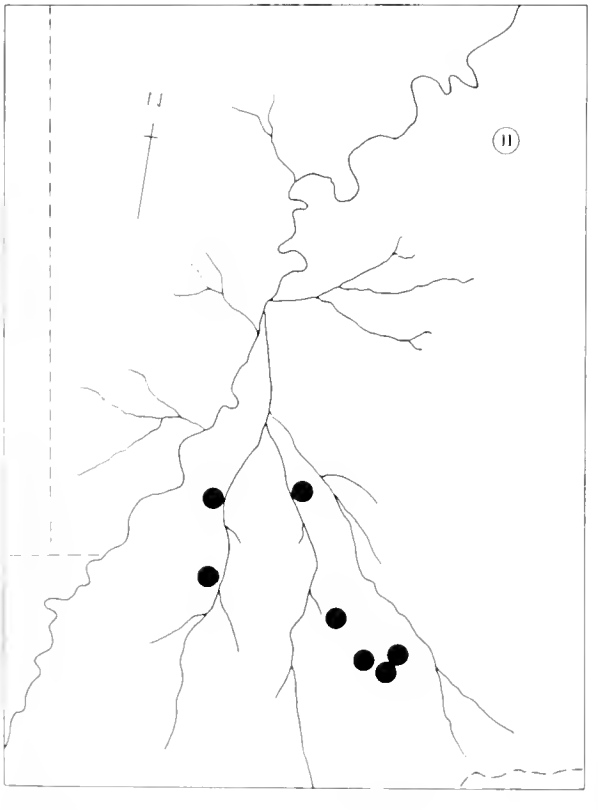
Krynitzkia leucophaea (Dougl.) Gray, Proc. Am. Acad. 20:280. 1885.

Oreocarya leucophaea (Dougl.) Greene, Pitt. 1:58. 1887.

Long-lived perennials, 1.5-3.7 dm tall; stems



Map No. 10. Southern Utah and northern Arizona. Range of *C. semiglabra* Barneby.



Map No. 11. Uintah County, Utah. Range of *C. barnebyi* Johnston.

slender, 1-several from a multiple caudex, 1.2-2.3 dm long, strigose, and appressed setose, leaves linear to narrowly oblanceolate, acute, 3-9 cm long, 0.4-0.7 cm wide, dorsal surface densely strigose, and with appressed setose hairs, pustulate, ventral surface uniformly strigose and with few or no pustulate hairs, petioles white-ciliate; inflorescence narrow, 0.8-1.7 dm long, conspicuously white setose, foliar bracts evident but not conspicuous; calyx segments linear, in anthesis 6-8 mm long, in fruit becoming 10-15 mm long, setose; corolla white, the tube 8-10 mm long, crests at base of tube evident, fornices yellow, emarginate, 0.5-1 mm long, limb 8-10 mm wide; style exceeding mature fruit 2-8 mm (heterostyled); nutlets ovate, 3.5-4.5 mm long, 2.5-3 mm wide, usually less than four maturing, margins acute, in contact, both surfaces smooth and glossy, scar straight, closed, elevated margin lacking. Collections: 16 (0); representative: J. H. Sandberg and J. B. Leiberg 373 (RM, US); J. W. Thompson 11453 (US, WTU); T. S. Brandegee 997 (US); L. Hitchcock 20952 (RM); A. Elmer 1056 (US); J. S. Cotton 1027 (US).

Type: Douglas s.n., collected in Washington State, on arid barrens of the Columbia River. Not seen.

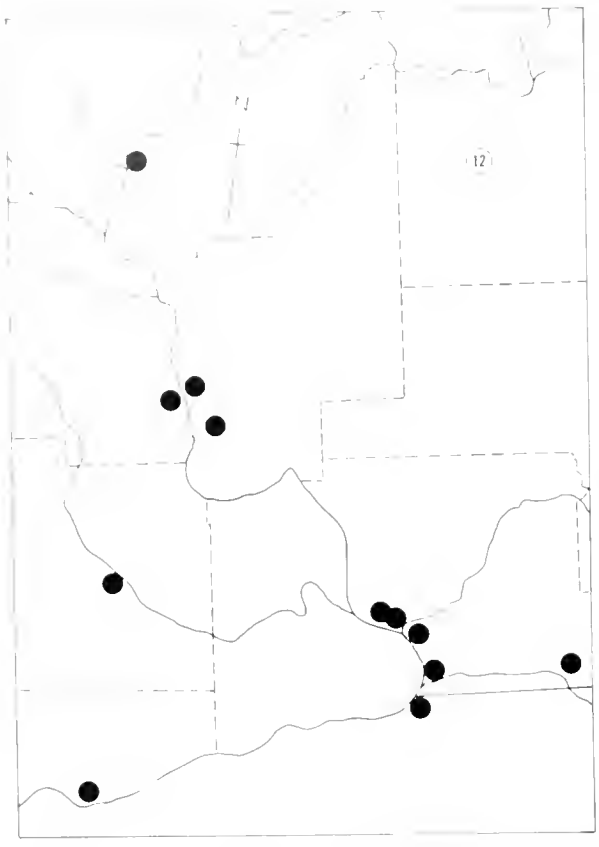
Distribution: Upper Sonoran Zone in south-central Washington along the Columbia River and its northern and southern tributaries. Growing in sandy soil. Map No. 12. Late April to early July.

This species of south-central Washington is most closely related to *C. confertiflora*, but differs from this species by the white corolla, the open and more elongated inflorescence, and the evident crests at the base of the corolla tube.

13. *Cryptantha salmonensis* (Nels. & Macbr.) Payson

Cryptantha salmonensis (Nels. & Macbr.) Payson, Ann. Mo. Bot. Gard. 14:263. 1927.
Orcocarya salmonensis Nels. & Macbr. Bot. Gaz. 61:43. 1916.

Moderately caespitose perennials, 1.5-3.5 dm tall; stems erect, 0.7-1.5 dm long, strigose, and with some white spreading setose hairs; leaves oblanceolate to spatulate, 2-9 cm long, 0.5-1.5 cm wide, strigose and spreading setose, also somewhat tomentose, pustulate on both of the surfaces; inflorescence narrow, 1-1.8 dm long, foliar bracts evident but not conspicuous; calyx segments lanceolate, 3-4 mm long in anthesis, in fruit becoming 6-8 mm long, setose; corolla white, the tube 3-4 mm long, fornices yellow, rounded, papillose, crests at base of tube well developed, limb 7-10 mm wide; nutlets lanceolate, 3-4 mm long, 1.5-2 mm wide, all four usually maturing, acute or narrowly winged-margined, the margins in contact, smooth and glossy on both surfaces, scar straight, closed, and without an elevated margin. Collections: 10 (v); representative: Macbride and Payson 3348 (RM); Hitchcock and Muhlick 8950 (UTC); A. Cronquist 3812 (UTC); F. B. Payson 1880 (RM); L.



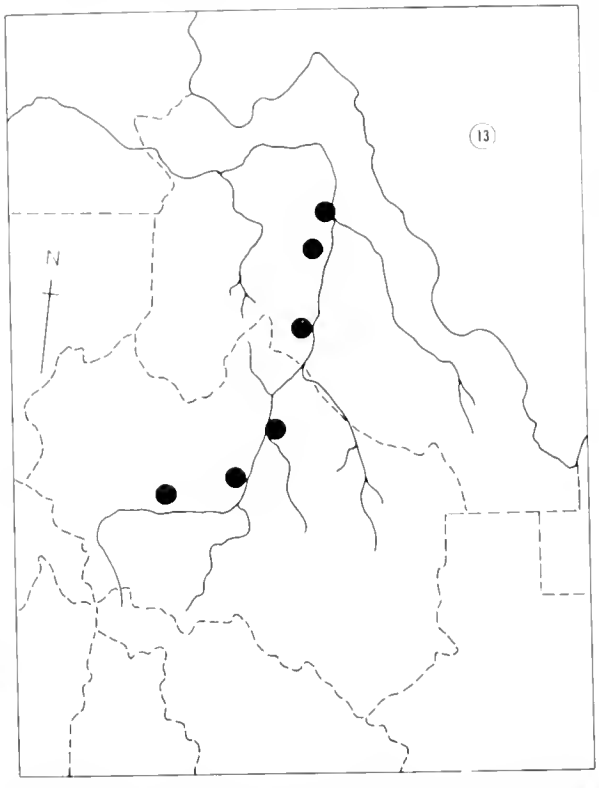
Map No. 12. Central and southern Washington. Range of *C. leucophaea* (Dougl.) Payson

C. Higgins 1710, 1711, 1713, 1714, 1715 (BRY).

Holotype: Kittley s.n., collected in Lemhi County, Idaho, at Salmon, June 1896, RM. Photograph at BRY.

Distribution: Along the Salmon River in Lemhi and Custer Counties, Idaho. Growing on loose talus slopes of volcanic origin, 4,500 to 7,500 feet. Map No. 13. June to August.

Cryptantha salmonensis is apparently confined to the Salmon River drainage of south-central Idaho. It is perhaps most closely related to *C. leucophaea*, but differs from that taxon by the short corollas, more lanceolate nutlets, shorter style, and shorter inflorescence.



Map No. 13. Central Idaho. Range of *C. salmonensis* (Nels. & Macbr.) Payson

14. *Cryptantha stricta* (Osterh.) Payson

Cryptantha stricta (Osterh.) Payson, Ann. Mo. Bot. Gard. 14: 264. 1927.
Oreocarya stricta Osterh. Bull. Torrey Bot. Club 50: 217. 1923.

Stout perennial, 1-3.7 dm tall, stems 1-several, 0.4-2 dm long, strigose and conspicuously setose-hirsute; leaves mostly basal, oblanceolate to spatulate, entire, 2-7 cm long, 0.4-0.9 cm wide, retrorsely strigose and spreading setose-hirsute, pustulate; inflorescence narrow, interrupted below the terminal cluster, 0.5-2 dm long, setose-hirsute, floral bracts inconspicuous; calyx segments lanceolate, 4-6 mm long in anthesis, in fruit becoming 7-9 mm long, setose-hirsute; corolla white, the tube 3-4 mm long, crests at base of tube conspicuous, fornices yellow, rounded, papillose, limb 7-10 mm wide; style exceeding mature fruit 1-1.5 mm; nutlets lanceolate to elliptic, 3-3.5 mm long, 1.5-2 mm wide, usually all four maturing, margins in contact, knifelike, dorsal surface with definite transverse ridges, also somewhat tuberculate, ventral surface smooth or nearly so, scar open, very narrowly linear, elevated margin lacking. Collections: 17 (m); representative: I. H. Graham 8163 (GH); L. Williams 489 (GH); R. C. Barneby 9145 (GH), Welsh and Moore 6714 (BRY); W. J. MacLeod 10a (COLO, CS); G. L. Osterhout 6391 (RM); L. C. Higgins 1869, 1874 (BRY, TTC, WTSU).

Holotype: G. L. Osterhout 6195, collected in Moffat County, Colorado, some distance south of the Yampa or Bear River along the Victory hwy., 21 June 1922, GH. Photograph at BRY. Isotype at RM.

Distribution: Southwestern Wyoming in Carbon County, south into Moffat County, Colorado, and west to Utah in Uintah, Daggett, and Summit Counties. Growing on clay soils, 5,000 to 8,500 feet. Map No. 14. June to September.

Cryptantha stricta is an endemic species, confined to the three corners area of Colorado, Wyoming, and

Utah. In general appearance it somewhat resembles *C. celosioides*, but is probably not very closely related to that plant. It may be distinguished from other species in the Uintah Basin by the strict stems with harsh setose hairs, the nutlets which are smooth on the ventral surface, and the conspicuous transverse ridges on the dorsal surface.

15. *Cryptantha nubigena* (Greene) Payson

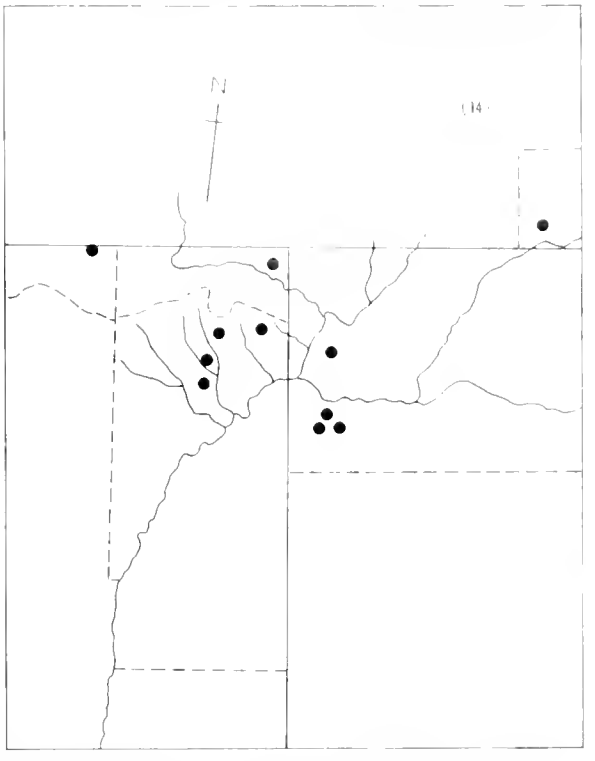
Cryptantha nubigena (Greene) Payson, Ann. Mo. Bot. Gard. 14:265. 1927.
Oreocarya nubigena Greene, Pitt. 3:112. 1896.
Cryptantha clemensae Payson, Ann. Mo. Bot. Gard. 14:267. 1927. (Type: Glenn's Pass, California, Mrs. Joseph Clemens, 22 July 1910, RM.)

Short-lived perennials, 0.8-2.5 dm. tall; stems several from a slender taproot, 0.4-1 dm. long, setose; leaves narrowly oblanceolate, flaccid, obtuse to acute, 2-5 cm. long, 0.3-0.7 cm. wide, strigose and spreading setose, dorsal surface pustulate, ventral surface with few or no pustules; inflorescence narrow, cylindrical or nearly capitate, 0.4-2 dm. long, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 2.5-3 mm. long, in fruit becoming 4-6 mm. long, setose; corolla white, the tube 2-2.5 mm. long, crests at base of tube evident, fornices light-yellow to nearly white, rounded, about 0.5 mm. long, slightly papillose, limb 3.5-5 mm. wide; style exceeding mature fruit 0.5-1 mm.; nutlets narrowly lanceolate, papery, 2.8-3.2 mm. long, 1.3-1.5 mm. wide, margin narrowly winged, in contact, dorsal surface weakly tuberculate to nearly smooth, ventral surface smooth, scar open, narrowly linear, margin of scar not elevated. Collections: 32 (0), representative: Chestnut and Drew s.n. (ND-G), G. J. Robbins 3399 (RM, WTU), P. A. Munz 12547 (POM, WTU), J. T. Howell 25933 (POM, UTC), I. W. Pierson 14030 (POM); Alexander and Kellogg 4552 (UTC).

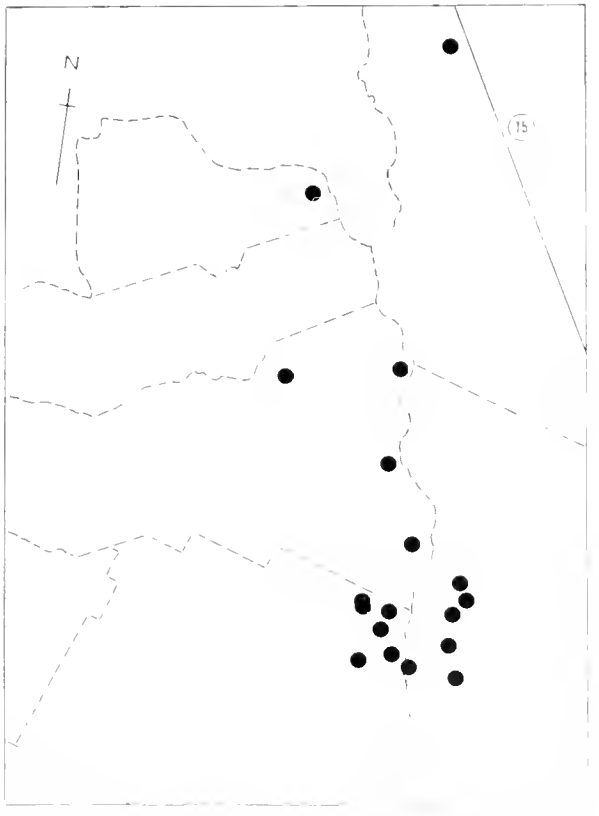
Lectotype: Chestnut & Drew s.n., collected in Mariposa County, California, on Clouds Rest, Yosemite Natl. Park, 10 July 1889, ND-G. Photograph at BRY. Isolectotype at CALIF.

Distribution: East-central California in Inyo, Tulare, Fresno, Mono, and Mariposa Counties. Growing in gravelly soil or talus slopes of volcanic origin, 9,000 to 13,000 feet. Map No. 15. July to September.

This species is endemic to the high Sierras, chiefly between 9,000 and 12,500 feet. The specimens of this species available to past monographers has been very poor and scanty. Payson saw a poor isotype of the species and mistakenly identified it with some plants of Oregon and Idaho. The reasonably good specimens of this plant from the southern Sierras Payson described as a new species *C. clemensae*. This latter name however falls in synonymy of *C. nubigena* and the plants of Oregon and Idaho mistakenly called *nubigena* were described as new (Johnston 1939).



Map. No. 14. Northeastern Utah and adjoining Colorado and Wyoming. Range of *C. stricta* (Osterhout) Payson.



Map No. 15. Parts of eastcentral California. Range of *C. nubigena* (Greene) Payson.

The Oregon plant is now known as *C. subretusa*, and the Idaho plant as *C. hypsophila*. *C. nubigena* may be separated from the latter two by being a weaker, more slender, more bristly plant with less firm, green, basal leaves, much smaller, smoother nutlets, and a more interrupted inflorescence with a capitate terminal cluster, and scattered smaller lateral ones below.

16. *Cryptantha subretusa* Johnst.

Cryptantha subretusa Johnst. Journ. Arn. Arb. 20:393. 1939.

Cryptantha andina Johnst. ex M. E. Peck, Man. Pl. Ore. 601. 1941. (Without latin diagnosis or type.)

Oreocarya subretusa (Johnst.) Abrams, Ill. Fl. Pac. St. 3:599. 1951.

Caespitose perennial, 1-2 dm. tall, stems several, 0.5-1.5 dm. long, setose; leaves spatulate, subretuse or obtuse at apex, congested at the base, reduced upward, 1-4 cm. long, 0.4-1 cm. wide, tomentose and weakly setose, pustules conspicuous on the dorsal surface, fewer and less evident on the ventral surface; inflorescence compact, cylindric, 0.2-1 dm. long, spreading setose, floral bracts inconspicuous; calyx segments lanceolate, 3-4 mm. long in anthesis, in fruit becoming 6-9 mm. long, setose and subtomentose; corolla white, the tube 3-4 mm. long, crests at base of tube conspicuous, fornices yellow, rounded, papillose, about 0.5 mm. long, limb 4-6 mm. wide; style exceeding mature fruit 0.5-1 mm.; nutlets lanceolate, 3-4 mm. long, 2-2.5 mm. wide, 2-4 maturing, the margins in contact, knifelike or narrowly winged, dorsal surface inconspicuously tuberculate, and with low short ridges, ventral surface similar, but the markings much less evident, or smooth, scar open, subulate or narrowly linear, and without an elevated margin. Collections: 25 (0); representative: J. W. Thompson 12206 (GH, POM, WTU); R. F. Rogers 87 (ORE); W. H. Baker 6282 (WTU); W. C. Cusick 2028 (ND-G); RME, G. Hansen 534 (GH, ORE); G. Mason 7502 (ORE); M. E. Peck 19480 (GH).

Holotype: J. W. Thompson 12206, collected in Klamath County, Oregon, on pumice rim of Crater Lake, 7,000 feet, 20 July 1935. GH. Photograph at BRY. Isotypes at POM, WTU.

Distribution: Northeastern Oregon in Wallowa County, south to Harney County and to Humbolt County, Nevada. West to northern California and north into Klamath County, Oregon. Growing on [illegible] or talus slopes of volcanic origin, 6,500 to 10,000 feet. Map No. 16. June to August.

Generally *C. subretusa* may be distinguished from [illegible] plants of Oregon by its elongate nutlets, [illegible] rounded, obtuse, truncate or subretuse [illegible] and the small corollas.

[illegible] part of *C. nubigena* in Payson's monograph [illegible] almost entirely to this species. His [illegible] as well as the nutlets belong to *C. subre-*

17. *Cryptantha hypsophila* Johnst.

Cryptantha hypsophila Johnst. Journ. Arn. Arb. 20:395. 1939.

Caespitose perennials, 1-2 dm. tall; stems several, 0.5-1.4 dm. long, setose-hispid; leaves oblanceolate-spatulate, obtuse, 2-6 cm. long, 0.3-0.7 cm. wide, strigose and spreading setose, dorsal surface evidently pustulate, ventral surface with fewer pustulae; inflorescence narrow, 0.2-0.7 dm. long, foliar bracts inconspicuous; calyx segments lanceolate, 3-4 mm. long in anthesis, in fruit becoming 5-7 mm. long, setose-hirsute, corolla white, the tube 3-4 mm. long, crests at base of tube well developed, fornices yellow, rounded, limb 4-5 mm. wide; style exceeding mature fruit 1.2-1.5 mm.; nutlets oblong-lanceolate, 3-3.7 mm. long, 1.5-1.8 mm. wide, margins acute, in contact, dorsal surface tuberculate or some of these connected to form short low ridges, ventral surface smooth or nearly so, scar narrowly linear, the margin not elevated. Collections: 11 (0); representative: J. W. Thompson 14129 (GH, WTU); A. Cronquist 2894 (GH, IDS); C. L. Hitchcock and C. V. Muhlick 10676 (WTU); Machride and Payson 3771 (POM).

Holotype: J. W. Thompson 14129, collected in Blaine County, Idaho, on crest of high barren ridge at head of Boulder Creek, Sawtooth Mountains, 11,000 feet, 6 August 1937. GH. Photograph at BRY. Isotype at WTU.

Distribution: Endemic to central Idaho in Blaine and Custer Counties. Growing on talus slopes and soils of volcanic origin, 8,000 to 11,500 feet. Map No. 17. July and August.

Payson identified this plant as part of *C. nubigena*. Its affinities, however, are not with that plant but with *C. subretusa* of Oregon. The Idaho plant can be distinguished by its spreading bristly hairs, narrower nutlets, and narrower less firm leaves that are obtuse or acute at the apex.

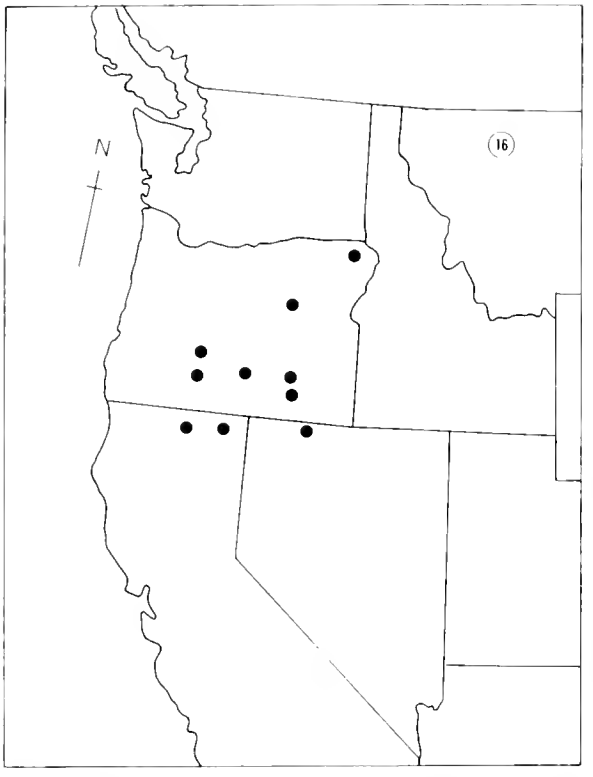
This species may also be confused with *C. spathifera*, but differs in being a smaller and more caespitose plant, with more elongate nutlets, and shorter basal leaves. It is also separated from this plant in elevation and flowering time.

18. *Cryptantha crymophila* Johnst.

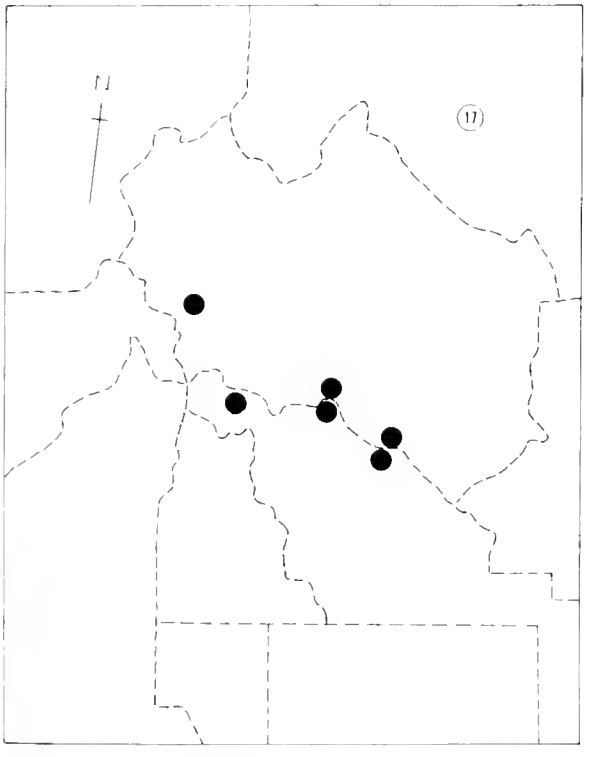
Cryptantha crymophila Johnst. Journ. Arn. Arb. 21:65. 1940.

Oreocarya crymophila (Johnst.) Tetps. & Hoover, in Tetpson Fl. Calif. 3:328. 1943.

Perennial, 1.5-3 dm. tall, stems 1-several, 0.9-1.3 dm. long, erect, hirsute; leaves oblanceolate, 4-10 cm. long, 0.5-1.3 cm. wide, finely setose and appressed hirsute, the dorsal setae pustulate at base, the ventral with fewer pustules, inflorescence narrow, 1.9-2.3 dm. long, setose; calyx segments lanceolate, 4-5 mm. long in anthesis, in fruit becoming 10-14 mm. long, hirsute; corolla white, the tube 3-5 mm. long, crests at base of



Map No. 16. Western United States. Range of *C. subretusa* Johnston



Map No. 17. Central Idaho, Blaine and Custer Counties. Range of *C. hypsophila* Johnston

tube evident, fornices yellow, rounded, papillose, 0.5 mm long, limb 4-7 mm wide; style exceeding mature fruit 1-2 mm; nutlets ovoid, usually four maturing, 5-6 mm long, 3-3.5 mm wide, the margins in contact, winged, dorsal surface with low ridges, also inconspicuously muricate, to nearly smooth, ventral surface smooth, scar open, linear, and without an elevated margin. Collections: 4(ii); representative: R. F. Hoover 4193 (GH); C. B. Hardham 6510 (POM); L. C. Higgins 1766, 1767 (BRY).

Holotype: R. F. Hoover 4193, collected in Alpine County, California, on Red Peak, 28 July 1939, GH. Photograph at BRY.

Distribution: Alpine ridges between the Clark Fork and the Middle Fork of the Stanislaus River in Alpine and Tuolumne Counties, California. Growing in loose rocks of volcanic origin, 9,000 to 10,000 feet. Map No. 18. Late June to September.

C. crymophila is probably closely related to *C. nubigena* of the southern Sierras. However, it differs from *C. nubigena* by being much taller and more robust, with longer leaves, much larger fruiting calyces, and the larger more rugose nutlets which are definitely winged-margined.

19. *Cryptantha setosissima* (Gray) Payson

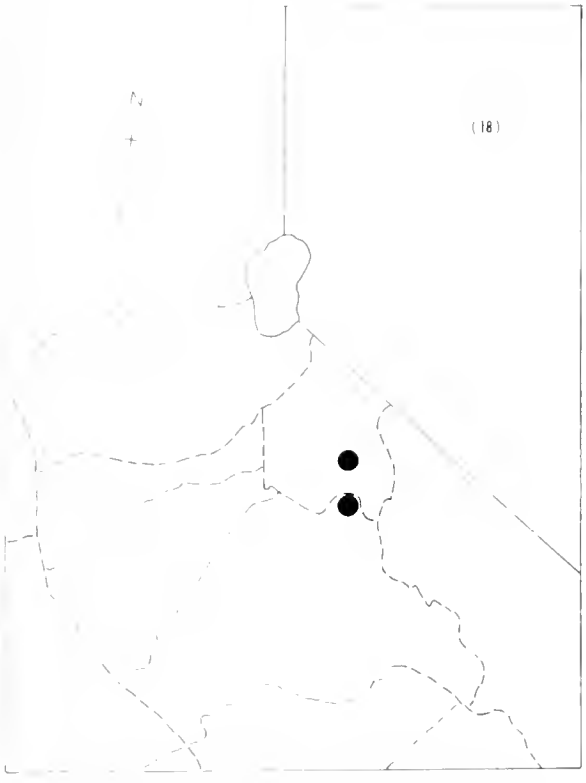
Cryptantha setosissima (Gray) Payson, Ann. Mo. Bot. Gard. 14:268. 1927.

Eritrichium setosissima Gray, Proc. Am. Acad. 12:80. 1877.

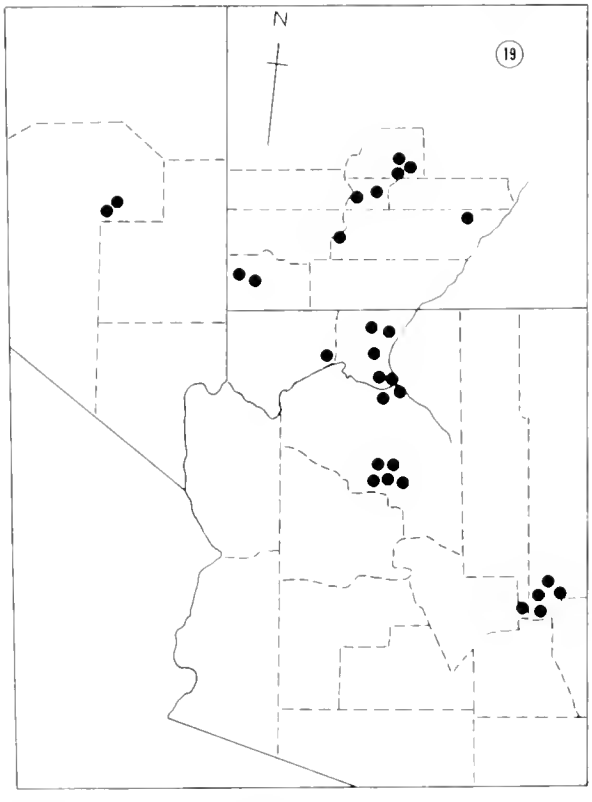
Krynitzkia setosissima (Gray) Gray, Proc. Am. Acad. 20:276. 1885.

Oreocarya setosissima (Gray) Greene, Pitt. 1:58. 1887.

Biennial or short-lived perennials, 3-10 dm tall, stems usually 1-3 erect, 1.5-5 dm long, hirsute; leaves clustered at the base, reduced upward, oblanceolate, the apices obtuse to acute, 3-13 cm long, 0.5-1.5 cm wide, setose, with some finer twisted pubescence beneath, pustulate hairs numerous on both surfaces; inflorescence broad-topped due to the elongation of the scorpioid racemes, 1-5 dm long; calyx segments broadly lanceolate, 4-6 mm long in anthesis, in fruit becoming 9-11 mm long, setose, and strigose; corolla white, the tube 3-5 mm long, constricted above the ovary by the conspicuous ring of crests, fornices yellow, emarginate, 0.5 mm long, limb 7-9 mm wide; style exceeding mature fruit 1-2 mm; nutlets ovate, 5-6 mm long, 3.5-4.5 mm wide, papery, with a broad-winged margin, dorsal surface muricate, and inconspicuously rugose or tuberculate, ventral surface smooth or nearly so, scar straight, narrow, slightly open, elevated margin lacking. Collections: 58 (viii); representative: Maguire and Holmgren 25583 (BRY, ORE, RM, UTC); L. F. Ward 646 (UC); R. H. Peebles 12566 (ARIZ); D. T. MacDougal 165 (ARIZ, RM); C. F. Deaver 6306 (ASC); W. D. Stanton 516 (UT); E. Palmer 591 (US); L. C. Higgins 1125, 1117, 1440, 1775, 1795 (BRY).



Map No. 18. East central California, Alpine and Tuolumne Counties, and adjoining Nevada. Range of *C. crymophila* Johnston.



Map No. 19. Utah, Arizona, and southeastern Nevada. Range of *C. setosissima* (Gray) Payson.

Holotype: J. T. Ward 646, collected in Sevier County, Utah, at Fish Lake, 25 August 1875, GH. Photograph at BRY. Isotypes at UC, MO, PH, US.

Distribution: Central Utah, south through most of Arizona in the mountainous areas, west to Nye County, Nevada. Growing in gravelly to sandy soils, 7,000 to 10,000 ft. Map No. 19. June to September.

This is one of the most distinctive species in the entire genus. It may be separated from all other species by the stout, strict, solitary stems, and the broadly winged ovate nutlets.

20. *Cryptantha virgata* (Porter) Payson

Cryptantha virgata (Porter) Payson, Ann. Mo. Bot. Gard. 14: 270. 1927.

Eritrichium virgatum Porter, Hayden R. pt. 479. 1870.

Eritrichium glomeratum var. *virgatum* Porter, in Porter & Coulter, Syn. Fl. Colo. 102. 1874.

Krynitzkia virgata (Porter) Gray, Proc. Am. Acad. 20: 279. 1885.

Oreocarya virgata (Porter) Greene, Pitt. 1: 58. 1887.

Oreocarya spicata Rydb., Bull. Torrey Bot. Club 36: 678. 1909. (Type: Artists Glen, Pikes Peak, Colorado, J. A. Purpus 1901, Clements 102.)

Oreocarya virgata forma *spicata* (Rydb.) Macbr., Proc. Am. Acad. 51: 546. 1916.

Stems biennial, arising from a stout taproot, 2.5-8 (10) dm. tall, stems usually solitary, but sometimes [illegible] at the base, stout, 0.5-2 dm. long, setose or hirsute-hispid; leaves narrowly oblanceolate, obtuse, 3-20 cm. long, 0.4-1.5 cm. wide, setose-hirsute, with pustulate hairs on both surfaces; inflorescence cylindrical, 1.5-7 (9) dm. long, with conspicuous, linear-oblanceolate foliar bracts that much exceed the cymules; calyx segments lanceolate, in anthesis 3.5-4 mm. long, in fruit becoming 10-12 mm. long, hirsute; corolla white, the tube 3.5-4 mm. long, crests at base of tube very conspicuous, fornices yellow, emarginate, papillose, about 0.5 mm. long, limb 8-11 mm. wide; style surpassing the mature fruit 1.6-2 mm.; nutlets ovate, 2.7-3.5 mm. long, 2.4-3 mm. wide, usually all four maturing, the margins in contact, acute, dorsal surface usually with conspicuous low ridges, and a few tubercles, or sometimes nearly smooth, ventral surface smooth or with a few indistinct tubercles, scar narrowly open, linear, and without an elevated margin. Collections: 62 (vi), representative: B. Maguire 16292 (UTC); A. Nelson 1937 (ND-G, RM); G. T. Robbins 3358 (ARIZ); T. B. Payson 4253 (RM); J. Iwan 14947 (COLO); A. Nelson 1267 (UC, RM); T. C. Higgins 1491, 1501, 1543 (BRY).

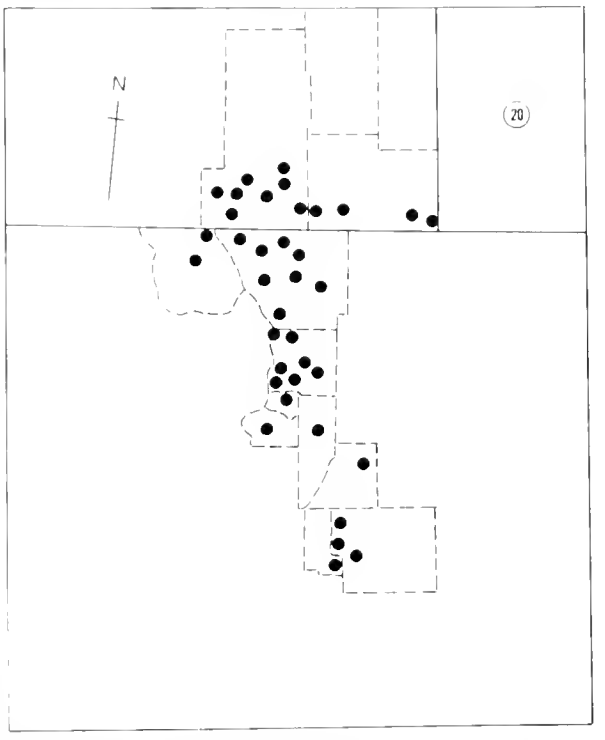
Type: B. H. Smith s.n., collected near Denver, Colorado, Colorado Territory, 1869. Not seen.

Distribution: Southeastern Wyoming, south through central Colorado, on foothills on the eastern side of the Rocky Mountains. Growing on gravelly soils, 5,000 to 9,500 feet. Map No. 20. Early May to

September.

C. virgata is one of the most conspicuous herbaceous plants on the eastern foothills of the Rocky Mountains. The stems of this plant are usually solitary, with long leafy foliar bracts that greatly exceed the individual cymules. For a few years this plant was treated as a variety of *C. celosioides*, but there is no reason to believe that it is even remotely related to that species.

Rydberg described *Orthocarya spicata* as a new species on the basis of the smooth nutlets. Later it was transferred as a form of *O. virgata*. Macbride contended that *O. spicata* was not deserving, even of varietal rank. In observing specimens from the type locality about Pikes Peak, it is even more evident that *spicata* is only a form of *virgata*.



Map No. 20. Southeastern Wyoming and central Colorado. Range of *C. virgata* (Porter) Payson

21. *Cryptantha tumulosa* (Payson) Payson

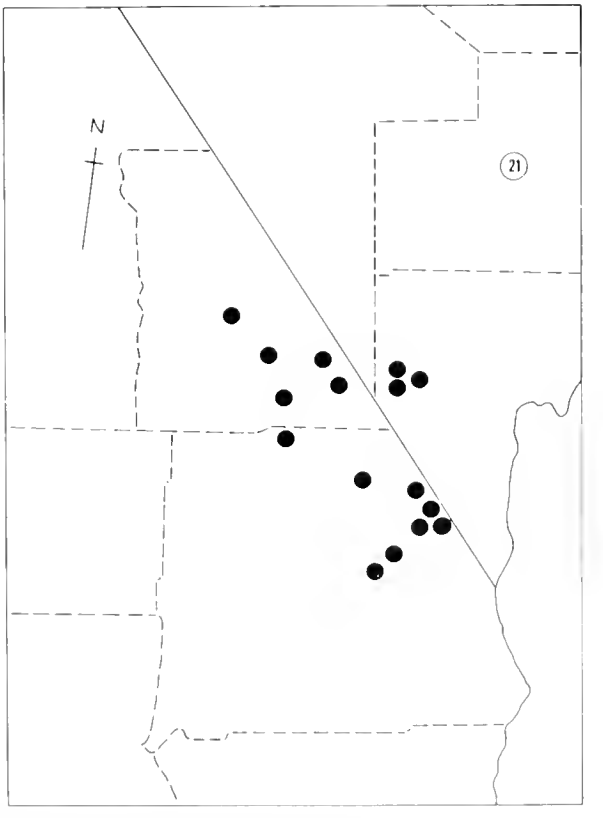
Cryptantha tumulosa (Payson) Payson, Ann. Mo. Bot. Gard. 14:276. 1927.
Orthocarya tumulosa Payson, Univ. Wyo. Publ. Bot. 1:164. 1926.

Long-lived perennials, 0.8-2.9 dm tall; stems 1-several from a woody taproot, 0.4-1.4 dm long, spreading setose; leaves oblanceolate, obtuse, 3-6 cm long, 0.4-0.9 cm wide, strigose, setose and tomentose, pustulate on both surfaces, but more conspicuous on the dorsal side; inflorescence narrow, cylindric, uninterrupted, 0.4-2 dm long, floral bracts not evident; calyx segments linear-lanceolate, 4-5 mm long in anthesis, in fruit becoming 7-10 mm long, yellowish setose; corolla white, the tube 3.5-4.5 mm long, crests at base of tube evident, fornices yellow, acute, papillose, 0.5-1 mm long, limb 6-8 mm wide; style exceeding mature fruit 0.5-1 mm; nutlets ovate, 3-4 mm long, 2.5-3 mm wide, one to three usually maturing, the margins in contact when more than one matures, acute, dorsal surface with a low inconspicuous crest, tuberculate, and with some low ridges, ventral surface similar, scar open, triangular, margin of scar slightly elevated. Collections: 40 (0); representative: I. W. Clokey 7667 (ARIZ, UC, LL, ORE, RM, UTC); T. S. Brandegee s.n. (UC), P. A. Munz 14787 (BRY, GH); R. S. Ferris 11265 (RM); E. K. Ball 19346 (POM), Alexander and Kellogg 1463 (UC).

Holotype: T. S. Brandegee s.n., collected in San Bernardino County, California, on the Providence Mountains, May 1902, UC. Photograph at BRY.

Distribution: Clark County, Nevada, in the Charleston Mountains, southwest to the Providence Mountains, California, north to Inyo County. Growing on gravelly to clayey soils, 5,000 to 10,200 feet. Map No. 21. March to July.

This species has been confused in the past with *C. humilis* and *C. nubigena*. The nutlets are quite different from either of those species. Its nearest relatives are probably *C. virginensis*, *C. insolita* and *C.*



Map No. 21. Southern Nevada and adjoining California. Range of *C. tumulosa* (Payson) Payson

abata. From *C. abata* it differs in the lack of a conspicuous elevated margin around the scar and by the indefinite roughenings on the dorsal surface. It differs from *C. virginensis* and *C. insolita* in its definite perennial habit, narrow congested inflorescence, more tomentose indument, and the smoother nutlets with only a slightly elevated margin around the scar.

22. *Cryptantha insolita* (Macbr.) Payson

Cryptantha insolita (Macbr.) Payson, Ann. Mo. Bot. Gard. 14:273. 1927.

Oreocarya insolita Macbr. Contr. Gray Herb. 48:28. 1916.

Biennial or short-lived perennial from a slender taproot, 3-4 dm tall; stems 1-several, 1-3 dm long, strigose and conspicuously setose; leaves spatulate, mostly basal, obtuse, 3-5 cm long, 0.5-1.4 cm wide, dorsal surface subtomentose and sparsely appressed setose pustulate, ventral surface similar but the setae smaller and fewer, pustules few and small, petioles long-hairy at the base; inflorescence open, cymes few, much elongating, 0.7-1.4 dm long, weakly setose, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 3.5-4.5 mm long, in fruit becoming 7-9 mm long, densely hirsute; corolla white, the tube 3-4 mm long, crests at base of tube well developed, fornices yellow, slightly emarginate, papillose, 0.5-1 mm long, limb 6-8 mm wide; style exceeding mature fruit 1-1.5 mm; nutlets ovate to lanceolate, 3.7-4 mm long, one to four maturing, the margins acute, in contact or nearly so, dorsal surface carinate, tuberculate, granulo-muricate and sometimes slightly rugulose, ventral surface tuberculate and somewhat rugulose, scar narrow but open, the margin showing some tendency to become elevated. Collections: 2 (0), representative: L. N. Goodding 2286 (GH, RM).

Holotype: L. N. Goodding 2286, collected in Clark County, Nevada, at Las Vegas, 4 May 1905, GH. Photograph at BRY. Isotype at RM.

Distribution: Known only from the region about Las Vegas. Growing in white alkaline soil, 1,900 to 2,500 feet. Map No. 22. April to June.

This species somewhat resembles *C. elata* of eastern Utah and western Colorado, but it is doubtful if the two are even remotely related. However, this plant is probably closely related to *C. virginensis*, but differs in the length of the floral bracts, number of cymules, and the shape of the nutlets.

23. *Cryptantha virginensis* (Jones) Payson

Cryptantha virginensis (Jones) Payson, Ann. Mo. Bot. Gard. 14:274. 1927.

K. [illegible] glomerata var. *virginensis* Jones, Contr. West. Bot. 13:8. 1910.

Oreocarya virginensis (Jones) Macbr. Proc. Am. Acad. 51:547. 1916.

Biennial, 1.5-3.5 (4) dm tall, stems 1-several, arising from a stout taproot, 0.3-0.6 dm long, setose-hirsute; leaves oblanceolate to spatulate, obtuse, 3-10 (12) cm long, 0.5-1.5 cm wide, dorsal surface sparsely setose, pustulate, also with some fine tangled hair beneath, ventral surface subtomentose and weakly appressed setose, with only a few pustulate hairs; inflorescence a broad thyrsus with the individual cymes much elongating, 0.5-3 dm long, foliar bracts conspicuous; calyx segments linear-lanceolate, in anthesis 3-4 mm long, in fruit becoming 7-11 mm long, hirsute; corolla white, the tube 3-4 mm long, crests at the base of tube conspicuous, fornices yellow, emarginate, papillose, about 1 mm long, limb 7-9 mm broad; style exceeding mature fruit 1-1.5 mm; nutlets ovate, 3.3-4.5 mm long, 2.4-2.6 mm wide, usually only one to two nutlets maturing, margins in contact, acute, dorsal surface with a distinct ridge, the surface tuberculate and usually rugulose, ventral surface very uneven with indeterminate rugae and tubercles, scar open, and triangular, with an elevated margin. Collections: 64 (ii); representative: I. W. Clokey 5820 (ARIZ, BRY, ORE, RM, UTC); B. Maguire 4470 (RM, UTC); I. W. Gould 1580 (ARIZ, BRY, DIX, RM); Maguire and Holmgren 25404 (ARIZ, BRY, UTC); Alexander and Kellogg 3019 (RM, UTC); J. Beatley 4275 (BRY, LA); L. C. Higgins 1243 (BRY).

Holotype: M. E. Jones 5195a, collected in Washington County, Utah, at Laverkin, 8 May 1894, POM. Isotypes at UC, RM, MO, US.

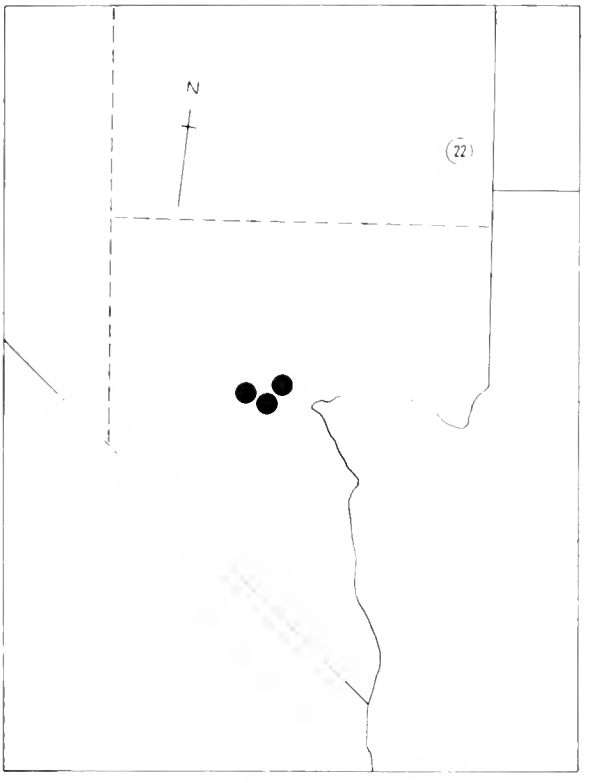
Distribution: Southwestern Utah, southern Nevada, northwestern Arizona, and southeastern California. Growing on gravelly to clay soils, 2,000 to 8,000 feet. Map No. 23. March to July.

Cryptantha virginensis has its closest relatives with *C. tumulosa* and *C. hoffmannii*. From the former it differs in the biennial habit, more open inflorescence, more setose indument, and the nutlets which are more conspicuously roughened.

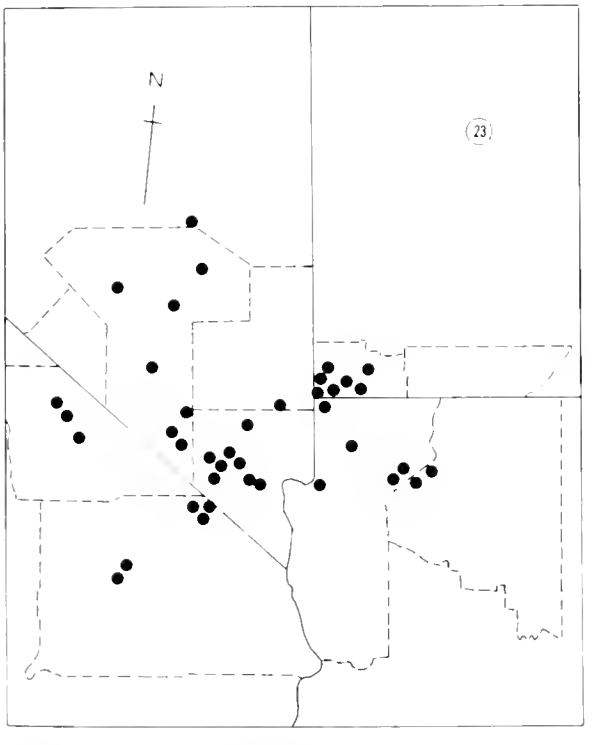
There can be no doubt that *C. virginensis* and *C. hoffmannii* are very closely related; and, because of the variation encountered in each, it is difficult to find characters of a high order which are consistently differential. Variation as now known in *C. virginensis* is rather great, especially marked in size of nutlets, length of the calyx, and the markings on the nutlets. However, where they approach each other in range, they occupy different life zones, and *C. virginensis* comes into flower a month or more earlier. The former also has fragrant flowers while *C. hoffmannii* does not. Additional collections of this complex are badly needed from western Nevada and eastern California.

24. *Cryptantha hoffmannii* Johnst.

Cryptantha hoffmannii Johnst. Contr. Arn. Arb. 3:90. 1932.



Map No. 22. Southern Nevada. Range of *C. insolita* (Macbr.) Payson.



Map No. 23. Southern Nevada and parts of adjoining states. Range of *C. virginensis* (M. E. Jones) Payson.

Orocarya hoffmanni (Johnst.) Abrams, Abrams, Ill. Fl. Pac. St. 3:600. 1951.

Plants biennial, 1.7-3.4 dm tall; stems 1-several, 0.2-1.6 dm long, conspicuously hirsute; leaves spatulate, crowded at the base, reduced upward, 2-5 cm long, 0.5-1.2 cm wide, spreading setose-hirsute, pustulate on both leaf surfaces, but more conspicuous dorsally; inflorescence broad-topped, interrupted, 1-2.8 dm long, floral bracts evident but not conspicuous; calyx segments lanceolate, in anthesis 3-5 mm long, in fruit becoming 5-8 mm long, hirsute-hispid; corolla white, the tube 3-4 mm long, crests at base of tube evident, fornices yellow, rounded, 0.5 mm long, papillose, limb 5-7 mm wide; style exceeding mature fruit 0.2-0.8 mm; nutlets ovate, 3-3.5 mm long, 2-2.5 mm wide, two to four nutlets maturing, the margins in contact, acute, both surfaces irregularly low rugose and minutely tuberculate, the dorsal with a low inconspicuous crest, scar open, triangular, without an elevated margin. Collections: 10 (1); representative: R. Hoffmann 78 (GH); Alexander and Kellogg 2503 (ARIZ, POM, RM); F. W. Pierson 7544 (GH, POM); P. Train 3977 (UTC); J. Roos 5849 (POM).

Holotype: R. Hoffmann 78, collected in Inyo County, California, on rocky open slopes of Westgard Pass, 7,300 feet, 11 July 1930, GH. Photograph at BRY.

Distribution: Western Nevada and southeastern California. Growing on gravelly soil in the pinyon-juniper community, 7,000 to 9,000 feet. Map No. 24. June and July.

Johnston, in the original description, said that this species was most closely related to *C. insolita*, however; I believe that its closest relative is *C. virginensis*, as discussed under that taxon.

25. *Cryptantha abata* Johnst.

Cryptantha abata Johnst., Journ. Arn. Arb. 24:240. 1948.

Krynitzkia depressa Jones, Contr. West. Bot. 13:5. 1910, not *C. depressa* A. Nels., Bot. Gaz. 34:29. 1902.

Orocarya depressa (Jones) Macbr., Contr. Gray Herb. 48:32. 1916.

Cryptantha modesta Payson, Ann. Mo. Bot. Gard. 14:278. 1927, not *C. modesta* Brand, Fedde, Rep. Spec. Nov. 24:48. 1924.

Plants perennial, arising from a strong woody taproot, 0.5-1.8 dm tall, stems many, 0.2-1.5 dm long, strigose and weakly setose, leaves oblanceolate to spatulate, obtuse, strigose, setose, and subtomentose, the petioles ciliate margined; inflorescence narrow, 0.2-0.8 dm long; calyx segments lanceolate to ovate, 2.5-4 mm long in anthesis, in fruit becoming 5-8 mm long, setose; corolla white, the tube 3-4 mm long, crests at base of tube conspicuous, fornices yellow, rounded, papillose, about 0.5 mm long, limb 7-8 mm wide; style exceeding mature fruit 0.5-1 mm; nutlets ovate, 3-3.5 mm long, 2-2.5 mm wide, usually all four maturing, margins in contact, obtuse to acute, dorsal surface carinate, tuberculate, muricate, and

Map No. 24. Inyo County, California, and adjoining Nevada. Range of *C. hoffmannii* Johnston.

sometimes with low inconspicuous ridges, ventral surface deeply and irregularly rugose, scar open, triangular, surrounded by a slightly elevated margin. Collections: 28 (v); representative: M. E. Jones 6692 (POM, UTC); B. E. Harrison 9009 (BRY), W. S. Boyle 1117 (BRY, UTC); L. N. Goodding 996 (POM, RM); Eastwood and Howell 651 (CAS); L. C. Higgins 1015, 1016 (BRY).

Lectotype: M. E. Jones 6692, collected at Aurum, Nevada, 7,300 feet, 20 June 1893, POM. Photograph at BRY. Isotype at US.

Distribution: South-central Utah, northwestern Arizona, and eastern Nevada. Growing on sandy or gravelly soil, 4,000 to 9,000 feet. Map No. 25. April to early July.

The name Payson applied to this species of southern Utah and eastern Nevada was invalid because of an earlier homonym. Johnston, noting this, named the plant *C. abata*.

Cryptantha abata is a modest, densely tufted *Cryptantha*, that is not greatly different in general appearance from some of the varieties of *C. humilis* or of *C. tumulosa*. It differs from these species by the short inflorescence, the deeply rugose nutlets on the ventral surface, and the spatulate leaves.

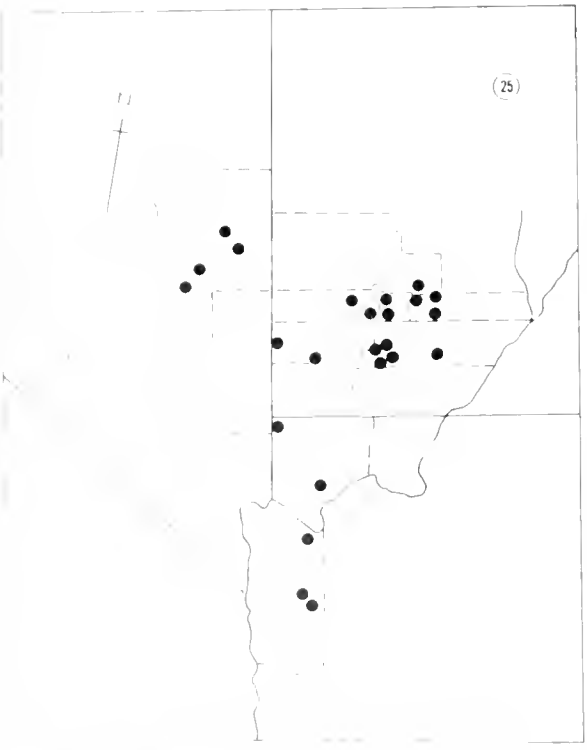
This plant is not often collected because of the early flowering time.

26. *Cryptantha caespitosa* (A. Nels.) Payson

Cryptantha caespitosa (A. Nels.) Payson, Ann. Mo. Bot. Gard. 14:281. 1927.

Oreocarya caespitosa A. Nels. Erythea 7:65. 1899.

Densely caespitose perennials, 0.5-1.5 dm tall; stems 1-many, arising from a much-branched woody caudex, 0.2-0.9 dm long, weakly setose, and appressed strigose; leaves oblanceolate to spatulate, 1-3 cm long, 0.3-0.7 cm wide, pubescence of two kinds, strigose and appressed setose, becoming tomentulose toward the petiole; inflorescence narrow, 0.3-1 dm long, foliar bracts inconspicuous; calyx segments lanceolate, in anthesis 3-4 mm long, in fruit becoming 5-8 mm long, strigose and weakly setose, also somewhat tomentulose; corolla white, the tube 3-4 mm long, crests at base of tube conspicuous, fornices yellow, rounded, about 0.5 mm long, limb 4-7 mm wide, style equalling or 0.5 mm longer than mature fruit; nutlets lanceolate, 3-3.5 mm long, 2-2.5 mm wide, the margins acute, in contact, dorsal surface with low rounded rugae, also tuberculate, and with numerous murications between the ridges, ventral surface muricate, scar open, narrowly triangular, margin of scar not elevated. Collections: 40 (vi); representative: A. Nelson 4671 (CS, RM); E. Nelson 4497 (RM); G. F. Osterhout 6248 (RM); E. B. Payson 4249 (RM); R. C. Rollins 1685 (RM, UTC); D. Atwood 1568 (BRY); L. C. Higgins 1557, 1562, 1563, 1566, 1586, 1570 (BRY).



Map No. 25. Southwestern Utah and adjoining states. Range of *C. caespitosa* Johnston.

Lectotype: A. Nelson 4749, collected in Sweetwater County, Wyoming, at Point of Rocks, 15 June 1898, RM. Photograph at BRY. Isotype at US.

Distribution: Southern Wyoming, but to be expected in northern Colorado and Utah, and perhaps eastern Idaho. Growing on heavy clay soils, 5,000 to 7,500 feet. Map No. 26. Early May to late July.

From the original description it is evident that Nelson also included in this species the plants that he later described as *C. cana*. In *C. cana* the leaves are silky-strigose, the inflorescence more capitate, and the nutlets are sharply muricate.

27. *Cryptantha ochroleuca* Higgins

Cryptantha ochroleuca Higgins, Great Basin Naturalist 28:197, 1968.

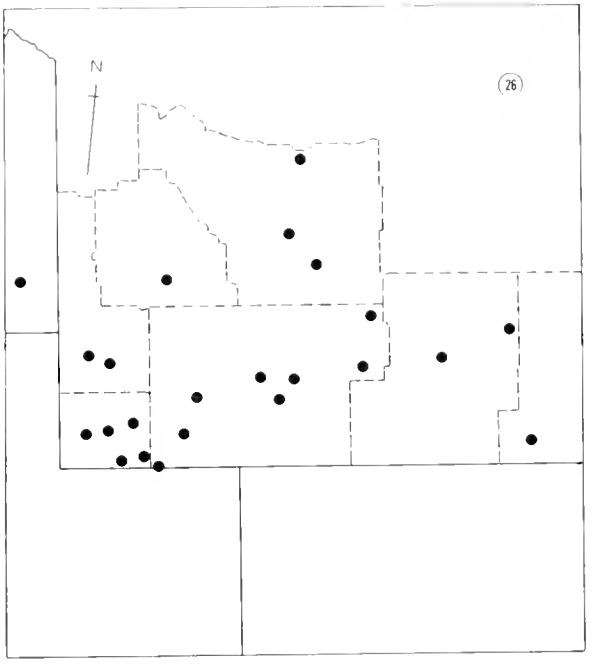
Low caespitose perennial, 0.2-1.3 dm tall; stems several, 0.1-0.4 dm long, strigose and weakly setose; leaves linear-oblanceolate to oblanceolate, the apices acute or sometimes obtuse, 1-2.5 cm long, 0.1-0.3 cm wide, basal leaves uniformly and densely strigose, sparsely setose, the petiole white-hairy, cauline leaves strigose and with some setose-pustulate bristles; inflorescence narrow, 0.2-0.7 dm long, weakly setose; calyx segments linear-lanceolate, 2-2.5 (3) mm long in anthesis, in fruit 4-6 mm long, setose; corolla pale-yellow, the tube 2-2.5 mm long, crests at base of tube conspicuous, fornices yellow, rounded, about 0.3 mm long, limb 4-5 mm wide; style scarcely surpassing mature fruit; nutlets lanceolate, 2.5-3 mm long, 1.4-1.6 mm wide, usually only one maturing, margin acute, dorsal surface irregularly rugose with low, rounded ridges; ventral surface only slightly uneven, scar open, narrowly triangular, extending $^3/_4$ the length of nutlet, no elevated margin. Collections: 5 (1); representative: L. C. Higgins 1788 (BRY); Reveal and Reveal 1031 (BRY); D. Atwood 1891 (BRY, WTSU).

Holotype: L. C. Higgins 1788, collected in Garfield County, Utah, on outcrop 100 meters south of Red Canyon Campground along hwy. 12, 6,500 feet, 21 July 1968, BRY. Isotypes at GH, NY, US.

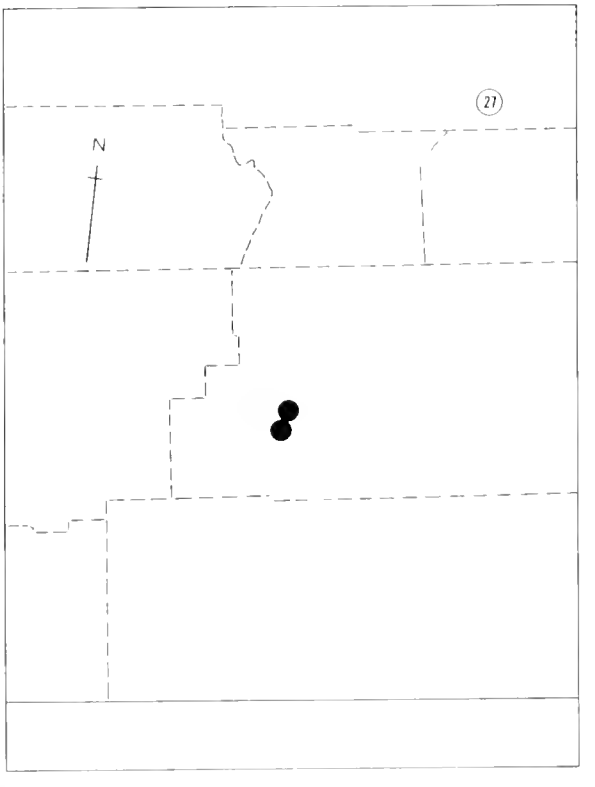
Distribution: Limited to the red Wasatch Formation near Red Canyon Campground in southwestern Garfield County, Utah, 6,500 to 7,000 feet. Map No. 27. May to August.

Cryptantha ochroleuca is apparently most closely related to *C. caespitosa* of southwestern Wyoming, but also has some affinities with *C. humilis*. It differs from *C. caespitosa* by its less caespitose habit, the slender, less woody taproot, shorter calyx, shorter, pale yellow instead of white corolla, and the smaller nutlets which are more rugose. From *C. humilis*, *C. ochroleuca* differs in the shorter calyx, pale yellow corolla, and the rugose nutlets.

This local species is apparently confined to the red Wasatch Formation in southwestern Garfield County, Utah.



Map No. 26. Southern Wyoming. Range of *C. caespitosa* (A. Nels.) Payson.



Map No. 27. Garfield County, Utah. Range of *C. ochroleuca* Higgins

28. *Cryptantha humilis* (A. Gray) Payson

Perennials, more or less densely caespitose, 0.5-3 dm tall; stems many, arising from the ends of the branched caudex, 0.2-1.5 dm long, strigose to spreading setose; leaves oblanceolate to spatulate, 1-6 cm long, 0.2-1.2 cm wide, strigose, setose or subtomentose, pustulate on both surfaces; inflorescence narrowly cylindrical to open and lax, 0.2-1.8 dm long, tomentose to conspicuously setose; calyx segments linear-lanceolate, in anthesis 2.5-4.5 mm long, in fruit becoming 6-13 mm long, setose or tomentose; corolla white, the tube 2.5-4.5 mm long, crests at base of tube conspicuous to nearly obsolete, fornices yellow, more or less papillose, rounded, about 0.5 mm long, limb 7-10 mm wide; the style shorter than to exceeding the mature fruit by 2.5 mm; nutlets lanceolate to ovate-lanceolate, 3-4.5 mm long, 1.8-3.2 mm wide, one to four of them maturing, margins in contact, acute to obtuse, dorsal surface muricate, tuberculate, or somewhat rugulose, ventral surface indistinctly muricate or tuberculate, scar open, triangular, margin not elevated.

Key to the varieties of *C. humilis*

1. Leaves strigose and setose but not conspicuously tomentose, calyx conspicuously setose (2).
1. Leaves densely strigose as well as tomentose; calyx setose and subtomentose (4).
   2. Nutlets rugulose as well as muricate; style 1.5-2.5 mm longer than mature fruit . . . . . 28a. var. *humilis*
   2. Nutlets muricate or tuberculate; style not exceeding the fruit by more than 1.5 mm (3).
3. Style exceeding the mature nutlets 1-1.5 mm; the inflorescence open and broad; plants loosely tufted . . . . . 28b. var. *commixta*
3. Style not or only slightly surpassing the nutlets; inflorescence congested, even in fruit; plants densely caespitose. . . . . 28c. var. *nana*
   4. Style scarcely exceeding the mature nutlets; inflorescence somewhat open at maturity; north-central Utah and southeastern Idaho . . . . . 28c. var. *shantzii*
   4. Style exceeding the mature nutlets 0.5-1.5 mm; inflorescence cylindrical and congested in fruit; southwestern Utah to southeastern California . . . . . 28d. var. *ovina*

28a. var. *humilis*

Cryptantha humilis (A. Gray) Payson var. *humilis*

Eremocarya chamaeraoides var. *humilis* A. Gray, Proc. Am. Acad. 10:61. 1875.

Oreocarya humilis Greene, Pitt. 3:112. 1896.

Oreocarya hispida Nels. & Kennedy, Proc. Biol. Soc. Wash. 19:156. 1906. (Type: Ormsby County, Nevada, in Carson Valley, 24 April 1904, G. B. True 865.)

Oreocarya echinoides Macbride, Contr. Gray Herb. 48:31. 1916, not *Krynitzkia echinoides* M. E. Jones.

Oreocarya macbridii Brand, Fedde, Rep. Spec. Nov. 19:73. 1923. (Type: Mt. Jarbidge, Nevada, 6 July 1912, Nelson and Macbride 1960.)

Cryptantha humilis (Greene) Payson, Ann. Mo. Bot. Gard. 14:278. 1927.

Caespitose perennial, 0.5-3 dm tall; stems 1-many, 0.4-1.5 dm long, erect, strigose and sparsely setose; leaves spatulate to oblanceolate, 1.5-7 cm long, 0.2-1 cm wide, weakly setose, strigose, and subtomentose, the petioles ciliate-margined, both surfaces pustulate; inflorescence narrow to somewhat open, 0.8-1.7 dm long, the floral bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 4-5 mm long, in fruit becoming 7-13 mm long, setose; corolla white, the tube 3.4-5 mm long, crests at base of tube evident to nearly obsolete, fornices yellow, rounded, papillose, about 0.5 mm long, limb 8-10 mm wide; style exceeding mature fruit 1.5-2.5 mm; nutlets ovate-lanceolate, 3-4.5 mm long, 1.8-2 mm wide, dorsal surface muricate, tuberculate, and usually rugulose, scar open at the base or nearly closed. Collections: 62 (vii); representative: Alexander and Kellogg 4443 (UC, US, UTC); Maguire and Holmgren 25938 (ARIZ, UC, ORE, UTC); A. Cronquist 8312 (ORE, UTC, WTU); P. A. Munz 21036 (CAS); M. E. Jones 5163 (US); Eastwood and Howell 8451 (POM); L. C. Higgins 1745, 1747, 1757, 1761 (BRY).

Lectotype: Bolander s.n., collected at Summit Station (Donner Pass), Nevada County, California, 1871. Not seen.

Distribution: Southeastern Oregon and southwestern Idaho, south throughout Nevada and into eastern California, mainly in mountainous regions. Usually growing on gravelly slopes and ridges, 4,500 to 12,000 feet. Map No. 28a. April to August.

In eastern Nevada and western Utah there is a mixing of two populations formerly referred to as *C. humilis* and *C. nana* var. *commixta* (Macbr.) Payson. The specific limits between *C. humilis* of A. Gray and that of *C. nana* are uncertain, and too many intermediates are present to hold them apart. For this reason the two species have been combined under humilis. The varieties within this complex are also very difficult to separate and can be done only tentatively in certain areas. For example, in central Utah the varieties *shantzii*, *commixta*, and *ovina* are extremely difficult to separate.

Brand's *O. macbridii*, from Jarbidge, Nevada, was described as new on the basis of the nutlets which tend to have rugae between the murications. The present author has found this same nutlet ornamentation in all the varieties of *C. humilis* which is just another reason for combining *C. humilis* and *C. nana*.

28b. var. *commixta* (Macbr.) Higgins stat. nov.

Cryptantha humilis (A. Gray) Payson var. *commixta* (Macbr.) Higgins

Oreocarya commixta Macbr. Contr. Gray Herb. 48:33. 1916.

Cryptantha nana (Eastw.) Payson var. *commixta* (Macbr.) Payson, Ann. Mo. Bot. Gard. 14:312. 1927.

Caespitose perennials, 1-2.7 dm tall; stems 1-several, arising from the ends of the branched caudex, 0.3-1 dm long, weakly strigose and spreading setose; leaves spatulate to broadly oblanceolate, 2.5-6 cm long, 0.5-1.2 cm wide, strigose and spreading setose; inflorescence open, 0.8-1.8 dm long, foliar bracts evident on lower part of the inflorescence; calyx segments linear-lanceolate, in anthesis 3.5-4.5 mm long, in fruit becoming 7-10 mm long, setose; style exceeding mature fruit 0.7-1.6 mm; nutlets lance-ovate, 3.5-4 mm long, muricate, tuberculate, or sometimes with the murications joined to form short irregular ridges, scar subulate or nearly closed. Collections: 18 (iv); representative: L. N. Goodding 1074 (GH, RM); M. E. Jones 5388L (US); B. F. Harrison 10148 (BRY); R. C. Holmgren 266 (BRY); L. C. Higgins 1468, 1617 (BRY).

Holotype: L. N. goodding 1074, collected in Juab County, Utah, on sandy slides at Juab, 9 June 1902, GH. Photograph at BRY. Isotype at RM.

Distribution: Central Utah to eastern Nevada. Growing on gravelly soil or talus slopes, 4,500 to 7,500 feet. Map No. 28b, May to July.

This variety may be distinguished by its open inflorescence, setose or coarsely strigose leaves, and the length of the style.

The variation within *commixta* is also noticeable, and a population along the Sevier River in Sevier and Piute Counties may prove to be another variety or species. The nutlets of this population along the Sevier River are more tuberculate than muricate, the scar is closed or nearly so, and the leaves are greener than in typical *commixta*.

28c. var. *shantzii* (Tidestr.) Higgins stat. nov.

Cryptantha humilis (A. Gray) Payson var. *shantzii* (Tidestr.) Higgins.

Oreocarya shantzii Tidestr. Proc. Biol. Soc. Wash. 26:122. 1913.

Oreocarya dolosa Macbr. Contr. Gray Herb. 48:32. 1916. (Type: College Bench, Logan, Utah, 4 June 1909, Smith 1605.)

Cryptantha nana (Eastw.) Payson var. *shantzii* (Tidestr.) Payson, Ann. Mo. Bot. Gard. 14:313. 1927.

Caespitose perennial, 1-2 dm tall; stems 1-many from the ends of the much branched caudex, 0.3-1 dm long, weakly setose and strigose; leaves spatulate to oblanceolate, obtuse, 2-5 cm long, 0.3-0.7 cm wide, tomentose and appressed setose, with slender more or less appressed bristles; inflorescence usually narrow, but the cymules slightly elongating, lower foliar bracts rather conspicuous in the young inflorescence; calyx segments densely setose and subtomentose; style scarcely exceeding the mature nutlets; nutlets muricate. Collections: 40 (v); representative: B. Maguire 12952 (RM); C. P. Smith 1573 (RM); C. P. Smith 1605 (RM); Kearney and Shantz 3098 (US); R. Gourley 8068 (UT); R. J. Davis 988 (IDS); A. A. Beetle 5792 (ND); E. Palmer 42 (RM); L. C. Higgins 1087 (BRY).

Holotype: Kearney and Shantz 3098, collected in dry saline soil at Grants Station south of the Great Salt Lake, Utah, 6 August 1912, GH.

Distribution: Southwestern Montana, eastern Idaho, and northern Utah. Growing on a wide variety of soils, 4,500 to 8,000 feet. Map No. 28b, April to July.

This variety may be distinguished by the short style, evident foliar bracts, and the basal leaves, which are silvery strigose and setose.

Payson designated the specimen collected by C. P. Smith 1605, as the type of var. *shantzii*. However, the plant collected by Kearney and Shantz 3098, should have been used since it was designated as the type in the original description.

28d. var. *orina* (Payson) Higgins stat. nov.

Cryptantha humilis (A. Gray) Payson var. *orina* (Payson) Higgins.

Cryptantha nana (Eastw.) Payson var. *orina* Payson, Ann. Mo. Bot. Gard. 14:314. 1927.

Densely caespitose long-lived perennials, 0.5-1.5 dm tall; stems several, 0.2-0.7 dm long; leaves spatulate to oblanceolate, obtuse, 2-4 cm long, tomentose and appressed setose with rather weak bristles; inflorescence narrow, cylindrical, lower foliar bracts inconspicuous; calyx segments linear-lanceolate, densely setose and tomentose; style exceeding the mature fruit 0.5-1 mm; nutlets muricate or tuberculate. Collections: 21 (v); representative: P. A. Munz 21036 (UT); Eastwood and Howell 9377 (CAS); Ripley and Barneby 3485 (CAS); G. H. Bentley s.n. (RM); J. L. Reveal 1414 (BRY, LA); S. L. Welsh 5226 (BRY); L. C. Higgins 1234, 1409, 1449, 1455 (BRY).

Holotype: Georgia H. Bentley s.n., collected in Nye County, Nevada, in the vicinity of Currant, June 1916, RM.

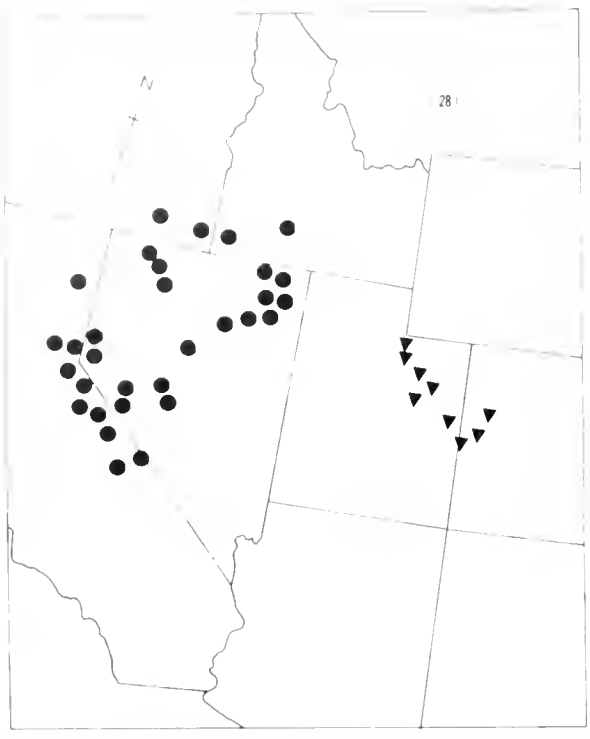
Distribution: Southwestern Utah, southern Nevada, and southeastern California. Growing on gravelly loam or clayey soils, mainly in the pinyon-juniper belt, 3,500 to 7,000 feet. Map No. 28b, April to July.

Variety *orina* has its closest relative in var. *shantzii*. It may be separated from that variety only tentatively by the more tomentose leaves and calyces and the longer style. The foliar bracts are also less evident in this variety.

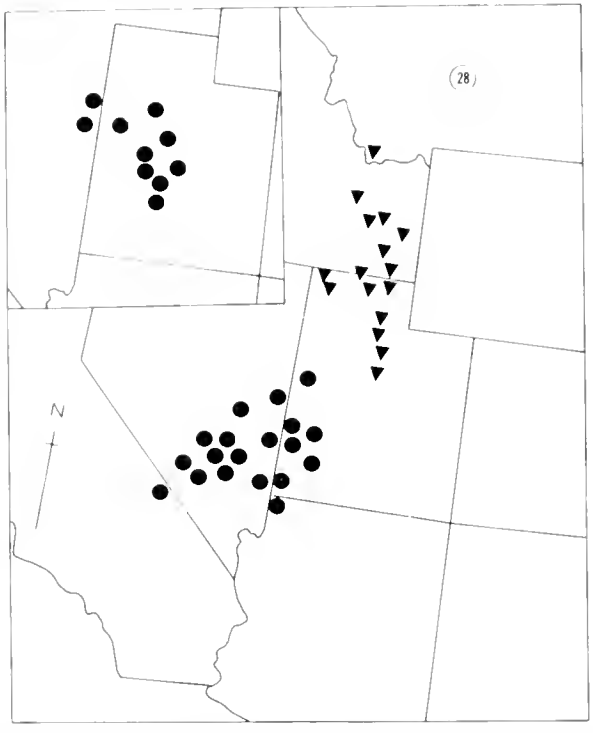
28e. var. *nana* (Eastw.) Higgins stat. nov.

Cryptantha humilis (A. Gray) Payson var. *nana* (Eastw.) Higgins.

Oreocarya nana Eastw. Bull. Torrey Bot. Club 30:243. 1903.



Map No. 28a. Parts of western United States. Range of *C. humilis* (Gray) Payson: (Circles), var. *humilis*, (Triangles) var. *nana* (Eastw.) Higgins.



Map No. 28b. Parts of western United States. Range of *C. humilis* (Gray) Payson: (circles), var. *ovina* (Payson) Higgins; (triangles) var. *shantzii* (Tidestr.) Higgins; inset, (circles), var. *commixta* (Macbr.) Higgins.

Cryptantha nana (Eastw.) Payson var. *typica*, Ann. Mo. Bot. Gard. 14: 315. 1927.

Caespitose perennial, 0.5-1.5 dm. tall; stems several, 0.2-0.7 dm. long, setose; leaves oblanceolate to spatulate, 0.5-4 cm. long, 0.2-0.6 cm. wide, strigose to subtomentose, spreading setose; inflorescence narrow, cylindrical, 0.2-1 dm. long, setose; calyx segments linear-lanceolate, in anthesis 2.5-3.5 mm. long, in fruit becoming 6-8 mm. long, setose; corolla white, the tube 2.5-3.5 mm. long, crests at base of tube evident; style shorter to slightly longer than mature fruit; nutlets muricate or sometimes tuberculate or rugulose. Collections: 18 (x), representative: Ripley and Barneby 4675 (CAS), W. A. Weber 11258 (COLO); A. Eastwood s.n. (CAS), G. F. Osterhout 4484 (RM), D. Wiens 3066 (COLO), I. C. Higgins 1066, 1598 (BRY).

Holotype: A. Eastwood s.n., collected in Mesa County, Colorado, near Grand Junction on the mesa above the Gunnison River, 17 May 1892, CAS. Photograph at BRY. Isotypes at RM, UC, GH.

Distribution: Western Colorado and eastern Utah. Growing on sandy or clay soils, 4,500 to 7,000 feet. Map No. 28a. April to July.

Variety *nana* can usually be separated from the other varieties of this complex by the setose leaves which are only rarely tomentose, the very short style which usually does not exceed the fruit, and the compact inflorescence.

The *C. humilis* complex is distinguished mainly by the short corollas and the uniformly muricate nutlets. These are also characteristics shared by *C. cana* and *C. breviflora*; however, these species have an indument which is silky-strigose and with few or no pustulate hairs especially on the ventral surface.

29. *Cryptantha roosiorum* Munz

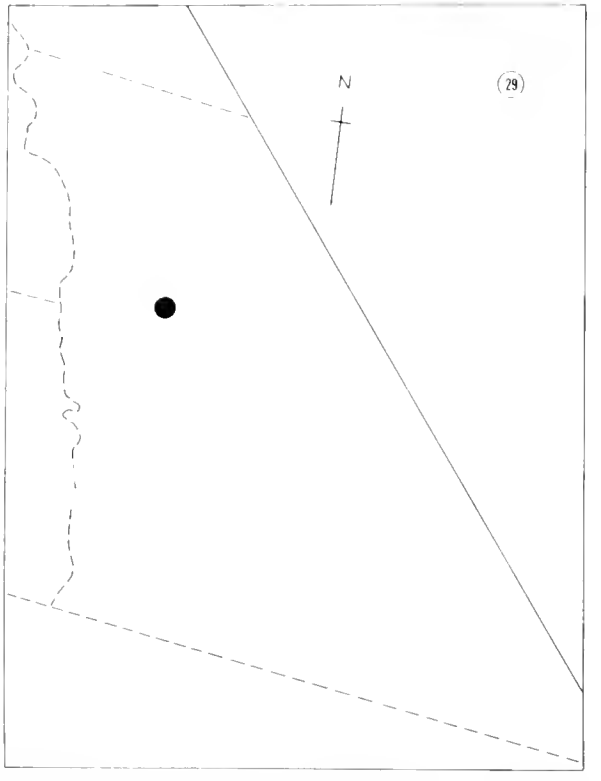
Cryptantha roosiorum Munz, El Aliso 3:124. 1955.

Densely caespitose, long-lived perennial, 0.1-0.3 dm. tall, stems many from the end of the branched caudex, rather slender, 0.1-0.2 dm. long; leaves spatulate to oblanceolate, acute, 0.5-1.2 cm. long, densely strigose and appressed setose, appearing almost tomentose, scarcely pustulate; inflorescence compact, about 1 cm. long, foliar bracts inconspicuous; calyx segments linear, in anthesis 2.8-3.1 mm. long, in fruit becoming 3.8-4.3 mm. long, strigose, and more or less setose; corolla white, the tube 2.5-3 mm. long, crests at base of tube well developed, fornices low, rounded, yellow, about 0.5 mm. long, limb 4.5-5.5 mm. wide; style slightly surpassing the nutlets; nutlets 2.3-2.5 mm. long, lance-ovate, acutish, dorsal surface rugulose, with low, rounded, irregular ridges, also somewhat muricate, ventral surface similar but the markings less evident, scar narrowly triangular, and lacking an elevated margin. Collections: 1 (O), representative: J. C. and A. R. Roos 6015 (RSA).

Holotype: J. C. and A. R. Roos 6015, collected in Inyo County, California, along crest of Inyo Mountains three miles east of Badger Flat, at 10,600 feet, 13 August 1953, RSA. Photograph at BRY. Isotypes at CAS, GH.

Distribution: Apparently endemic to the type locality, Inyo County, California. Growing on open rocky slopes, 10,600 feet. Map No. 29. July and August.

Cryptantha roosiorum is not very well known, and many more collections of this species are badly needed. It is perhaps most closely related to *C. humilis*, but differs in the more caespitose habit, smaller leaves, calyx, and corolla. The inflorescence is also more compact, and the whole plant is much smaller.



Map No. 29. Inyo County, California. Range of *C. roosiorum* Munz.

30. *Cryptantha compacta* Higgins

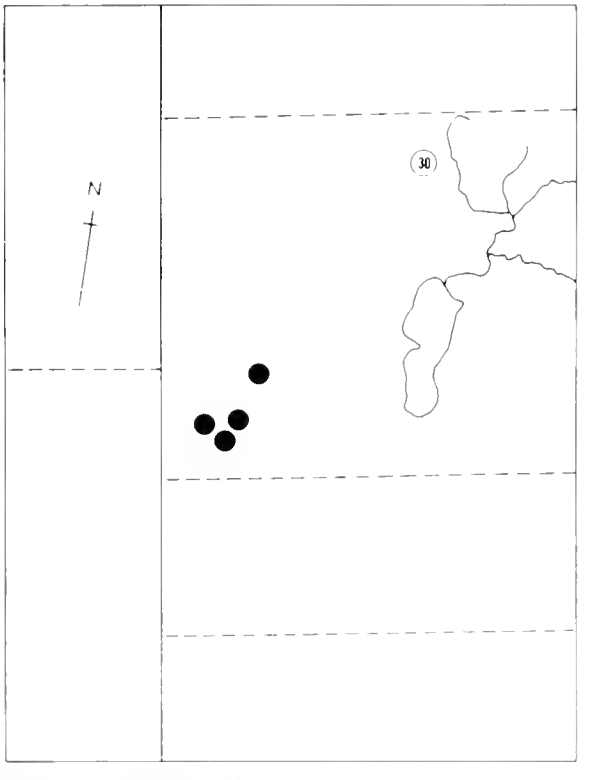
Cryptantha compacta Higgins, Great Basin Naturalist 28:196, 1968.

Densely caespitose perennial, 0.3-1 dm tall; stems numerous, arising from a woody root, 0.1-0.4 dm long, tomentose below, weakly strigose above; leaves oblanceolate to spatulate, obtuse, 0.5-1.5 (2) cm long, 0.2-0.4 cm wide, dorsal surface with appressed setose-pustulate bristles, also densely strigose or subtomentose, ventral surface similar but with fewer pustulate hairs, the petioles tomentose; inflorescence narrow, nearly capitate, 1-5 cm long; foliar bracts evident but not conspicuous; calyx segments lanceolate, 2-2.5 mm long in anthesis, in fruit becoming 3.5-4.5 (5) mm long, densely white setose and tomentose; corolla white, the tube 1.8-2.2 mm long, crests at base of tube evident, fornices yellow, rounded, papillose, about 0.5 mm long, limb 4.5-5.5 mm wide; style equalling or shorter than mature fruit; nutlets lance-ovate, acute, 2.5-3 mm long, 1.5-1.8 mm wide, only one to two maturing, dorsal surface muricate or weakly tuberculate-rugulose, ventral surface muricate, scar open, subulate to narrowly triangular, elevated margin lacking. Collections: 6 (ii); representative: R. C. Holmgren 521 (BRY); B. F. Harrison 6371 (BRY); L. C. Higgins 1462 (BRY).

Holotype: L. C. Higgins 1613, collected in Millard County, Utah, about 8 miles west of Desert Range Experiment Station Headquarters along Hwy. 21, 100 m west of pass at the north end of Needle Range, 18 June 1968, BRY. Isotypes at CAS, GH, NY, POM, US, UTC.

Distribution: Known only from southwestern Millard County, Utah, but to be expected from northern Beaver County, Utah, and perhaps in eastern Nevada. Growing on gravelly loam soil, 4,500 to 6,000 feet. Map No. 30. May to July.

Cryptantha compacta is most closely related to *C. humilis* but differs in its more compact and caespitose habit, smaller leaves, shorter calyx segments, and



Map No. 30. Western Utah and adjoining Nevada. Range of *C. compacta* Higgins.

smaller corolla. This plant has been known for over 30 years, but has been placed with *C. humilis*, probably due to the immaturity of the specimens. In observing this species in the field it becomes even more apparent of its right to specific distinction, due to its dense caespitose habit that more resembles *C. caespitosa* than *C. humilis*. At the type locality it is the most common plant, growing on shallow stony loam.

31. *Cryptantha cana* (A. Nels.) Payson

Cryptantha cana (A. Nels.) Payson, Ann. Mo. Bot. Gard. 14:316. 1927.
Oreocarya cana A. Nels. Bot. Gaz. 34:30. 1902.

Caespitose perennials, 0.5-2 dm tall; stems many, arising from a multiple caudex, 0.2-0.5 dm long, weakly setose; leaves narrowly oblanceolate, acute, very dense at the ends of the caudices, 2-6 cm long, 0.3-1 cm wide, uniformly silky-strigose, also with small inconspicuous pustulate hairs on both leaf surfaces; inflorescence narrow, setose, foliar bracts inconspicuous; calyx segments linear-lanceolate, 3-4 mm long in anthesis, in fruit becoming 6-7 mm long, weakly setose; corolla white, the tube 3-4 mm long, crests at base of tube evident, fornices yellow, rounded, papillose, about 0.5 mm long, limb 6-9 mm wide; nutlets lance-ovoid, 2.5-3 mm long, 1.4-1.8 mm wide, usually only one maturing, margins acute, dorsal surface muricate with elongated papillae, or sometimes tuberculate, ventral surface similar but less roughened, scar narrowly triangular, and without an elevated margin; style shorter than the mature fruit. Collections: 31 (iv), representative: E. J. Palmer 37423 (GH); C. L. Porter 5723 (GH, RM); Ripley and Barneby 10547 (GH); A. Nelson 2876 (ND-G); J. Iwan 12770 (GH); L. C. Higgins 1534, 1542, 1537 (BRY).

Holotype: A. Nelson 8309, collected in Goshen County, Wyoming, at Fort Laramie, on gravelly hilltop, 29 June 1901, RM. Photograph at BRY. Isotype at GH.

Distribution: Western Nebraska, northeastern Colorado, and southeastern Wyoming. Growing on gravelly loam soils, 4,000 to 6,000 feet. Map No. 31. May to early September.

Cryptantha cana is similar to *C. caespitosa* in habit, but can be distinguished from *C. caespitosa* by the silky-strigose pubescence, sharply muricate nutlets, and the different range.

32. *Cryptantha breviflora* (Osterh.) Payson

Cryptantha brevifloa (Osterh.) Payson, Ann. Mo. Bot. Gard. 14:318. 1927.
Oreocarya brevifloa Osterh. Univ. Wyo. Publ. Bot. 1:169. 1929.

Lignified perennials, 1.0-3 dm tall, stems several, rather 0.3-1.5 dm long, densely white setose at the base, strigose above; leaves oblanceolate to spatulate, 2.5-9 cm long, 0.4-1.4 cm wide, clustered at the ends of the branched caudices, the apices obtuse, dorsal surface densely and uniformly silky-strigose, with many small pustulae, ventral surface similar but with fewer pustules; inflorescence narrow in flower, but becoming broad and open at maturity, 0.6-2.7 dm long, setose; calyx segments linear-lanceolate, 4.5-6 mm long in anthesis, in fruit becoming 7-9 mm long, setose; corolla white, 3.5-4.5 mm long, crests at base of tube evident, fornices yellow, rounded, about 0.5 mm long, limb 8-12 mm wide; style exceeding mature fruit by 2 mm or less; nutlets lanceolate, 3.4-4 mm long, 2-2.5 mm wide, less than four nutlets maturing, margins in contact, knifelike, dorsal surface uniformly muricate or tuberculate, ventral surface similar, scar open, narrowly triangular, margin not elevated. Collections: 25 (vii); representative: R. C. Rollins 1736 (UTC); S. L. Welsh 466 (COLO); J. Brotherson 806 (BRY); W. A. Weber 5310 (COLO); Higgins and Welsh 1018 (BRY); L. C. Higgins 1084 (BRY).

Holotype: G. E. Osterhout 6414, collected in Uintah County, Utah, 6½ miles north of Jensen, 19 June 1925, RM. Photograph at BRY.

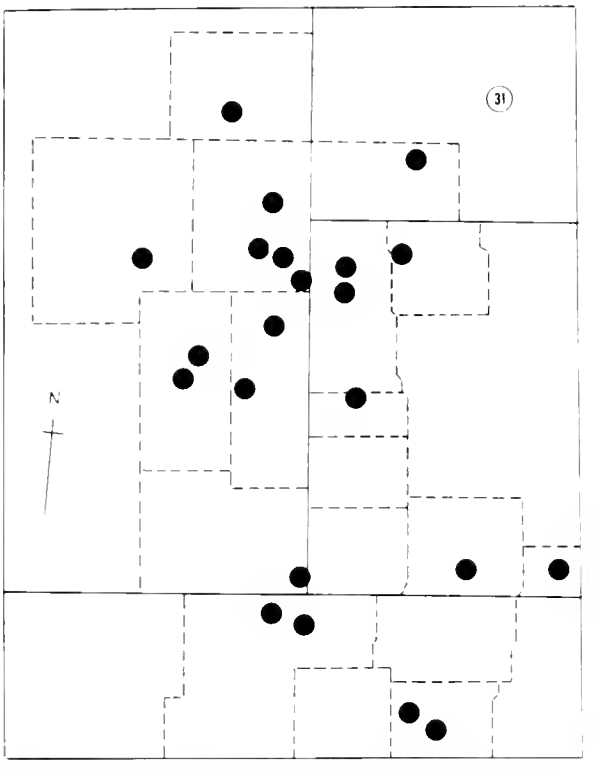
Distribution: Northeastern Utah in Duchesne and Uintah counties. Growing on heavy clay soils, 4,500 to 7,000 feet. Map No. 32. May to July.

Cryptantha breviflora is apparently endemic to the Uintah Basin. It differs from its closest relative, *C. fulvocanescens*, by the short corolla, low fornices, different pubescence, and shorter style. The range of the two is also consistently different, *C. fulvocanescens* being more southerly and never in the Uintah Basin.

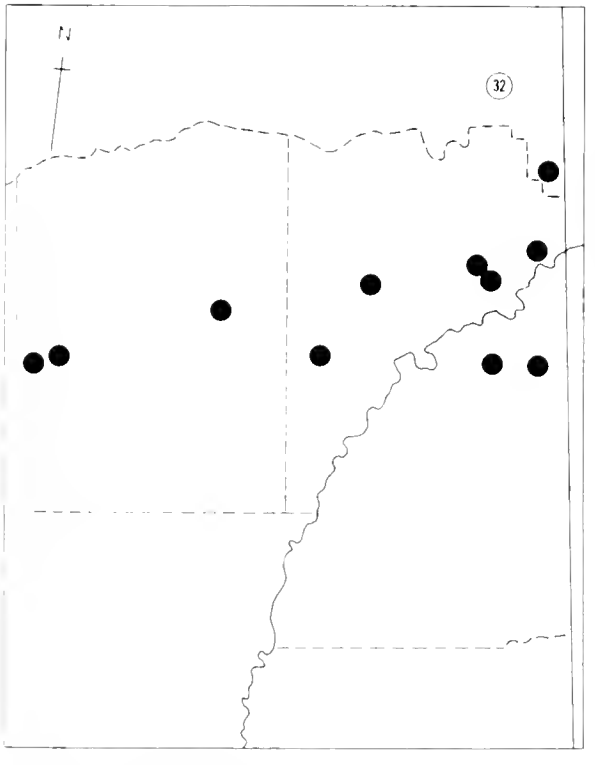
33. *Cryptantha propria* (Nels. & Macbr.) Payson

Cryptantha propria (Nels. & Macbr.) Payson, Ann. Mo. Bot. Gard. 14:317. 1927.
Krynitzkia fulvocanescens var. *idahoensis* Jones, Contr. West. Bot. 13:6. 1910. (Type: Jones 6474, near Weiser, Idaho, 28 April 1910.)
Oreocarya propria Nels. & Macbr. Bot. Gaz. 62:145. 1916.

Caespitose perennials from a strongly lignified taproot, 1-2.3 dm tall, stems several, 0.7-1.2 dm long, finely strigose and setose; leaves oblanceolate to spatulate, obtuse, 3-9 cm long, 0.4-1.2 cm wide, dorsal surface finely strigose and scattered appressed setose, ventral surface finely and uniformly strigose, without pustules; inflorescence narrow, 0.5-1.2 dm long, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 4-6 mm long, in fruit becoming 7-13 mm long, densely setose-hirsute; corolla white, the tube 3.5-4.5 mm long, crests at base of tube conspicuous, fornices yellow, rounded, papillose, about 0.5-1 mm long, limb 6-8 mm wide; style exceeding mature fruit 1.5-2 mm; nutlets ovate-lanceolate, 3-4 mm long, 2.5-3 mm wide, margins in



Map No. 31. Southeastern Wyoming, southwestern South Dakota, western Nebraska, and north central Colorado. Range of *C. cana* (A. Nels.) Payson.



Map No. 32. Northeastern Utah, Duchesne and Uintah Counties. Range of *C. breviflora* (Osterh.) Payson.

contact, acute, dorsal surface densely and irregularly rugulose, with narrow high ridges, muricate between the ridges, ventral surface tuberculate, or with some of the tuberculations joined to form short ridges, scar open, linear, and without an elevated margin. Collections: 6 (0); representative: J. B. Leiberg 2049 (UC, GH, POM, US); J. B. Leiberg 2223 (UC, GH, US); R. J. Davis 4496 (GH); H. M. Tucker 1022 (GH, IDS); M. E. Jones 4674 (POM).

Holotype: J. B. Leiberg 2049, collected in Malheur County, Oregon, at Vale, 14 May 1896, GH. Photograph at BRY. Isotypes at UC, GH, POM, US.

Distribution: Southwestern and western Idaho and eastern Oregon in Malheur County. Growing in clay soils, 2,000 to 4,000 feet. Map No. 33. April to June.

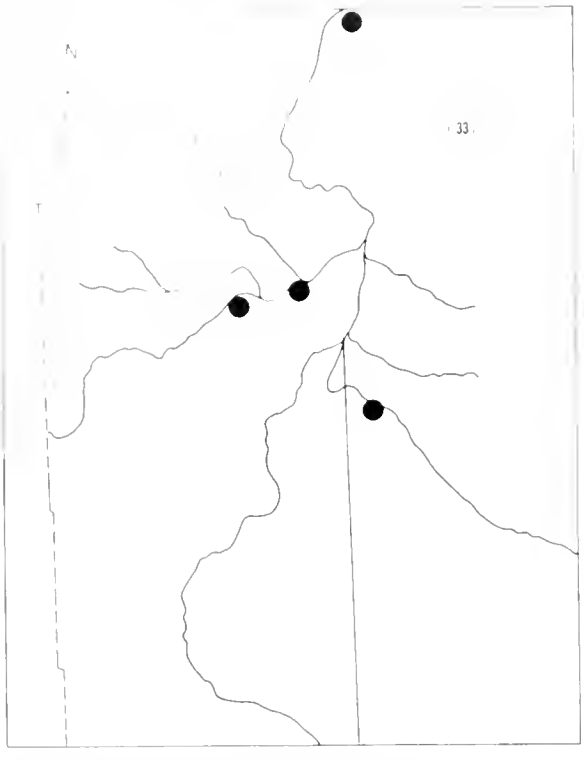
Cryptantha propria, a relatively sporadic species occurring in western Idaho and eastern Oregon, is not often collected throughout its range. In general appearance it is not unlike *C. humilis* var. *humilis*, *C. cana*, or *C. breviflora*. The latter two species are far removed geographically, occurring in Wyoming and Utah respectively. This species is probably most closely related to *C. humilis*, however, very distinct in its racemose inflorescence and the uniformly strigose ventral leaf surface which lacks pustules.

34. *Cryptantha fulvocanescens* (Wats.) Payson

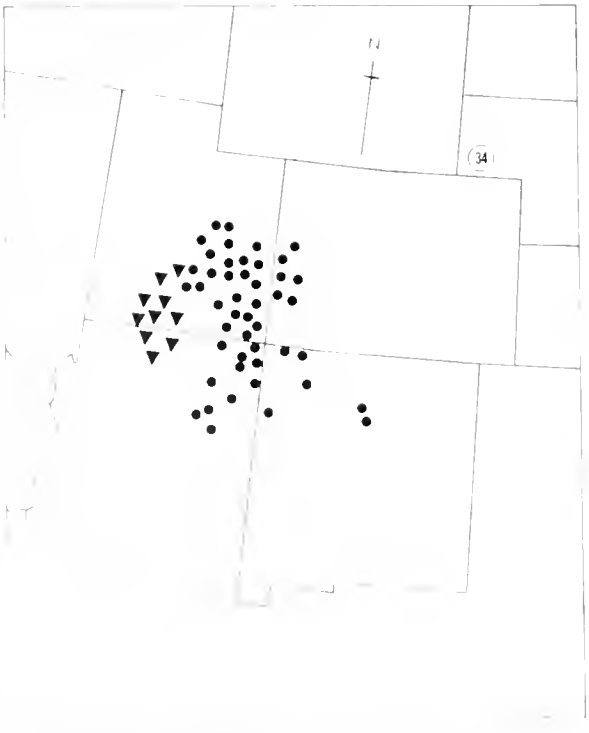
Densely caespitose perennials from a strongly lignified taproot, 0.8-3 dm tall; stems many from a multiple caudex, 0.5-1.3 dm long, white hairy at the base, setose-hirsute upward; leaves spatulate or oblanceolate, acute to obtuse, 1.5-7 cm long, 0.4-1.2 cm wide, uniformly strigose, pustules mainly confined to the dorsal surface; inflorescence narrow or somewhat open at maturity, 0.3-1.9 dm long, white or yellowish setose, foliar bracts inconspicuous; calyx segments linear, 4-6 mm long in anthesis, in fruit becoming 9-13 mm long, densely white or yellowish setose, pedicels 2-10 mm long; corolla white, the tube 7-11 mm long, crests at base of tube evident or lacking, fornices yellow, emarginate or rounded, 0.7-1.3 mm long, limb 7-9 mm broad; style exceeding mature fruit 3-7 mm; nutlets lance-ovate, 3.5-4.5 mm long, 2-3 mm wide, one to two usually maturing, margins acute to obtuse, in contact when more than one nutlet matures, both surfaces densely and uniformly muricate, scar open or nearly closed, elevated margin lacking.

Key to the varieties of *C. fulvocanescens*

1. Muricationes on the nutlet rounded; corolla 9-13 mm long; inflorescence narrow, white setose at maturity ..... 34a. var. *fulvocanescens*
1. Muricationes on the nutlet with one or two setose projections; corolla 7-9 mm long; inflorescence broader and usually yellowish at maturity ..... 34b. var. *echinoides*



Map No. 33. Parts of western Idaho and eastern Oregon Range of *C. propria* (Nels. & Macbr.) Payson.



Map No. 34. Parts of western United States. Range of *fulvocanescens* (Gray) Payson, ▼ var. *echinoides* (Jones) Higgins.

34a. var. *fulvocanescens*

Cryptantha fulvocanescens (Wats.) Payson var. *fulvocanescens*

Eritrichium glomeratum var. ? *fulvocanescens* S. Wats. Bot. King Exp. 243. 1871.

Eritrichium fulvocanescens Gray, Proc. Am. Acad. 10:61. 1875.

Krynitzkia fulvocanescens Gray, Proc. Am. Acad. 20:280. 1885.

Oreocarya fulvocanescens (Wats.) Greene, Pitt. 1:58. 1887.

Oreocarya nitida Greene, Pl. Baker. 3:21. 1901. (Type: Deer Run, Colorado, 11 June 1901, C. F. Baker 95.)

Cryptantha fulvocanescens (Wats.) Payson, Ann. Mo. Bot. Gard. 14:319. 1927.

Densely caespitose perennial, 1-3 dm tall; inflorescence narrow, white setose; pedicels 2-3 mm long; corolla white, the tube 9-11 mm long, crests at base of tube evident or lacking, fornices yellow, rounded to acute; nutlets lanceolate, 3.5-4 mm long, 2-2.5 mm wide, the dorsal surface with rounded muricications, scar straight, closed or slightly open. Collections: 58 (viii); representative: A. Cronquist 9096 (POM, UTC); A. H. Holmgren 3225 (US); G. Heller 3517 (ND-G, US); Fendler 632 (GH); C. F. Baker 561 (ND-G, US); C. F. Baker 95 (UC, POM, GH, RM, US); I. C. Higgins 999, 1012, 1307 (BRY).

Holotype: Fendler 632, collected in Santa Fe County, New Mexico, near Santa Fe, 1847, GH. Photograph at BRY. Isotypes at PH, US.

Distribution: Western Colorado, northwestern New Mexico, northeastern Arizona, and eastern Utah. Growing on sandy soil, 4,000 to 7,500 feet. Map No. 34. April to August.

Cryptantha fulvocanescens var. *fulvocanescens* is most likely to be confused with *C. breviflora* but differs in the longer corolla tube, narrower inflorescence, longer style, and different pubescence.

34b. var. *echinoides* (Jones) Higgins

Cryptantha fulvocanescens (Wats.) Payson var. *echinoides* (Jones) Higgins, Great Basin Naturalist 29:30. 1969.

Krynitzkia echinoides Jones, Proc. Calif. Acad. Sci. II 5:709. 1895.

Oreocarya echinoides (Jones) Macbr. Contr. Gray Herb. 48:31. 1916, as to synonymy, not as to specimens cited.

Cryptantha echinoides (Jones) Payson, Ann. Mo. Bot. Gard. 14:321. 1927.

Caespitose perennials, 0.8-3.6 dm tall; inflorescence narrow to somewhat open at maturity, yellowish setose; pedicels 3-10 mm long; corolla white, the tube 7-9 mm long, crests at base of tube lacking or sometimes evident, fornices yellow, emarginate; nutlets lance-ovoid, 4-4.7 mm long, 2.5-3 mm wide, the dorsal surface with one to two setose projections terminating each murication, scar asymmetrical, and without an elevated margin. Collections: 19 (vi); representative: M. E. Jones 5297p (POM); M. E. Jones 5312ae (POM), Eastwood and Howell 9265

(UTC); R. H. Peebles 14688 (ARIZ, US); Reveal, Gentry and Davidsee 781 (BRY); A. Cronquist 10212 (BRY, NY); L. C. Higgins 1008, 1344 (BRY).

Lectotype. M. E. Jones 5297p, collected in Kane County, Utah, in Pahria Canyon, 26 May 1894, POM. Photograph at BRY.

Distribution: South-central Utah and north-central Arizona. Usually growing on heavy saline clay soils, 4,000 to 7,500 feet. Map No. 34. April to July.

"Payson cites *Fritrichium glomeratum* var. (?) *fulvocanescens*, Wats. Bot. King Exp. 243 (1871), as a synonym of *C. humilis*. This I believe is incorrect. Watson took a herbarium name of Gray's and described under it an aggregate species. When Gray finally published his name *E. fulvocanescens* he cited Watsons trinomial as a synonym and appears to have accepted the limits given it by Watson. Watson, however, found Gray's name on a specimen from New Mexico collected by Fendler (no. 632). He accepted that specimen as belonging to his variety and indicated it as the source of his botanical name. He erred in taxonomic judgment, though, in placing with it certain material from Nevada and possibly Utah that belongs at least in part to *C. humilis*. Payson placed particular emphasis on these latter specimens. However, since Watson included the Fendlerian New Mexican plant in his concept and indicated it as the source of his name, then, it should be taken as the type of *fulvocanescens*, both as variety and species. Consequently the name applies to a very different plant from that described as *Oreocarya humilis* by Greene." (Johnston 1932)

The variety *echinoides* was entirely misunderstood by Macbride (1916). From the specimens he cited from western Nevada and adjacent California, it is evident that he never saw a specimen of true *echinoides*. It differs from the typical plant in that the murications are setose, and the nutlets are usually larger.

35. *Cryptantha jonesiana* (Payson) Payson

Cryptantha jonesiana (Payson) Payson, Ann. Mo. Bot. Gard. 14:323. 1927.
Oreocarya jonesiana Payson, Univ. Wyo. Publ. Bot. 1:168. 1926.

Coarse perennials, 0.5-1.5 dm tall; stems many, arising from a thick multiple caudex, 0.2-0.7 dm long, setose; leaves spatulate, 1-4 cm long, 0.4-1.3 cm wide, coarsely appressed setose-pustulate, leaf bases also setose with dense white hairs; inflorescence narrow, somewhat capitate, with one to three flowers in the axis of the bracts below the terminal cluster; calyx segments lanceolate to nearly linear, in anthesis 5-7 mm long, in fruit becoming 7-10 mm long, densely setose, with ascending, yellowish bristles; corolla white, the tube 10-15 mm long, campanulate in the throat, fornices low and broad, papillose, crests at base of tube lacking, limb 9-13 mm wide; nutlets lanceolate, 3.5-4.5 mm long, densely and uniformly muricate, or with a few short, low ridges, scar narrow, open, and without an elevated margin. Collections: 11 (v), representative: W. P. Cottam 5247 (UT); M. E. Jones s.n. (POM); D. Atwood 1301 (BRY); Higgins and Reveal 1265, 1275, 1299 (BRY); L. C. Higgins 1322, 1308 (BRY).

Holotype: M. E. Jones s.n., collected in Emery County, Utah, on the San Rafael Swell, 15 May 1914, POM. Photograph at BRY.

Distribution: Endemic to the San Rafael Swell in Emery County, Utah. Usually growing on barren clay hills, 4,000 to 7,000 feet. Map No. 35. April to June.

Cryptantha jonesiana is probably most closely related to *C. fulvocanescens*, but resembles it not at all. This handsome plant can be distinguished by its very large corolla, low broad fornices, spatulate leaves, and harsh pubescence.

36. *Cryptantha thyrsiflora* (Greene) Payson

Cryptantha thyrsiflora (Greene) Payson, Ann. Mo. Bot. Gard. 14:283. 1927.
Eritrichium glomeratum var. *hispidissimum* Torr. Bot. Mex. Bound. Surv. 140. 1859, at least in part.
Oreocarya thyrsiflora Greene, Pitt. 3:111. 1896.
Oreocarya hispidissima (Torr.) Rydb. Bull. Torrey Bot. Club 33:150. 1906.
Oreocarya urticacea Wooton & Standl. Contr. U. S. Natl. Herb. 16:166. 1913. (Type: Canyoncito, Santa Fe County, New Mexico, 18 June 1897, A. A. & E. G. Heller 3731.)
Oreocarya dura Nels. & Macbr. Bot. Gaz. 62:144. 1916. (Type: E. L. Johnston 418, 1907, central Colorado.)
Oreocarya monosperma Osterh. Bull. Torrey Bot. Club 46:55. 1919. (Type: Trinidad, Las Animas Co., Colorado, 20 July 1918, Osterhout 5754.)

Short-lived perennials or sometimes biennial, 1.7-4 dm tall; stems stout, 1-several, arising from the base, 0.5-1.8 dm long, conspicuously spreading setose; leaves oblanceolate, obtuse, 5-12 cm long, 0.5-1.4 cm wide, conspicuously spreading setose, pustulate on both surfaces, with some finer strigose hairs beneath, the petioles ciliate-hirsute; inflorescence very broad and open, cymules much elongating, 1-2 dm long, 0.6-2.5 dm wide, setose, foliar bracts 2-3 cm long, but not very conspicuous due to the width of the inflorescence; calyx segments linear, in anthesis 3-4 mm long, in fruit becoming 6-9 mm long, setose; corolla white, the tube 3-4 mm long, crests at base of tube conspicuous, fornices yellow, emarginate, papillose, about 0.5 mm long, limb 5-8 mm wide; style exceeding mature fruit 1-1.5 mm; nutlets ovate to ovate-lanceolate, 2.5-3.5 mm long, 1.5-2 mm wide, usually two to four maturing, acute, margins in contact, dorsal surface low rugulose and tuberculate, sometimes with murications between the rugae, ventral surface similar but with fewer ridges or sometimes almost smooth, scar subulate, the margin not elevated. Collections: 110 (xv), representative: A. Nelson 7306 (RM, COLO, US); M. E. Jones 972 (RM,

US, UTC); C. T. Baker, T. S. Earle & Tracy 13 (ND-G, RM, US), W. A. Weber 4389 (ARIZ, COLO); R. C. Rollins 1865 (ND, RM), U. T. Waterfall (COLO, UTC), M. Ownbey 1311 (COLO, RM, UTC); T. C. Higgins 2030, 3290, 3823, 3830, 2042 (BRY, WTSU).

Lectotype: T. L. Greene s.n., collected in southeastern Wyoming, at Cheyenne, 6 July 1892, ND-G. Photograph at BRY.

Distribution: Western Nebraska and southeastern Wyoming, south throughout eastern Colorado, New Mexico, and into Oklahoma. Growing in gravelly loam soil, 4,500 to 9,600 feet. Map No. 36. Late May to September.

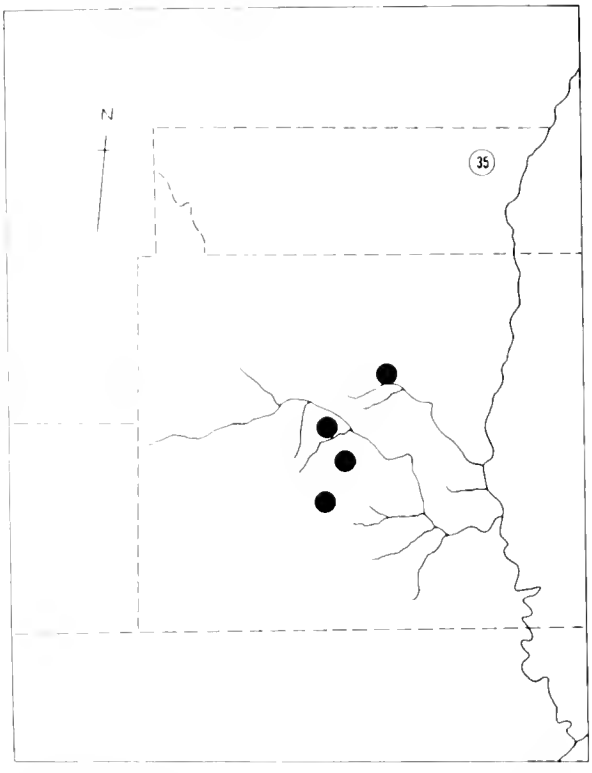
Early collections of this species were often referred to *C. celosioides*, but it is probably not very closely related to that plant. The broad inflorescence is the outstanding characteristic of the species, but in addition the flowers of *thyrsiflora* are much smaller and the blooming season later than in *C. celosioides*. In observing the types of *O. urticacea*, *dura*, and *monosperma* it is apparent that they are exact synonyms of *thyrsiflora*.

37. *Cryptantha clata* (Eastw.) Payson

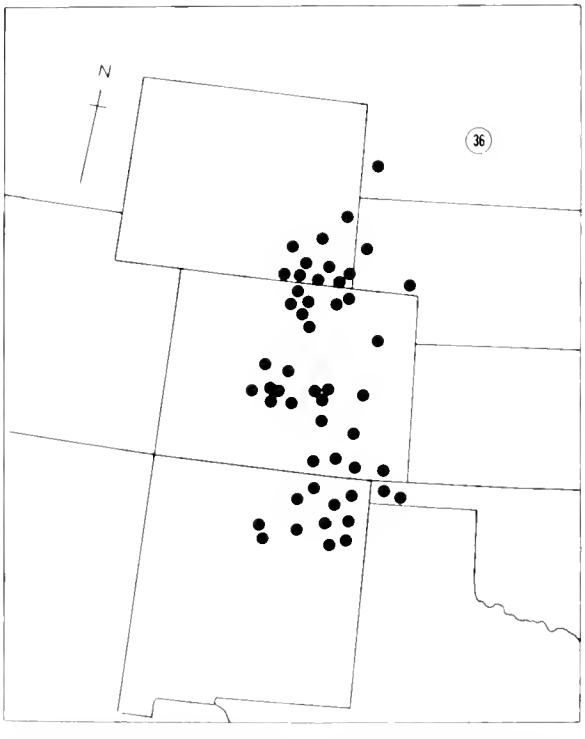
Cryptantha clata (Eastw.) Payson, Ann. Mo. Bot. Gard. 14:285. 1927.
Oreocarya clata Eastw. Bull. Torrey Bot. Club 30:241. 1903.

Short-lived perennials, 3-5 dm tall; stems 1-6, erect, stout, weakly setose with spreading white hairs, 0.9-1.5 dm long; leaves oblanceolate to spatulate, 2-5 cm long, 0.4-1.3 cm wide, apices acute to obtuse, the blade tapering abruptly to the narrow petiole, dorsal surface strigose and appressed setose, ventral surface strigose, both surfaces pustulate; inflorescence spreading in age, 1.5-3.5 dm long, setose, foliar bracts inconspicuous; calyx segments lanceolate, in anthesis 3-4.5 mm long, in fruit becoming 7-8 mm long, hirsute; corolla white, the tube 3.5-5 mm long, fornices yellow, rounded, papillose, about 1 mm long, crests at base of tube well developed, limb 6-8 mm wide; style exceeding mature fruit 0.5-2 mm; nutlets lanceolate-ovate, 4-4.5 mm long, 2-2.5 mm wide, usually all four maturing, margins in contact, dorsal surface densely tuberculate and somewhat rugulose, the surface also covered with dense, minute papillae, ventral surface similar but the roughenings less prominent, scar closed, or narrowly open at the base, and without an elevated margin. Collections: 11 (ID), representative: A. Eastwood s.n. (CAS, GH); S. L. Welsh 6952 (BRY), G. E. Osterhout 5996 (RM); W. A. Weber 11294 (BRY, COLO), T. C. Higgins 1479 (BRY).

Lectotype: A. Eastwood s.n., collected in Mesa County, Colorado, near Grand Junction on the road to the coal mines, growing on bare clay hills, charac-



Map No. 35. Emery County, Utah. Range of *C. jonesiana* (Payson) Payson.

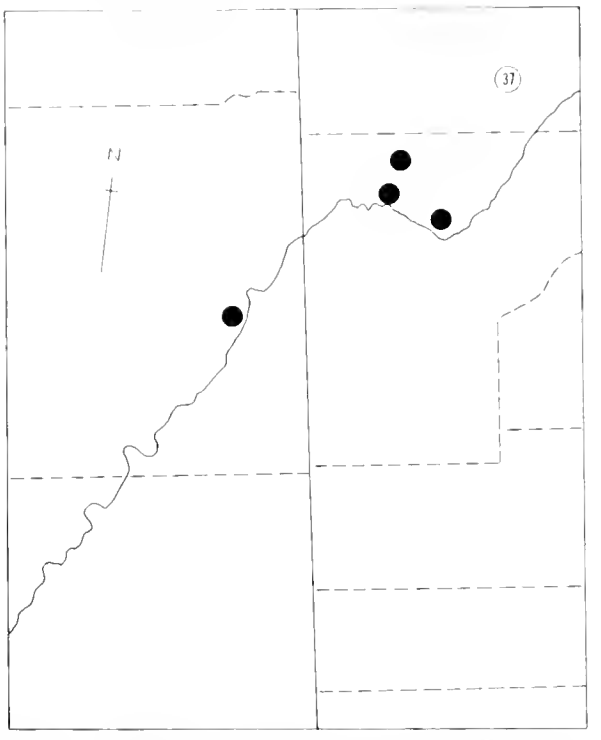


Map No. 36. Parts of western United States. Range of *C. thyrsiflora* (Greene) Payson.

teristic of the region, 25 May 1892, CAS. Photograph at BRY. Isotypes at GH, NY, US.

Distribution: West central Colorado in Mesa County, and east-central Utah in Grand County. Growing on heavy clay soil, 4,500 to 5,500 feet. Map No. 37. May to June.

This species resembles *C. insolita* from southern Nevada, but is probably not very closely related to that taxon. It differs in the shorter spatulate leaves and larger differently marked nutlets which have the scar closed. In practice this plant is so distinct that it is not to be confused with any other species in this subgenus. Additional collections of this very narrow endemic are badly needed in order to determine the exact limits of the species.



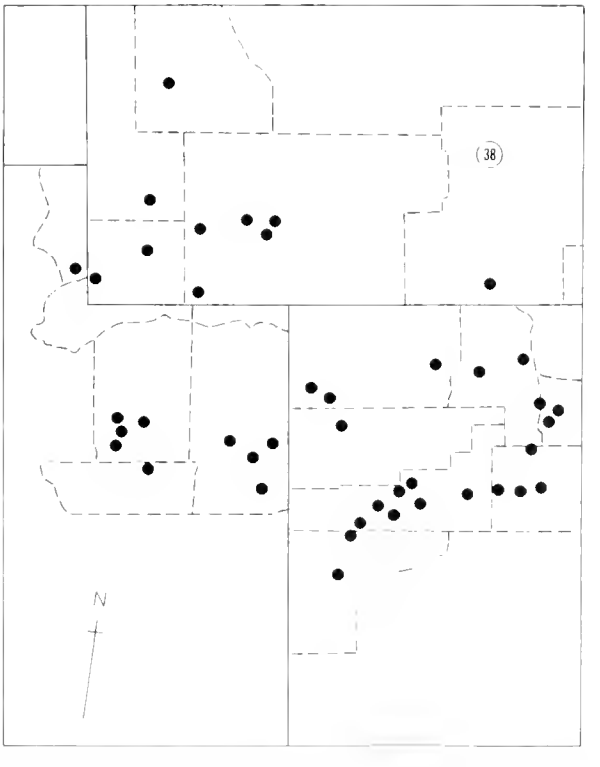
Map No. 37. Mesa Co., Colorado and Grand Co., Utah. Range of *C. elata* (Lastw.) Payson.

38. *Cryptantha sericea* (Gray) Payson

Cryptantha sericea (Gray) Payson, Ann. Mo. Bot. Gard. 14:286. 1927.

Krynitzkia sericea Gray, Proc. Am. Acad. 20:279. 1885.
Oreocarya sericea Greene, Pitt. 1:58. 1887.
Oreocarya affinis perennis A. Nels. Erythea 7:67. 1899. (Type: Green River, Wyoming, 31 May 1897, A. Nelson 3035.)
Oreocarya argentea Rydb. Bull. Torrey Bot. Club 31:637. 1904. (Type: Rifle, Garfield County, Colorado, 1900, Osterhout 2122.)
Oreocarya perennis Rydb. Bull. Torrey Bot. Club 33:150. 1906.
Oreocarya procera Osterh. Bull. Torrey Bot. Club 47:211. 1920. (Type: Glenwood Springs, Garfield County, Colorado, 18 June 1899, Osterhout 1867.)
Cryptantha sericea var. *perennis* (Nels.) Payson, Ann. Mo. Bot. Gard. 14:288. 1927.

Perennials, 1.5-4.3 dm tall; stems 1-several, branched from the base, 0.5-1.2 dm long, setose with spreading hairs; leaves oblanceolate to spatulate, obtuse, 2.5-10 (15) cm long, 0.5-2 cm wide, dorsal surface strigose and slightly appressed to spreading setose, pustulate, ventral surface silky-strigose, pustules lacking or very inconspicuous; inflorescence narrow to somewhat open, 0.5-3.2 dm long, setose-hispid, foliar bracts 2-5 cm long; calyx segments lanceolate, 2.5-4 mm long in anthesis, in fruit becoming 6-8 mm long; pedicels 0.5-1 mm long; corolla white, the tube 2.5-3.5 mm long, crests at base of tube conspicuous, fornices yellow, depressed, broad, 0.5-0.6 mm long, limb 7-9 mm wide; style exceeding the mature fruit 0.5-1.3 mm; nutlets lanceolate, 2.5-3.5 mm long, 1.5-2 mm wide, usually all four maturing, margins acute or narrowly winged, in contact, dorsal surface with low rounded tuberculations, also somewhat rugulose and muricate, ventral surface similar but the markings less evident, scar straight, closed, and without an elevated margin. Collections: 80 (ND); representative: C. L. Porter 4583 (MONT, RM, WTU), R. C. Rollins 1772 (ND, UTC); B. Maguire 12378 (UTC); L. Williams 464 (RM); S. L. Welsh and L. M. Christensen 6572 (BRY); W. A. Weber 6111 (ARIZ, COLO, RM, UTC, CS); G. L. Osterhout 5119 (RM); F. C. Higgins 1048, 1055 (BRY).



Map No. 38. Southwestern Wyoming, northeastern Utah, and adjoining Colorado. Range of *C. sericea* (Gray) Payson.

Lectotype: H. Engelmann s.n., collected in Wyoming at Bridger Pass, 1856, GH vide Payson.

Distribution: Southwestern Wyoming, northwestern Colorado, and northeastern Utah. Growing on heavy clay soils, 4,200 to 7,000 feet. Map No. 38. Late May to August.

The name sericea has always been a stumbling block in the way of any satisfactory treatment of this group of plants. Payson (1927) was faced with the problem of selecting a type from the collections available to Dr. Gray at the time he described *sericea*. The specimens that were considered to compete for the type of *sericea* were as follows:

Sheet 1 contains four specimens:

a. Bridger's Pass, 1856, H. Engelmann — equals *O. argentea* Rydb.
b. Wasatch Mts., 1844, Fremont — equals *O. humilis* Greene
c. Clover Mts., Nevada, 1868, Watson — equals *O. humilis* Greene
d. Mountain Hot Springs, Yellowstone Park, 1885, Tweedy 816 — equals *C. celosioides*

Sheet 2 contains three specimens:

a. Montana Terr., 1867 — equals *C. celosioides*
b. Summit, California, 1871, Bolander — equals *C. nubigena* Greene
c. Grass Valley, Utah, 1875, Ward 49 — equals *C. abata* Johnst.

Sheet 3 contains two specimens at the present time and probably five (including fragments) in Gray's time:

a. Southern Montana, 1880, Watson 287 — equals *C. celosioides*
b. A specimen of celosioides without data — equals *C. celosioides*
c. Fragment, Baker County, Oregon, 1879, Cusick — equals *C. subretusa* Johnst.
d. Fragment from southern Wyoming — equals *C. caespitosa*
e. Fragment from Scotts Bluff, 1858 — equals *C. cana*

The specimens that were considered to compete for the type of sericea were then *O. argentea, humilis, C. celosioides, abata, nubigena, subretusa, caespitosa,* and *cana*. By a process of elimination, a type for *sericea* was selected that from Bridger's Pass, collected by Engelmann as this was the only specimen that fit the published description, the maturity of the plant Dr. Gray had in mind, and the geographical range.

Cryptantha sericea is similar in appearance to *C. celosioides* but can be recognized at once by the silky strigose ventral surface of the leaves, which lack pustulate hairs and the differently marked nutlets.

39. *Cryptantha aperta* (Eastw.) Payson

Cryptantha aperta (Eastw.) Payson, Ann. Mo. Bot. Gard. 14:295. 1927.
Oreocarya aperta Eastw. Bull. Torrey Bot. Club 30:241. 1903.

Caespitose perennial, 1.2-2 dm tall, stems several, slender, arising from a woody root, 0.3-0.5 dm long, strigose and conspicuously white setose-hispid, leaves spatulate to oblanceolate, somewhat folded, and with the midrib strongly developed, obtuse, 2-3.5 cm long, 0.3-0.6 cm wide, both surfaces setose-hispid and pustulate, with fine appressed hairs beneath the bristles; inflorescence open, branched from near the base, with simple or two-forked spikes, 1-1.3 dm long, the individual spikes becoming 4-7 cm long, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 2.8-3 mm long, in fruit becoming 7-9 mm long, densely setose; corolla white, the tube 2.6-3 mm long, crests at base of tube conspicuous, fornices yellow, truncate, distinctly papillose, about 0.5 mm long, limb 4-6 mm wide; style exceeding mature fruit 1.5-2 mm; nutlets ovate-lanceolate, 2-2.6 mm long, 1.4-1.6 mm wide, usually all four maturing, margins acute, in contact, dorsal surface indistinctly carinate, tuberculate, somewhat rugulose, and indistinctly muricate, ventral surface indistinctly roughened, scar closed, and without an elevated margin. Collections: 1 (0); representative: A. Eastwood s.n. (CAS).

Holotype: A. Eastwood s.n., collected in Mesa County, Colorado, at Grand Junction, 27 June 1892, CAS. Photograph at BRY.

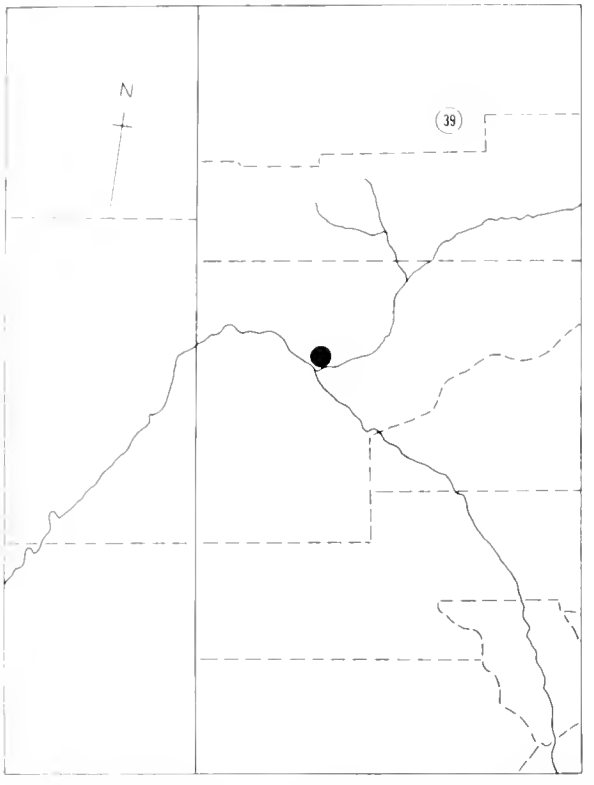
Distribution: Known only from the type locality, Mesa County, Colorado. Probably growing on clay soil characteristic of the region, 4,000 to 5,500 feet. Map No. 39. May to July.

This species still remains obscure because of the lack of herbarium material. In observing the type specimen it appears that the plant is quite distinct, with its broad inflorescence and the ornamentation on the nutlet. It is perhaps closely related to *C. thyrsiflora*, but is entirely distinct.

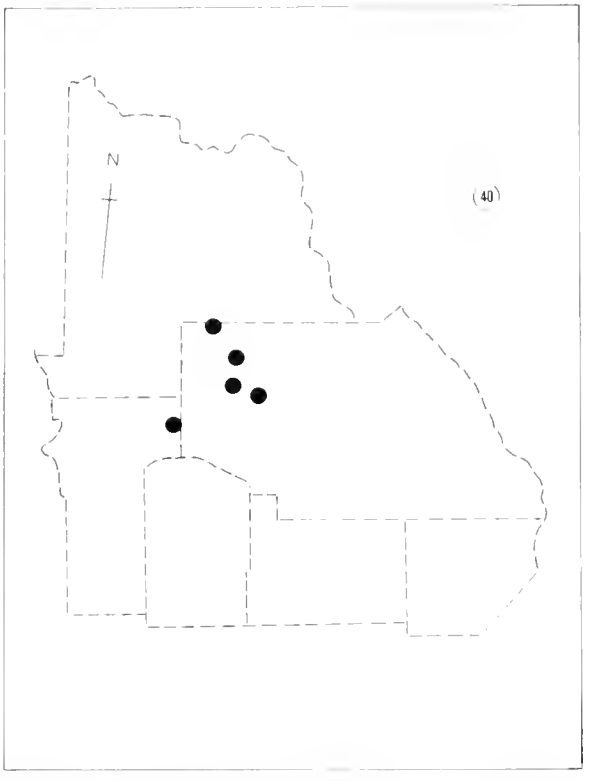
40. *Cryptantha weberi* Johnst.

Cryptantha weberi Johnst. Journ. Arn. Arb. 33:72. 1952.

Caespitose perennials, 1-1.8 dm tall; stems numerous, erect, 0.2-0.5 dm long, strigose, and weakly setose, leaves numerous, narrowly oblanceolate, 3-8 cm long, 0.3-0.7 cm wide, densely hispid villous, with pustules on both surfaces; inflorescence cylindrical, narrow, 0.4-1 dm long, hispid-villous; foliar bracts evident on lower part of inflorescence; calyx segments lanceolate, in anthesis 3-4 mm long, in fruit becoming 5-6 mm long, hispid-villous; corolla white, the tube 3-3.2 mm long, crests at base of tube conspicuous, fornices yellow, emarginate, somewhat papillose, about 0.5 mm long; style exceeding mature fruit 1.5-1.8 mm; nutlets ovate, 2-2.3 mm long, 1.3-1.8 mm wide, all four usually maturing, margins acute or narrowly winged, dorsal surface tuberculate, and with short irregular transverse ridges, ventral surface nearly smooth, scar open, triangular or narrowly cuneate, elevated margin lacking. Collections: 11 (v); representative: W. A. Weber 5778



Map No. 39. Mesa County, Colorado. Range of *C. aperta* (Eastw.) Payson.



Map No. 40. Central Colorado, Saguache and Hinsdale Counties. Range of *C. weberi* Johnston.

(COLO, GH, LL); J. H. Langenheim 4047 (RM), H. Gentry 2405 (ARIZ); J. Barrell 92-55 (CS); S. A. Spongberg 62-55 (CS); W. A. Weber 9411 (UT); L. C. Higgins 2256, 2268, 2269, 3719, 3727 (BRY, WTSU).

Holotype: W. A. Weber 5778, collected in Saguache County, Colorado, along road to Stone Cellar Ranger Station and Saguache Park, near junction of main highway, 4 miles west of Cochetopa Pass, volcanic ash deposit, 9,700 feet, 28 July 1950, GH. Photograph at BRY. Isotypes at COLO, LL.

Distribution: Saguache and Hinsdale counties, Colorado. Growing on volcanic ash deposits, 9,000 to 10,500 feet. Map No. 40. July and August.

This delicate little Cryptantha from the high mountains of Colorado is one of the most distinct in the entire subgenus and is not confused with any other species because of the narrow inflorescence, pubescence, and the very distinctive nutlets. It keys out in Payson's monograph to *C. rugulosa*, but is only remotely related to that species.

41. *Cryptantha rugulosa* (Payson) Payson

Cryptantha rugulosa (Payson) Payson, Ann. Mo. Bot. Gard. 14:295. 1927.
Orecocarya rugulosa Payson, Univ. Wyo. Publ. Bot. 1:166. 1926.

Biennial or short-lived perennial, 1.2-3 dm tall; stems slender, 1-several, 0.8-1.6 dm long, spreading setose-hispid; leaves oblanceolate to spatulate, obtuse to acute, strigose and conspicuously setose-hispid, pustulate on both surfaces; inflorescence 0.2-2 dm long, hispid; foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 4-5 mm long, in fruit becoming 7-9 mm long, strigose and spreading hirsute; corolla white, the tube 3-4 mm long, crests at base of tube conspicuous, fornices rounded, distinctly papillose, about 0.5 mm long, limb 5-7 mm wide; style exceeding mature fruit 1-1.5 mm; nutlets lanceolate, 2.8-3.2 mm long, 1.3-1.7 mm wide, all four usually maturing, margins in contact, acute, dorsal surface with short low ridges, also somewhat tuberculate, ventral surface smooth or nearly so, scar open, subulate, without an elevated margin. Collections: 30 (vii); representative: B. Maguire 22021 (ARIZ, UTC); Maguire and Becraft 2729 (RM, UTC); W. P. Cottom 9569 (UT); B. F. Harrison 11658 (BRY); M. E. Jones s.n. (POM, RM); L. C. Higgins 1463, 1474, 1614, 1621, 1720 (BRY).

Holotype: M. E. Jones s.n., collected in Juab County, Utah, at Fish Springs, 4 June 1891, RM. Photograph at BRY. Isotypes at UC, POM.

Distribution: Central Utah to northeastern Nevada. Growing in clay or gravelly loam soils, 4,500 to 6,500 feet. Map No. 41. May to July.

Cryptantha rugulosa is closely related to *C. spicu-*

hirta and *C. interrupta*, but differs in the very setose-hispid indument, differently marked nutlets which are smooth on the ventral surface, and different geographical range.

42. *Cryptantha interrupta* (Greene) Payson

Cryptantha interrupta (Greene) Payson, Ann. Mo. Bot. Gard. 14: 296. 1927.
Oreocarya interrupta Greene, Pitt. 3: 111. 1896.

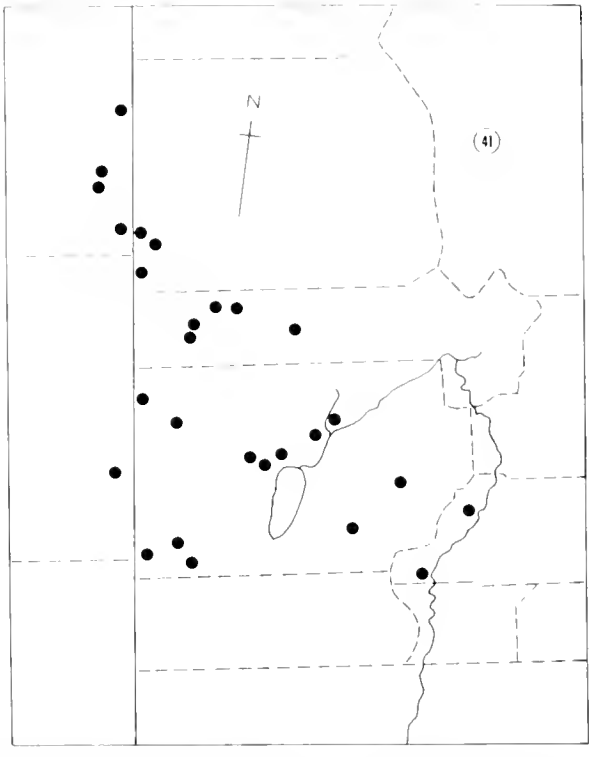
Long-lived perennial, 1.7-6 dm tall; stems few to several, slender, 1-3.5 dm long, strigose and weakly setose with slender white hairs; leaves oblanceolate to spatulate, obtuse, 1.5-7 cm long, 0.4-1.2 cm wide, dorsal surface densely strigose, and appressed setose pustulate, upper surface more finely strigose, setose hairs less conspicuous, pustules fewer; inflorescence narrow, interrupted, 1-2.5 dm long, densely setose, cymes somewhat elongating at the top, foliar bracts evident on lower part of stem; calyx segments lanceolate, 2-3 mm long in anthesis, in fruit becoming 5-8 mm long, setose; corolla white, the tube 2-2.5 mm long, crests at base of tube very conspicuous, fornices light yellow, slightly emarginate, about 0.5 mm long, limb 5-6 mm wide; style exceeding mature fruit by less than 1 mm; nutlets lanceolate, 3.3-3.6 mm long, 1.7-2 mm wide, all four usually maturing, margins in contact, acute, both surfaces tuberculate with scattered, rounded tubercles, or sometimes nearly smooth, scar slightly open, linear, margin not elevated. Collections: 10 (iv); representative: A. A. Heller 9185 (NY, PH, RM, US); Hitchcock 1005, 929 (US); R. C. Rollins 2542 (UTC); Gentry and Davidse 1824 (BRY, NY); L. C. Higgins 1721, 1724 (BRY).

Neotype: L. C. Higgins 1721, collected about 8 miles east of Wells, Elko County, Nevada, 13 July 1968, BRY.

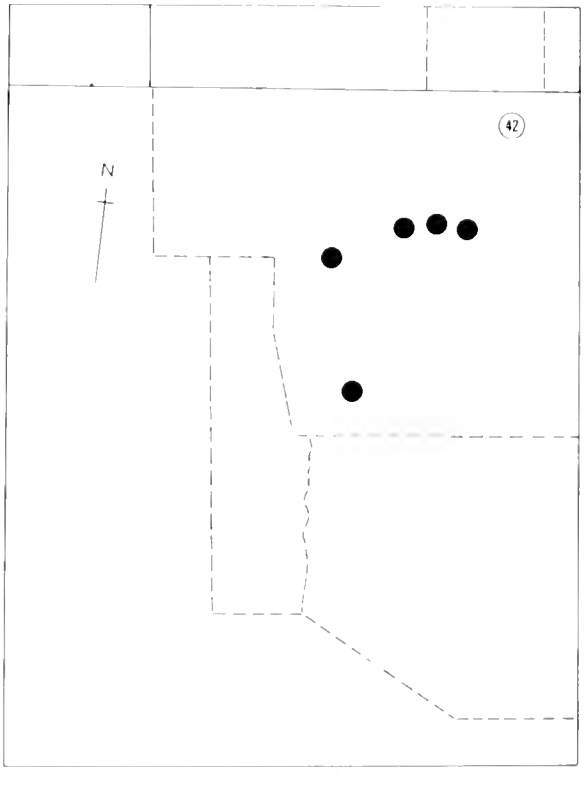
Distribution: Apparently endemic to Elko County, Nevada. Growing on clay soil, in the pinyon-juniper community, 5,000 to 7,500 feet. Map No. 42. June to August.

Dr. Greene stated that he had not seen this plant in any herbarium, but it was collected by him in the mountains of eastern Nevada. He also said, "it abounds in open woods some miles east of Wells." In an attempt to locate this collection of Greene's from east of Wells, no specimen could be found which fit his description. Payson also stated that he was unable to locate the specimen. This type specimen is apparently lost or has been destroyed; as a result a neotype has been selected, Higgins 1721.

This distinctive plant is most closely related to *C. humilior*, but differs in the shorter style, tuberculate nutlets, and the longer stems. In a collection by Gentry and Davidse 1824, from Harrison Pass the nutlets were almost smooth; otherwise the plant was quite the same.



Map No. 41. Western Utah and adjoining Nevada. Range of *C. rugulosa* (Payson) Payson



Map No. 42. Northeastern Nevada. Range of *C. interrupta* (Greene) Payson

43. *Cryptantha spiculifera* (Piper) Payson

Cryptantha spiculifera (Piper) Payson, Ann. Mo. Bot. Gard. 14:298. 1927.
Oreocarya spiculifera Piper, Contr. U.S. Natl. Herb. 11:481. 1906.
Oreocarya cilio-hirsuta Nels. & Macbr. Bot. Gaz. 55:378. 1913. (Type: Nelson and Macbride 1799, Minidoka, Idaho, 23 June 1912.)

Perennial, 1.5-3 dm tall; stems 1-several, 1.2-2 dm long, strigose, and spreading setose; leaves oblanceolate, acute to obtuse, 2-7 cm long, 0.3-0.6 cm wide, dorsal surface densely strigose and spreading setose, pustulate, ventral surface similar, petioles conspicuously setose ciliate-margined; inflorescence narrow, 0.4-1.5 dm long, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 4-5 mm long, in fruit becoming 6-10 mm long, strigose and spreading setose; corolla white, the tube 3-4 mm long, crests at base of tube conspicuous, fornices yellow, rounded, nearly glabrous, about 0.5 mm long, limb 5-9 mm wide; style exceeding mature fruit 1.5-2 mm; nutlets lanceolate to ovate-lanceolate, 2.8-4 mm long, 1.5-2.2 mm wide, one to four nutlets maturing, margins acute, in contact, dorsal surface rugulose, or tuberculate, and with some inconspicuous murications, scar subulate, the margin not elevated. Collections: 65 (ii); representative: A. Cronquist 2396 (GH, IDS, UTC); J. S. Cotton 359 (WTU); R. J. Davis 3803 (GH, IDS); J. F. Macbride 875 (GH, RM, UTC); M. E. Peck 19918 (GH, ORE); Sandberg and Leiberg 164 (GH); Maguire and Holmgren 26223 (GH, UTC, WTU); L. C. Higgins 1635, 1636 (BRY).

Holotype: J. H. Sandberg and J. B. Leiberg 164, collected in Adams County, Washington, at Ritzville, 6 June 1893, US. Photograph at BRY. Isotypes at UC, GH, WTU.

Distribution: Southeastern Washington to southern Idaho and eastern Oregon. Growing on sandy or clay soils, 1,500 to 7,000 feet. Map No. 43. May to July.

Cryptantha spiculifera is a fairly well defined species characterized by narrow radial leaves with their ciliate-margined petioles. In various parts of its range, it may be confused with *C. interrupta*, *C. humilis*, or *C. celosioides*. It differs from *C. interrupta* by the narrower leaves, rugulose nutlets, and the longer style. It can be distinguished from *C. humilis* by its taller habit, rugose nutlets which are not at all muricate, and the different pubescence. From *C. celosioides* it differs in the narrower leaves, a stronger tendency to a multiple caudex, somewhat different nutlets, and a more southerly range.

The plant described as *C. cilio-hirsuta* by Nelson and Macbride is almost identical to the type of *C. spiculifera*, and so is placed in synonymy under that species.

44. *Cryptantha shackletteana* Higgins

Cryptantha shackletteana Higgins, Great Basin Naturalist 29:28-30. 1969.

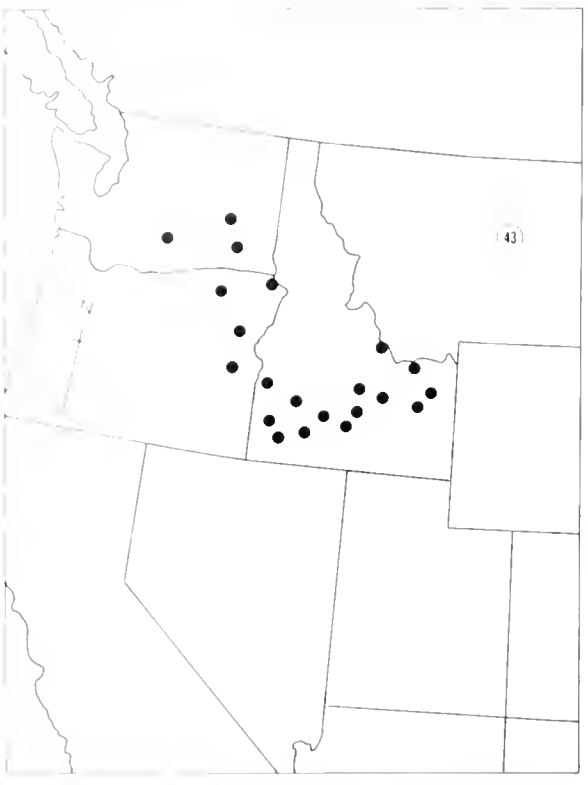
Caespitose perennial herb, 1-3 dm tall; stems slender, weak, 1-several, 0.7-1.8 dm long, strigose and spreading setose with slender weak hairs; leaves linear, 2-13 cm long, 0.1-0.5 cm wide, strigose on both surfaces, and with a few inconspicuous pustulate hairs on the dorsal surface; inflorescence narrow, nearly capitate, 0.2-0.8 dm long; calyx segments linear or narrowly lanceolate, in anthesis 3-5 mm long, in fruit becoming 7-10 mm long, setose, with yellowish spreading hairs; corolla white, the tube 3-3.3 mm long, crests at base of tube evident, fornices yellow, emarginate, 0.5 mm long, limb 5-6 mm wide; style exceeding mature fruit 1.3-1.6 mm; nutlets lanceolate, 3.3-3.6 mm long, 1.6-2 mm wide, usually all four maturing, the margins acute, in contact, dorsal surface muricate and rugulose with low inconspicuous ridges, the ventral surface similar but the markings much less evident, scar open, subulate, and without an elevated margin. Collections: 2 (0); representative: H. T. Shacklette 6183 (US); Welsh and Moore 8629 (BRY).

Holotype: S. L. Welsh and G. Moore 8629, collected in Alaska, on steep south-facing slope of Eagle Bluff, about 1 mile northwest of Eagle. Growing with *Artemisia frigida* and *Agropyron smithii*, 26 July 1968, BRY.

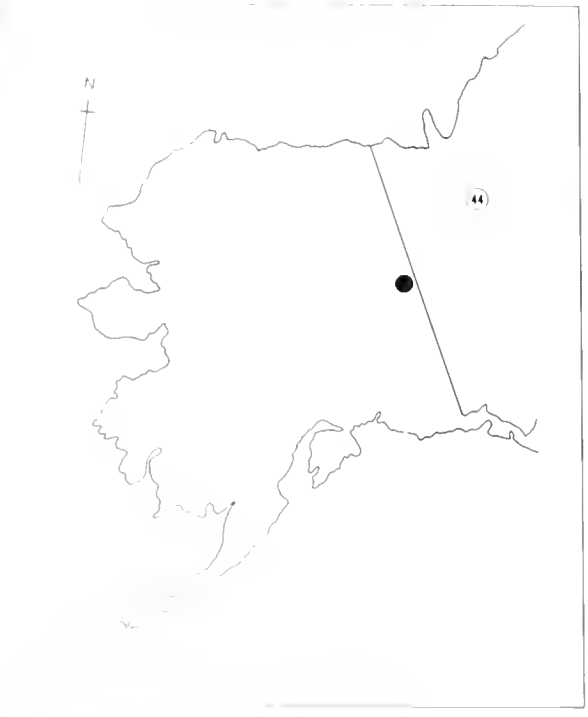
Cryptantha shackletteana is probably closely related to *C. spiculifera* but differs in the longer and narrower leaves with only inconspicuous pustulate hairs, the more capitate inflorescence, more elongated nutlets with less evident markings, and weaker stems.

45. *Cryptantha celosioides* (Eastw.) Payson

Cryptantha celosioides (Eastw.) Payson, Ann. Mo. Bot. Gard. 14:299. 1927.
Cynoglossum glomeratum Nutt. ex Pursh, Fl. Am. Sept. 2:729. 1814, not *Cryptantha glomerata* Lehm.
Myosotis glomerata Nutt. Gen. Pl. 1:112. 1818.
Rochelia glomerata Torr. Ann. Lyc. N.Y. 2:226. 1827.
Eritrichium glomeratum A. DC. Prod. 10:131. 1846.
Krynitzkia glomerata Gray, Proc. Am. Acad. 20:279. 1885.
Oreocarya glomerata Greene, Pitt. 1:58. 1887.
Oreocarya affinis Greene, Pitt. 3:110. 1896. (Type: Sand hills near Red Buttes, Wyoming, 5 July 1896, Greene.) not *O. affinis* (Gray) Greene.
Oreocarya celosioides Eastw. Bull. Torrey Bot. Club 30:240. 1903. (Type: T. J. Howell, collected on the banks of the Columbia River, eastern Washington Territory, July 1881.)
Krynitzkia pustulata Blankenship, Mont. Agr. Coll. Stud. Bot. 1:96. 1905. (Greene, Red Buttes, Wyoming, 5 July 1896.) not *C. pustulata* (Rydb.) Payson.
Oreocarya sericea sensu Piper, Contr. U.S. Natl. Herb. 11:482. 1906, not *C. sericea* (Gray) Payson.
Oreocarya macounii Eastw. Bull. Torrey Bot. Club 40:480. 1913. (Type: Moose Mt. Creek, Saskatchewan, 6 July 1880, John Macoun.)
Oreocarya perennis Rydb. Fl. Rocky Mts. 722. 1917, in part, not *O. affinis perennis* A. Nels.
Oreocarya sheldonii Brand, Fedde, Rep. Spec. Nov. 19:73. 1923. (Type: Deep Creek, Wallowa County, Oregon, 16 June 1897, Sheldon 8315.)



Map No. 43. Parts of northwestern United States. Range of *C. spiculifera* (Piper) Payson.



Map No. 44. Alaska. Range of *C. alaskaensis* Higgins.

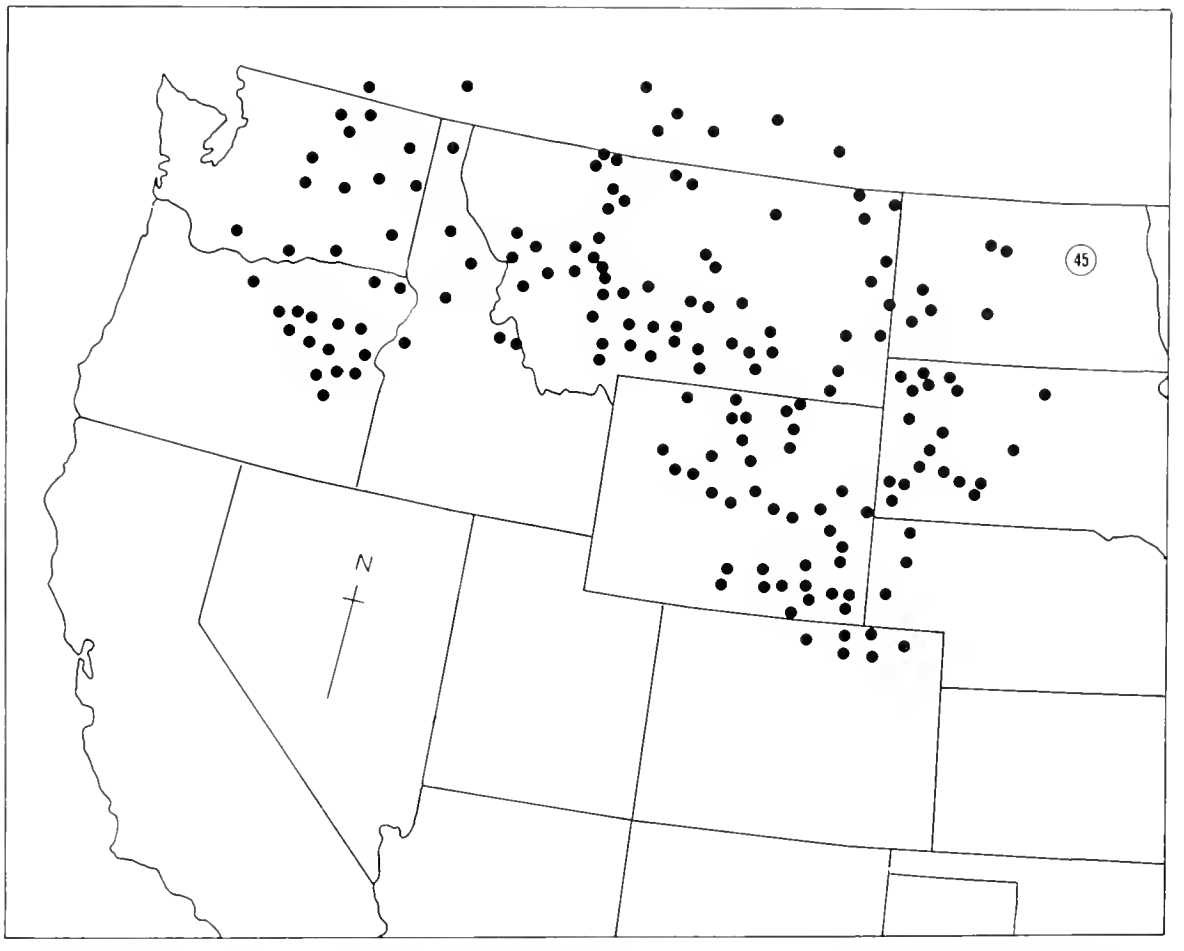
Cryptantha sheldonii (Brand) Payson, Ann. Mo. Bot. Gard. 14:301. 1927.
Cryptantha macounii (Lastw.) Payson, Ann. Mo. Bot. Gard. 14:303. 1927.
Cryptantha bradburiana Payson, Ann. Mo. Bot. Gard. 14:307. 1927.

Biennial or short-lived perennial, with or without a branched caudex; stems 1-several, 1-6 dm tall, often relatively robust, strigose, setose-hirsute, and subtomentose with pustulate bristles; leaves oblanceolate to spatulate, obtuse to acute, 2.5-9 cm long, 0.4-1.5 cm wide, strigose, setose, and subtomentose, pustulate on both surfaces; inflorescence narrow to open and very broad, 1-3.8 dm long, setose-hirsute; calyx segments lanceolate, 3-6 mm long in anthesis, in fruit becoming 7-12 mm long, setose-hirsute; corolla white, the tube 3-7 mm long, crests at base of tube evident, fornices yellow, rounded or emarginate, about 0.5 mm long, limb 7-12 mm wide; style exceeding mature fruit 1.5-6 mm; nutlets lanceolate to ovate-lanceolate, 2.8-5 mm long, 1.5-2.6 mm wide, two to four maturing, margins acute or narrowly winged, in contact, dorsal surface tuberculate to deeply and sharply rugose, sometimes papillose between the markings, ventral surface similar but the markings less evident, scar closed or narrowly open at the base, elevated margin lacking. Collections: 457 (XXIV); representative: A. Nelson 1956 (ND-G, RM); M. Ownbey 1043 (IDS, RM); C. L. Hitchcock 17955 (RM, WTU); W. E. Booth 55110 (MONT, RM); P. A. Rydberg and E. A. Bessey 4883 (MONT, RM); C. L. Porter 7752 (RM, WTU); Hitchcock and Muhlick 12553 (RM, UTC, WTU); Maguire and Holmgren 26615 (UC, CAS, IDS, UTC, WTU); A. R. Kruckeberg 2197 (UC, CAS, ORE, UTC, WTU); T. J. Howell s.n. (UC, CAS); J. W. Thompson 11696 (MONT, US, WTU); H. T. Rogers 613 (UC, CAS, UTC); L. C. Higgins 1535, 1538, 1558, 1689, 1693, 1697, 1701, 1704 (BRY).

Lectotype: Bradbury s.n., collected in Upper Louisiana, supposed to be about the Big Bend of the Missouri in what is now South Dakota, PH. Photograph at BRY.

Distribution: Eastern Oregon from Grant County to northern Washington and southern British Columbia, east through the lower parts of northern Idaho to Montana, thence south and east into North Dakota, Nebraska, and Colorado. Growing on dry open slopes and valleys, plains and foothills, occasionally ascending to moderate elevations in the mountains, 1,500 to 8,500 feet. Map No. 45. May to August.

Cryptantha celosioides is a very widespread and polymorphic species with a great amount of variation throughout its range. The species *C. bradburiana*, *sheldonii*, *macounii*, and *celosioides* as recognized by Payson in his monograph have here been combined. The basis for this wholesale combining of species is that no differential characters of high enough magnitude exist to separate out species or even varieties with any consistency. The consistent characters used



Map No. 45. Parts of northwestern United States and adjoining Canada. Range of *C. celosioides* (Eastw.) Payson

to distinguish species throughout this subgenus seem to entirely break down in the present case; so until more information can be gleened and utilized, this complex is best treated as a single taxon, even though this is not entirely satisfactory.

This species is distinguished by its setose indument, large corollas, habit, and characteristic inflorescence.

46. *Cryptantha thompsonii* Johnst.

Cryptantha thompsonii Johnst. Contr. Arn. Arb. 3:88. 1932.
Oreocarya thompsonii (Johnst.) Abrams, Abrams Ill. Fl. Pac. St. 3:600. 1951.

Caespitose perennials, 1.5-3 dm tall; stems several from a woody caudex, 1-1.7 dm long, setose-hirsute; leaves oblanceolate, acute to obtuse, 4-8 cm long, 0.4-0.8 cm wide, yellowish tomentose and with scattered appressed setose bristles on both surfaces; inflorescence usually narrow, 0.2-1.3 dm long, foliar bracts evident to conspicuous; calyx segments lanceolate, in anthesis 3.5-4.5 mm long, in fruit becoming 9-12 mm long, setose; corolla white, the tube 3-4 mm long, crests at base of tube evident, fornices yellow, low, rounded or emarginate, papillose, limb 6-8 mm wide; style exceeding mature fruit 1-2 mm; nutlets lanceolate, 4-5 mm long, 2-3 mm wide, all four usually maturing, margins narrowly winged or knifelike, in contact, dorsal surface tuberculate and irregularly rugose, ventral surface smooth or slightly uneven, scar open, cuneate, and without an elevated margin. Collections: 25 (ii); representative: J. W. Thompson 8742 (GH, WTU); A. R. Kruckeberg 2750 (ORE, WTU); W. W. Canby 996 (UC); L. C. Higgins 1661, 1667 (BRY).

Holotype: J. W. Thompson 7663, collected in Kittitas County, Washington, on the crest of Iron Mountain, Mount Stuart Region, 1930, GH.

Distribution: Kittitas and Chelan counties in the Wenatchee Mountains of central Washington. Growing on steep talus slopes, 3,000 to 7,000 feet. Map No. 46. Late May to August.

Cryptantha thompsonii is a loosely caespitose species arising from a thick, very woody taproot. It is endemic to the high mountains of east-central Washington. The plant may be distinguished by its thick leaves, nutlets which are smooth on the ventral surface, and the scar which is evidently open for most

of its length. A very distinct species not to be confused with any other in the region where it grows.

47. *Cryptantha soboliifera* Payson

Cryptantha soboliifera Payson, Ann. Mo. Bot. Gard. 14:305. 1927.

Long-lived perennials, 1-1.8 dm tall; stems 1-several from the branched caudex, some of them sterile and prostrate and terminating in soboles, 0.5-0.7 dm long; leaves spatulate to oblanceolate, obtuse, 1.5-4 cm long, 0.5-0.8 cm wide, strigose, and setose-hirsute, also somewhat tomentose, pustules conspicuous on both surfaces, petioles ciliate-margined; inflorescence cylindric, narrow, 0.3-0.8 dm long, setose, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 3-5 mm long, in fruit becoming 6-7 mm long, strigose and conspicuously setose; corolla white, the tube 3.5-4 mm long, crests at base of tube well developed, fornices yellow, emarginate, distinctly papillose, about 1 mm long, limb 6-8 mm wide; style exceeding mature fruit 1.8-2.5 mm; nutlets ovate-lanceolate, 2.5-3.5 mm long, 1.4-1.7 mm wide, dorsal surface with low inconspicuous tubercles or ridges, or sometimes almost smooth, ventral surface smooth or nearly so, scar straight, closed, the margin not elevated. Collections: 3 (0); representative: M. E. Jones s.n. (POM); Pennell, Cotner and Schaeffer 23928 (US); Hitchcock and Muhlick 13021 (RM).

Holotype: M. E. Jones s.n., collected in Glacier County, Montana, at Upper Marias Pass, 10 September 1909, POM. Photograph at BRY.

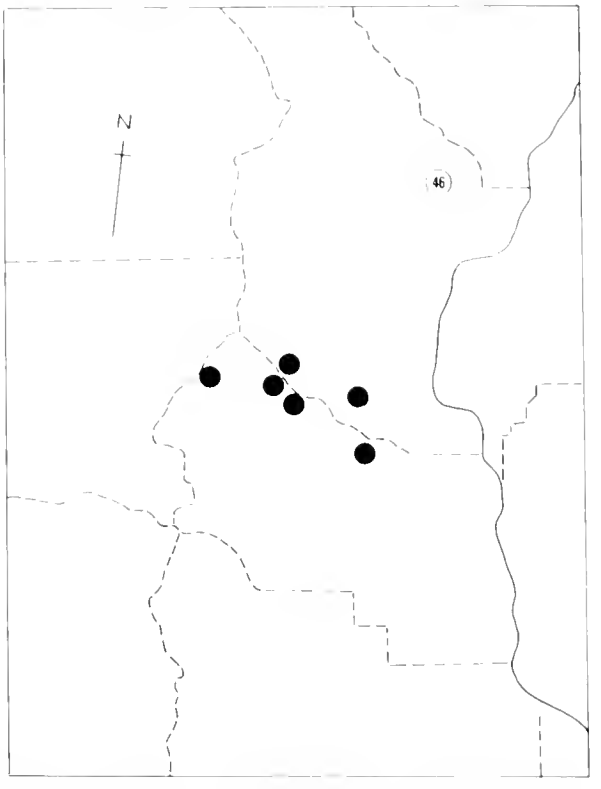
Distribution: Western Montana in the high Rocky Mountains. Growing on sandy soil or serpentine talus slopes, 5,000 to 10,000 feet. Map no. 47. Late June to September.

This species is not very well known or represented by herbarium specimens, and more collections of it are badly needed. It is perhaps most closely related to *C. echinoides*, but differs in the smooth ventral surface of the nutlets, the soboliferous leaves, and different flowering time.

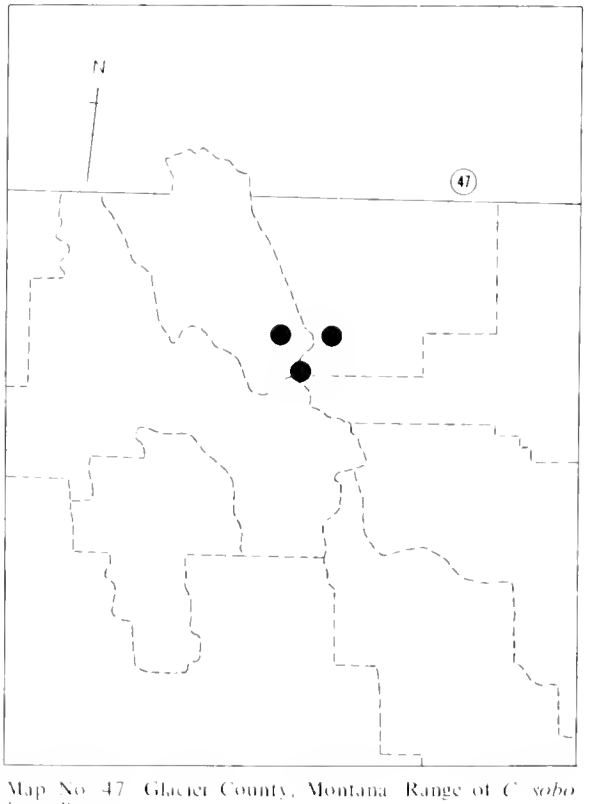
48. *Cryptantha grahamii* Johnst.

Cryptantha grahamii Johnst. Journ. Arn. Arb. 20:391. 1939.

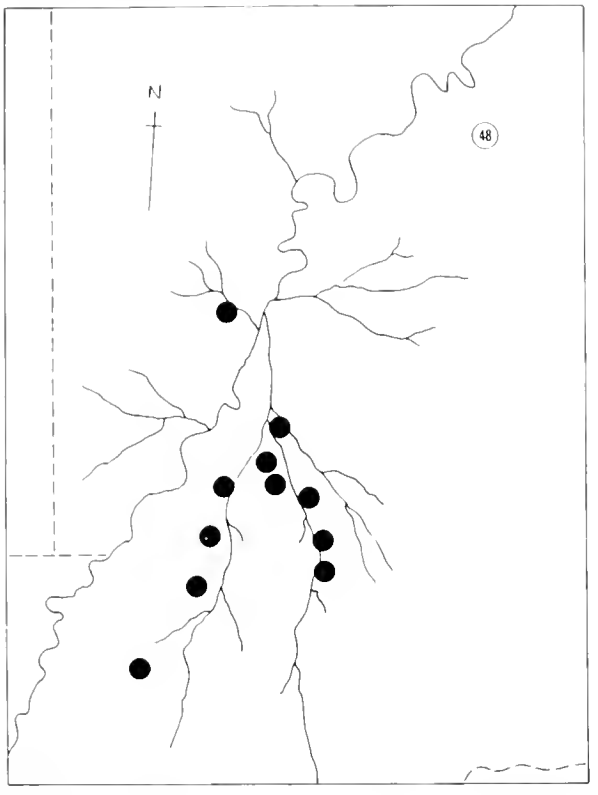
Long-lived perennial from a thick woody taproot, 1.5-2 dm tall; stems several, 0.4-1.2 dm long, weakly spreading setose; leaves spatulate to oblanceolate, 2-4.5 cm long, 0.4-1 cm wide, conspicuously setose-pustulate on both surfaces, with some finer pubescence beneath; inflorescence narrow, 0.4-1 dm long, setose, foliar bracts evident but not conspicuous; calyx segments lanceolate, in anthesis 5-7 mm long, in fruit becoming 7-9 mm long, abundantly setose;



Map No. 46. Central Washington, Kittitas and Chelan Counties. Range of *C. thompsonii* Johnston.



Map No. 47. Glacier County, Montana. Range of *C. soboliifera* Payson.



Map No. 48. Uintah County, Utah. Range of *C. grahamii* Johnston

corolla white, the tube 3.5-5 mm long, constricted at the middle, crests at base of tube evident, fornices yellow, emarginate, papillose, 0.5-1 mm long, limb 11-15 mm wide; style coarse, exceeding mature fruit 1.8-2.1 mm; nutlets lanceolate, 3-3.8 mm long, 1.7-2 mm wide, two to four maturing, margins in contact, acute, both surfaces of nutlet with inconspicuous small, low rounded tubercles, or some of these confluent into short irregular ridges, scar straight, open, narrowly linear, the margin not elevated. Collections: 17 (x); representative: R. C. Rollins 1707 (GH, RM); E. H. Graham 7924 (GH); Holmgren and Reveal 1879 (BRY, UTC); R. C. Rollins 1716 (GH); E. H. Graham 8962 (GH); L. C. Higgins 1602, 1607, 1610, 1876, 1885 (BRY).

Holotype: Edward H. Graham 7924, collected in Uintah County, Utah, on bench west of Green River north of mouth of Sand Wash, 4,500 feet, 28 May 1933. GH. Photograph at BRY.

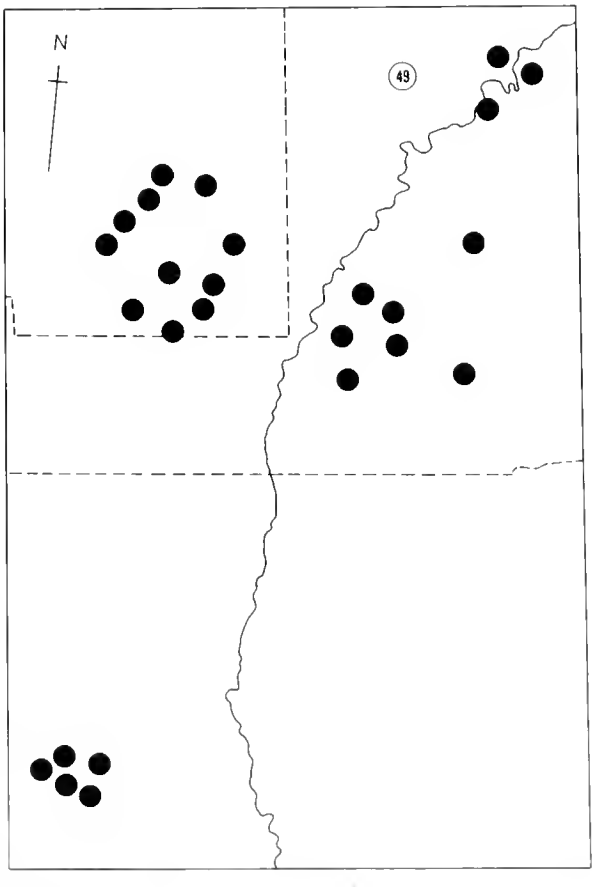
Distribution: Endemic to the Uintah Basin, Uintah County, Utah, along Willow Creek and the Willow Creep drainage basin. Growing on white shale, 4,300 to 6,000 feet. Map No. 48. May to June.

Cryptantha grahamii can be distinguished from other species of the Uintah Basin by its large corolla, tuberculate nutlets, coarse style, and the thick, black, woody caudex.

49. *Cryptantha rollinsii* Johnst.

Cryptantha rollinsii Johnst. Journ. Arn. Arb. 20:391. 1939.

Biennial herbs 1-3.5 dm tall; stems 1-several, 0.2-1 dm long, setose; leaves clustered at the base, gradually reduced upward, oblanceolate to spatulate, obtuse to acute, 2-5 cm long, 0.5-1.5 cm wide, setose and hispid, pustulate on both surfaces; inflorescence narrow to somewhat open at maturity, cylindric to obovoid, racemes in dense glomerules, three to six flowered, hispid, 0.5-2 dm long; calyx segments linear, in anthesis 7-8 mm long, in fruit becoming 8-10 mm long, hispid; corolla white, campanulate, the tube 7-9 mm long, crests at base of tube evident, fornices yellow, papillose, about 0.5-1 mm long, limb 7-8 mm wide; plants slightly heterostyled; nutlets lanceolate, 3-4 mm long, 1-1.5 mm wide, obscurely rugulose and tuberculate on the dorsal surface, ventral surface smooth, scar closed, and without an elevated margin. Collections: 42 (xii); representative: R. C. Rollins 3084 (GH, RM); R. C. Rollins 1715 (GH); Ripley and Barneby 7804 (GH); E. H. Graham 7870 (GH); B. F. Harrison 400H (BRY, GH); J. Brotherson 1049 (BRY); D. Atwood 1617 (BRY); Welsh and Christensen 6622 (BRY); L. C. Higgins



Map No. 49. Eastern and northern Utah. Range of *C. rollinsii* Johnston

1056, 1068, 1324, 1606, 1880 (BRY).

Holotype: Reed C. Rollins 1715, collected in Uintah County, Utah, shale hillside on Thorne's Ranch near Willow Creek, 22 miles south of Ouray, 5,500 feet, 16 June 1937, GH. Photograph at BRY.

Distribution: Central and northeastern Utah in Emery, Uintah, and Duchesne counties. Growing on white or red shale, 4,000 to 6,000 feet. Map No. 49. May to July.

Cryptantha rollinsii is very common in the Uintah Basin, and can be found on most shaley hillsides throughout the region. An isolated population also occurs in Emery County on the south end of the San Rafael Swell near Temple Mountain, but is undoubtedly the same species.

This distinctive plant may be recognized by its campanulate corolla, nearly smooth nutlets, noncaespitose habit, and single stem.

50. *Cryptantha wetherillii* (Eastw.) Payson

Cryptantha wetherillii (Eastw.) Payson, Ann. Mo. Bot. Gard. 14:324. 1927.
Krynitzkia glomerata var. *acuta* Jones, Zoe 2:250. 1891. (Type: Cisco, Utah, 2 May 1890, Jones.)
Oreocarya wetherillii Eastw. Bull. Torrey Bot. Club 30:242. 1903.

Biennial or short-lived perennials, 1-3.5 dm tall; stems 1-6, 0.5-0.8 dm long, branched from the base with one stout stem and usually several low slender stems; leaves clustered at the base, gradually reduced upward, spatulate to broadly oblanceolate, the apices obtuse to rounded, 2.5-5 cm long, 0.7-1.6 cm wide, strigose and appressed setose, dorsal surface conspicuously pustulate, ventral surface with few or no pustules; inflorescence becoming broad in age due to the elongation of the racemes, 0.6-3 dm long; calyx segments lanceolate, in anthesis 5-7 mm long, in fruit becoming 7-13 mm long, white setose; corolla white, the tube 7-10 mm long, crests at base of tube lacking, fornices light-yellow, emarginate, papillose, about 1 mm long, limb 6-13 mm wide; style exceeding mature fruit 3-5 mm; nutlets lanceolate or ovate-lanceolate, 3.5-4 mm long, 2-2.5 mm wide, usually all four maturing, margins acute, in contact, dorsal surface distinctly tuberculate and often rugulose as well as with numerous munications between the larger roughenings, ventral surface similar but the markings not as distinct, scar open, linear, surrounded by a slightly elevated margin. Collections: 24 (v); representative: A. Eastwood s.n. (UC, CAS), M. E. Jones 6734 (UC, GH, RM), B. Maguire 18229 (UC, UTC); W. P. Cottam 2073 (BRY), G. L. Pyrah (BRY, UTC), Welsh and Moore 2786 (BRY), E. C. Higgins 1476 (BRY).

Lectotype: A. Eastwood s.n., collected in Grand County, Utah, near Moab, Court House Wash, 25 May 1892, CAS. Photograph at BRY. Isotype at UC.

Distribution: East central Utah in Grand, Carbon, Emery, Wayne, and Garfield counties. Usually growing on heavy clay soils, 4,000 to 6,000 feet. Map No. 50. April to June.

Cryptantha wetherillii is a close relative of *C. longiflora*, but differs in the shorter corolla tube, tuberculate nutlets, ventral surface of the leaves without or with only a few pustules, and the flowers which are not strongly dimorphic.

51. *Cryptantha longiflora* (A. Nels.) Payson

Cryptantha longiflora (A. Nels.) Payson, Ann. Mo. Bot. Gard. 14:326. 1927.
Oreocarya longiflora A. Nels. Erythea 7:67. 1899.
Oreocarya horridula Greene, Pl. Baker 3:20. 1901. (Type: Deer Run, Colorado, 11 June, on dry bank, C. F. Baker 133.)

Short-lived perennial or possibly biennial, 0.8-3 (5) dm tall; stems 1-several, 0.5-1 dm long, setose and spreading hirsute; leaves spatulate, obovate or oblanceolate, 2-7 cm long, 0.5-1.5 cm wide, both surfaces strigose and strongly hirsute, pustulate; inflorescence broad and open, 0.7-2.5 dm long, setose, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 7-10 mm long, in fruit becoming 10-16 mm long, setose; corolla white, the tube 12-14 mm long, crests at base of tube lacking, fornices yellow, emarginate, broad, rounded, papillose, 0.5-1 mm long, limb 9-11 mm wide; style exceeding mature fruit 4-9 mm (heterostyled); nutlets lanceolate-ovate, 3-4 mm long, 2.2-2.6 mm wide, 2-4 maturing, both surfaces with tubercles and low rounded ridges, scar straight, closed or very narrowly open, with a slightly elevated margin. Collections: 36 (vi), representative: S. L. Welsh 6989, 6966 (BRY); R. C. Rollins 2181 (RM, UTC), W. A. Weber 3799 (COLO, UTC), D. Wiens 3061 (BRY, COLO), G. E. Osterhout 5995 (RM); A. H. Barnum 799 (DIX); C. F. Baker 133 (ND-G); L. C. Higgins 1478, 3314 (BRY).

Holotype: C. S. Crandall s.n., collected in Mesa County, Colorado, at Palisades, 14 May 1898, RM. Photograph at BRY.

Distribution: Western Colorado and eastern Utah along the Colorado River drainage. Growing on sandy to clay soils, 3,800 to 6,000 feet. Map No. 51. May and June.

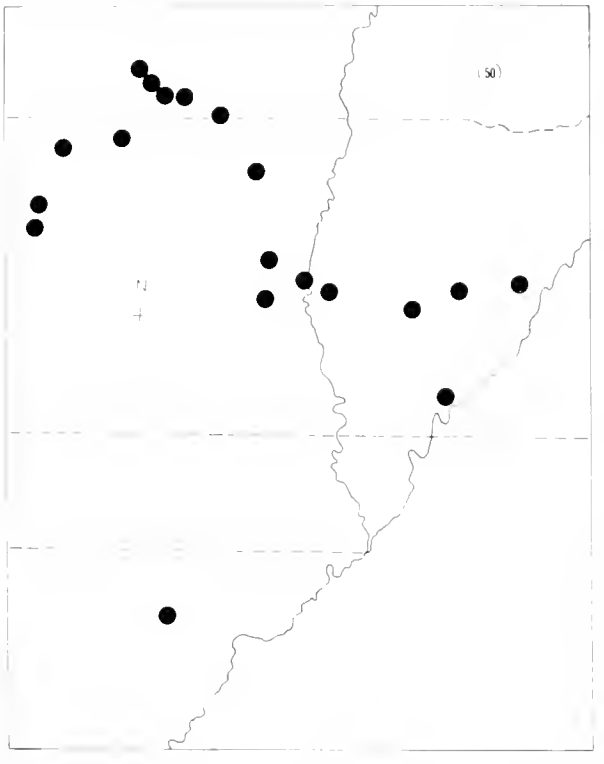
This species is perhaps most closely related to *C. wetherillii*, but differs in several notable respects as discussed under that species.

The type of *Oreocarya horridula*, described by Greene from Deer Run is the same in every respect as this taxon, so is placed in synonymy under it.

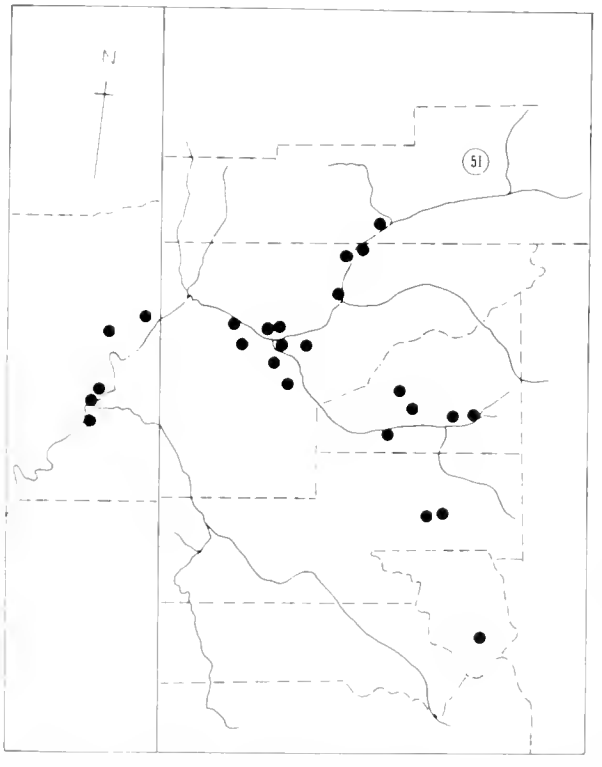
52. *Cryptantha tenuis* (Eastw.) Payson

Cryptantha tenuis (Eastw.) Payson, Ann. Mo. Bot. Gard. 14:327. 1927.
Oreocarya tenuis Eastw. Bull. Torrey Bot. Club 30:244. 1903.

Caespitose perennials, 1.3-2.5 dm tall; stems



Map No. 50. Eastern Utah. Range of *C. wetherillii* (Eastw.) Payson.



Map No. 51. Western Colorado and eastern Utah. Range of *C. longiflora* (A. Nels.) Payson.

slender, 1-many, 0.8-1.2 dm long, strigose and weakly spreading setose; leaves linear-spatulate, mostly basal, obtuse, 2-5 cm long, 0.3-0.6 cm wide, dorsal surface strigose and weakly spreading setose, conspicuously pustulate, ventral surface uniformly strigose and without pustules; inflorescence narrow, interrupted, 0.6-1.4 dm long, weakly setose, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 4.5-6 mm long, in fruit becoming 7-9 mm long, white setose; corolla white, the tube 5.5-7 mm long, crests at base of tube lacking or sometimes evident, fornices yellow, broad, emarginate, papillose, about 0.5 mm long, limb campanulate, 5-8 mm wide; style exceeding mature fruit 3-4 mm; nutlets lanceolate, 3-4 mm long, 1.8-2 mm wide, all four usually maturing, margins acute, nearly in contact, dorsal surface carinate, sharply and deeply rugose, ventral surface rugose, scar open, constricted above the base, and with an elevated margin. Collections: 40 (vii); representative: A. H. Holmgren 3237 (US); R. C. Barneby 13075 (CAS); A. Eastwood s.n. (UC, CAS); B. F. Harrison 11576 (BRY, UC); A. Cronquist 8978 (UTC); S. L. Welsh 6999, 7053, 7061, 7066 (BRY); D. Atwood 1541 (BRY); L. C. Higgins 1000, 537, 1281, 1326, 1334 (BRY).

Holotype: Alice Eastwood s.n., collected in Grand County, Utah, near Moab, in Court House Wash, 25 May 1892, CAS. Photograph at BRY.

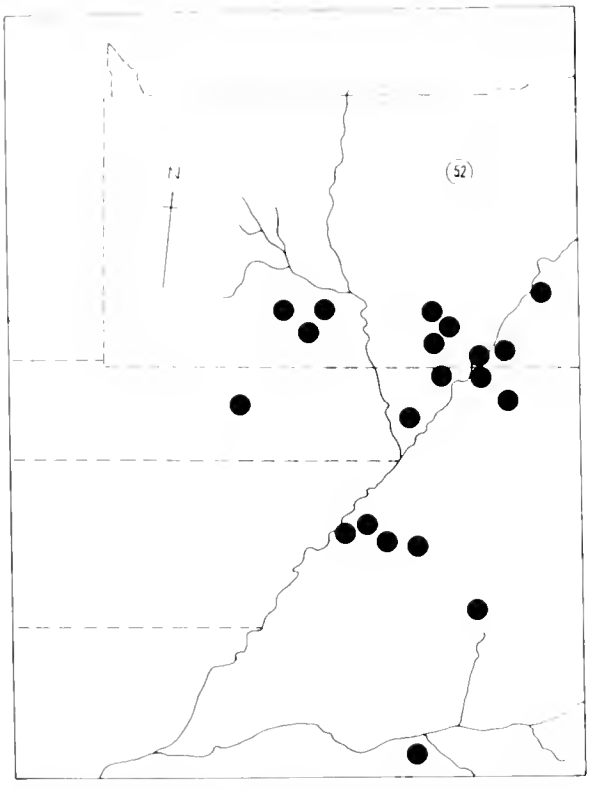
Distribution: Southeastern Utah in Emery, Grand, Wayne, and San Juan counties. Growing on sandy to clay soils, 2,500 to 5,500 feet. Map No. 52. Late April to July.

Cryptantha tenuis is often confused with *C. osterhoutii*, but differs in its taller habit, longer leaves, larger campanulate corolla, and the longer calyx and style.

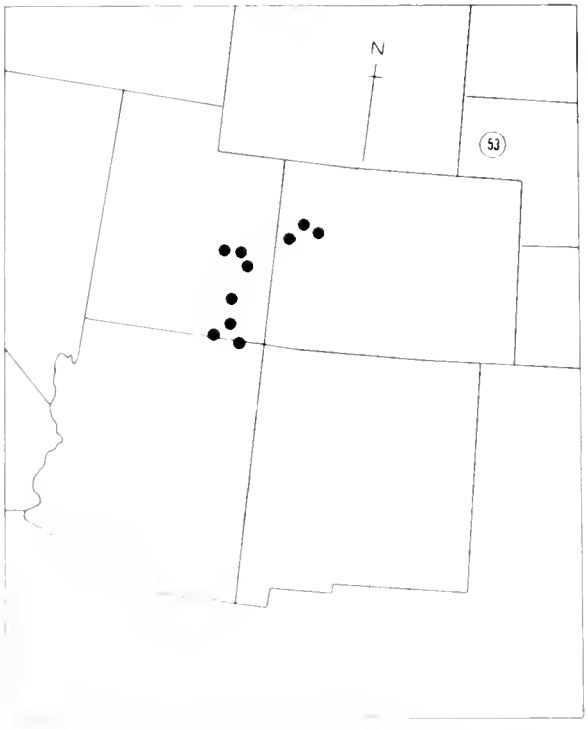
53. *Cryptantha osterhoutii* (Payson) Payson

Cryptantha osterhoutii (Payson) Payson, Ann. Mo. Bot. Gard. 14:329. 1927.
Oreocarya osterhoutii Payson, Univ. Wyo. Publ. Bot. 1:167. 1926.

Densely caespitose perennials, 0.7-1.2 dm tall; stems slender, many, arising from the densely branched multiple caudex, 0.3-0.6 mm long, strigose and spreading setose; leaves spatulate to oblanceolate, obtuse, 1-3 cm long, 0.3-0.8 cm wide, dorsal surface strigose and appressed setose, pustulate, ventral surface strigose, not pustulate or the pustulae inconspicuous, petioles ciliate margined; inflorescence open, 0.3-0.8 dm long, weakly white setose, foliar bracts inconspicuous; calyx segments lanceolate, in anthesis 2.5-4 mm long, in fruit becoming 5-6.5 mm long, strigose and spreading white setose; corolla white, the tube 2-3 mm long, crests at base of tube usually evident but poorly developed, fornices yellow, broad, emarginate, papillose, about 0.5 mm long, limb 5-7 mm wide; style exceeding mature fruit



Map No. 52. Southeastern Utah. Range of *C. tenuis* (Eastw.) Payson



Map No. 53. Western Colorado and southeastern Utah. Range of *C. osterhoutii* (Payson) Payson

0.2-0.7 mm; nutlets lanceolate, 2.7-3.2 mm long, 1.8-2.2 mm wide, usually less than four maturing, margins obtuse, not in contact, dorsal surface carinate, sharply tuberculate and rugose, ventral surface sharply tuberculate, scar open, constricted above the base, elevated margin evident but not conspicuous. Collections: 16 (11); representative: W. A. Weber 6088 (ARIZ, COLO, CS, RM, UTC); G. E. Osterhout 6138 (COLO, RM); D. Atwood 1538A (BRY); B. F. Harrison 11923 (BRY), Welsh, Moore and Canter 2946 (BRY); G. Moore 399 (BRY); G. Moore 299 (BRY); S. L. Welsh 7070 (BRY).

Holotype: G. E. Osterhout 6138, collected in Monument Park, near Grand Junction, Mesa County, Colorado, 3 June 1921, RM. Photograph at BRY. Isotype at COLO.

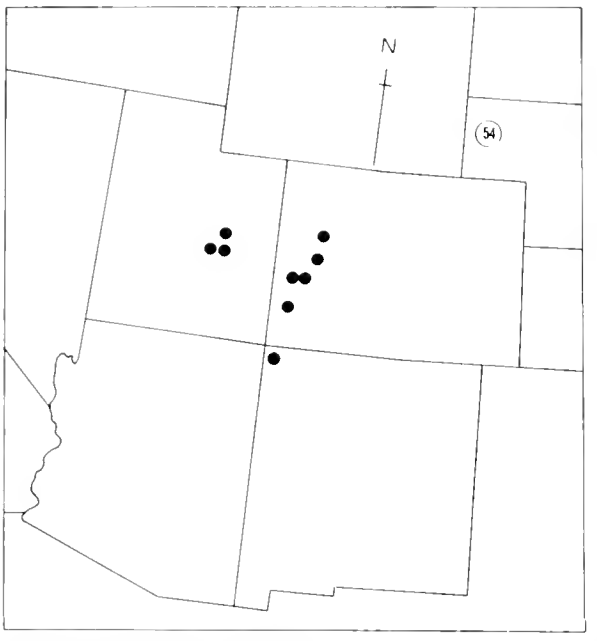
Distribution: Mesa County, Colorado, and San Juan County, Utah. Growing in sandy soil, 2,500 to 6,000 feet. Map No. 53. May to June.

This very distinctive specie is not often collected, but is one of the most distinct in the entire subgenus because of its small size.

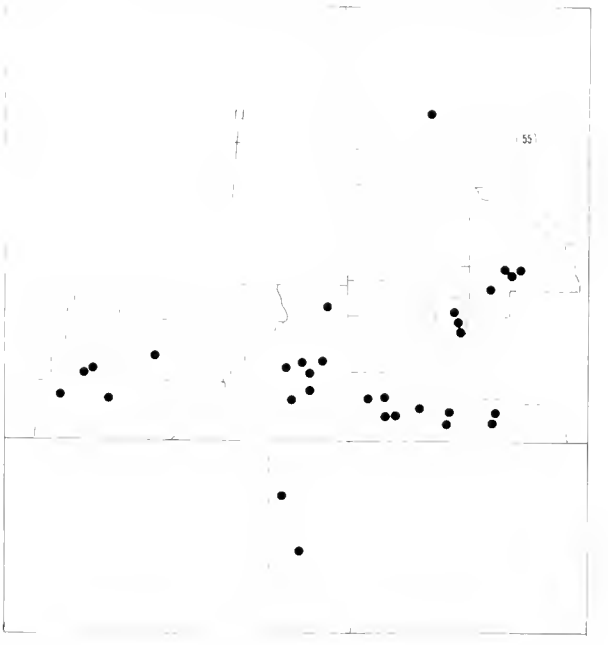
54. *Cryptantha paradoxa* (A. Nels.) Payson

Cryptantha paradoxa (A. Nels.) Payson, Ann. Mo. Bot. Gard. 14:330. 1927.
Oreocarya paradoxa A. Nels. Bot. Gaz. 56:69. 1913.
Oreocarya gypsophila Payson, Bot. Gaz. 60:380. 1915. (Type: On dry gypsum hill in Paradox Valley, Colorado, 18 June 1914, Payson 458.)

Caespitose perennial, 0.4-1.2 dm tall; stems 1-many, slender, 0.2-0.8 dm long, subtomentose near the base, weakly setose above; leaves oblanceolate to spatulate, usually folded, obtuse, 1.5-4 cm long, 0.2-0.4 cm wide, dorsal surface with appressed setose-pustulate hairs, ventral surface uniformly strigose and without pustulate hairs, the petioles ciliate-margined; inflorescence subcapitate, 0.1-0.4 dm long, setose, foliar bracts inconspicuous; calyx segments linear-lanceolate, in anthesis 5-6 mm long, in fruit becoming 6-8 mm long, weakly setose; corolla white, usually with a yellow tube 10-12 mm long, crests at base of tube lacking, fornices yellow, broad, slightly emarginate, papillose, about 0.5 mm long, limb 10-12 (15) mm wide; style exceeding mature fruit 4-9 mm; nutlets lanceolate, turgid, 2-3 mm long, 1.3-1.6 mm wide, all four usually maturing, margins acute to obtuse, not in contact, dorsal surface densely tuberculate and conspicuously rugose, ventral surface tuberculate, also somewhat rugulose, scar open, constricted below the middle, the margin elevated. Collections: 16 (vii); representative: F. P. Walker 91 (RM); Payson and Payson 4223 (GH, RM); E. B. Payson 458 (GH, RM); W. A. Weber 4722 (COLO, RM, UTC); A. Cronquist 9204 (UTC); B. Maguire 18282 (UTC); B. F. Harrison 9607 (BRY); Higgins and Reveal 1272 (BRY); L. C. Higgins 1314, 1317, 1319, 1901, 3298 (BRY).



Map No. 54. Western Colorado and eastern Utah. Range of *C. paradoxa* (A. Nels.) Payson.



Map No. 55. Southwestern Colorado, southeastern Utah, and parts of adjoining states. Range of *C. bakeri* (Greene) Payson.

Holotype: E. P. Walker 91, collected in Montrose County, Colorado, on dry gypsum hills in Paradox Valley, 17 June 1912, RM. Photograph at BRY. Isotypes at GH, POM, US.

Distribution: Western and southwestern Colorado and Emery County, Utah. Growing on clay or sandy soil, 4,000 to 7,000 feet. Map No. 54. May and June.

Cryptantha gypsophila is the same plant in every respect as *C. paradoxa*. Payson noted, "unfortunately the specimens of *paradoxa* had not been mounted and so were not available when *gypsophila* was described. However, there is no doubt that the two names are completely synonymous."

This delicate little species may be distinguished by its densely caespitose habit, short leaves, and the long dimorphic corollas.

55. *Cryptantha bakeri* (Greene) Payson

Cryptantha bakeri (Greene) Payson, Ann. Mo. Bot. Gard. 14:331. 1927.

Oreocarya bakeri Greene, Pitt. 4:92. 1899.

Oreocarya eulophus Rydb. Bull. Torrey Bot. Club 31:637. 1904. (Type: Delores, Colorado, 1892, Crandall s.n.)

Biennial or short-lived perennials, 1-3 dm tall; stems 1-4 (6), 0.5-1 dm long, spreading setose-hirsute; leaves oblanceolate, obtuse, mostly basal, 3-6 cm long, 0.5-1.2 cm wide, dorsal surface strigose and spreading setose, pustulate, ventral surface uniformly strigose and with few or no pustulate hairs; inflorescence narrow, 0.6-2.5 dm long, setose-hirsute, foliar bracts evident, slightly surpassing the individual cymes; calyx segments broadly lanceolate or ovate, in anthesis 3.5-4 mm long, in fruit becoming 6-8 mm long, conspicuously setose; corolla white, the tube 4-6 mm long, crests at base of tube lacking, fornices yellow, emarginate, 1-1.5 mm long, limb 6-8 mm wide; style exceeding mature fruit 1-2 mm; nutlets ovate-lanceolate, 2.5-3 mm long, 1.5-2 mm wide, three to four usually maturing, margins obtuse, nearly in contact, dorsal surface deeply and sharply rugose, ventral surface tuberculate and short rugose, scar closed, surrounded by a definitely elevated white margin. Collections: 49 (vi); representative: Baker, Earle and Tracy 827 (ND-G); R. C. Rollins 2223 (RM, UTC); W. A. Weber 8732 (COLO); Eardman 39 (BRY, COLO); A. H. Holmgren 3374 (BRY, UTC); H. M. Schmoll 1281 (COLO, RM); A. Nelson 10408 (RM); D. Atwood 1539A (BRY) L. C. Higgins 1903, 1948, 3558 (BRY, WTSU).

Holotype: Baker, Earle and Tracy 827, collected on the Mancos River sage plains in southern Colorado, 8 July 1898, ND-G. Photograph at BRY. Isotype at POM.

Distribution: Southwestern Colorado, northeastern Arizona, and southeastern Utah. Growing on sandy or clay soils, 4,000 to 8,000 feet. Map No. 55. May to August.

This species is very distinct, however, very closely related to *C. flavoculata* and often confused with it. It can be distinguished by its leaves which lack pustules on the ventral surface, shorter corolla tube, the shorter style, and the nutlets which have the scar tightly closed and the margin elevated.

56. *Cryptantha mensana* (Jones) Payson

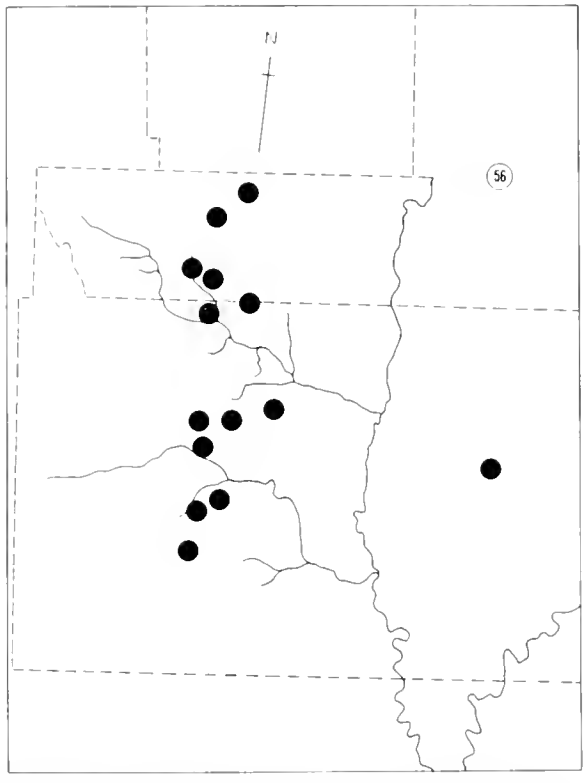
Cryptantha mensana (Jones) Payson, Ann. Mo. Bot. Gard. 14:333. 1927.
Krynitzkia mensana Jones, Contr. West. Bot. 13:4. 1910.
Oreocarya mensana (Jones) Payson, Univ. Wyo. Publ. Bot. 1:171. 1926.

Short-lived perennials, 1-1.5 dm tall; stems 1-several, 0.5-1.2 dm long, setose-hirsute, with some finer strigose hairs beneath; leaves oblanceolate to spatulate, obtuse, 3-8 cm long, 0.5-1.4 cm wide, lower surface setose with pustulate hairs, also finely strigose, ventral side strigose, less setose, and with fewer pustules; inflorescence broad, open, 0.4-1.2 dm long, setose, foliar bracts well developed; calyx segments lanceolate, in anthesis 4-5 mm long, in fruit becoming 7-8 mm long, setose-hirsute; corolla white, the tube 3-4 mm long, crests at base of tube lacking or nearly so, fornices yellow, rounded, slightly papillose, about 0.5 mm long, limb 5-8 mm wide; style exceeding mature fruit 1.5-2 mm; nutlets ovoid, 3-3.5 mm long, 1.6-1.9 mm wide, margins obtuse, not in contact, dorsal surface rugose, tuberculate and somewhat muricate, ventral surface conspicuously tuberculate, scar open, constricted at the middle and surrounded by a high elevated margin. Collections: 20 (vi); representative: B. F. Harrison 5625 (RM); M. E. Jones 5445 (POM); S. L. Welsh 6915 (BRY); B. Maguire 18596 (UTC); A. Nelson 5625 (RM); G. L. Pyrah 15 (BRY); D. Atwood 1270, 1284 (BRY); Higgins and Reveal 1298 (BRY); Higgins and Welsh 1043 (BRY); L. C. Higgins 996, 1039, 1318, 3323 (BRY).

Holotype: M. E. Jones 5445p, collected in Emery County, Utah, 16 May 1894, POM. Photograph at BRY. Isotype at US.

Distribution: Central and eastern Utah in Emery, Carbon, and Grand counties. Growing on clay soils, 4,500 to 6,500 feet. Map No. 56. Late April to July.

Cryptantha mensana is closely related to *C. flavoculata*, but the short corolla and the more open inflorescence serve to distinguish it from that species.

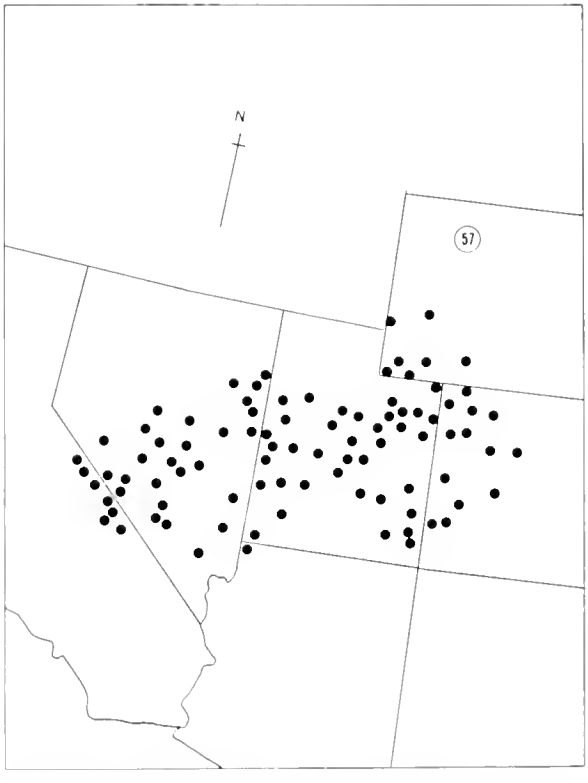


Map No. 56. Central and eastern Utah. Range of *C. mensana* (M. E. Jones) Payson.

57. *Cryptantha flavoculata* (A. Nels.) Payson

Cryptantha flavoculata (A. Nels.) Payson, Ann. Mo. Bot. Gard. 14:334. 1927.
Oreocarya flavoculata A. Nels. Erythea 7:66. 1899.
Oreocarya flavoculata spatulata A. Nels. Erythea 7:67. 1899. (Type: from gravelly hilltops near Evanston, Wyoming, Nelson 2977, 29 May 1897.)
Oreocarya cristata Eastw. Bull. Torrey Bot. Club 30:244. 1903. (Type: Grand Junction, Colorado, 17 May 1892, Eastwood.)
Oreocarya shockleyi Eastw. Bull. Torrey Bot. Club 30:245. 1903. (Type: Miller Mountain, Esmeralda County, Nevada, elevation 7,500 feet, Shockley 244.)
Oreocarya eastwoodae Nels. & Kennedy, Muhlenbergia 3:141. 1908. (Type: Mormon Mountains, Lincoln County, Nevada, P. B. Kennedy and E. N. Goodding 146.)

Caespitose perennial, 1-3.7 dm tall; stems 1-several, slender, 0.5-2 dm long, strigose and spreading



Map No. 57. Parts of western United States. Range of *C. flavoculata* (A. Nels.) Payson.

setose with slender bristles; leaves linear-oblanceolate to spatulate, obtuse to sometimes acute, 3-11 cm long, 0.3-1.5 cm wide, densely strigose and weakly setose, dorsal surface conspicuously pustulate, ventral surface with few pustules or sometimes silky-strigose; inflorescence narrow, or sometimes slightly open and lax, 0.5-3 dm long, foliar bracts evident but not conspicuous; calyx segments in anthesis linear-lanceolate, 5-6 mm long, in fruit becoming 8-10 mm long and becoming broadly lanceolate to ovate; corolla white or pale yellow, tube 7-10 mm long, crests at base of tube lacking, fornices yellow, minutely papillose, 1-2 mm long, limb 8-12 mm wide; style exceeding mature fruit 4-8 mm (heterostyled); nutlets lanceolate to lance-ovate, 2.5-3.5 mm long, 1.8-2 mm wide, usually all four maturing, margins obtuse, in contact or slightly separated, dorsal surface muricate, tuberculate, and with conspicuously ridges, sometimes nearly foveolate, ventral surface tuberculate, rarely with ridges, scar open, constricted near the middle and surrounded by a high elevated margin. Collections: 188 (XIX); representative: Maguire and Holmgren 26064 (ORE, UTC); I. W. Clokey 7668 (ARIZ, ORE, LL, UTC); B. Maguire 25234 (ARIZ, BRY, ORE, UTC), J. Beatley 4007 (BRY, LA); B. F. Harrison 10320 (BRY, UTC); A. Nelson 4572 (RM); A. Eastwood s.n. (UC); G. E. Osterhout 6006 (GH, RM, US); Kennedy and Goodding 146 (RM, US); Shockley 244 (UC) L. C. Higgins 557, 997, 1026, 1061, 1112 (BRY); E. C. Higgins 3291, 3324, 3403 (BRY, WTSU).

Holotype: A. Nelson 4572, collected at Piedmont, Wyoming, 7 June 1898, RM.

Distribution: Southern Wyoming, western Colorado, Utah, Nevada, and southeastern California. Growing in a wide variety soils, 3,000 to 8,500 feet. Map No. 57, April to July.

This widespread species may be distinguished by its long corolla tube, very rugose nutlets with the scar open and the margin elevated, and the only slightly heterostyled flowers.

This species possesses a number of different forms, but they seem to be unworthy of named segregation from the main specific complex. In western Colorado the author is familiar with two forms, on the basis of setose-hispid and silky-strigose indument. For a limited locality it would seem that these two forms are worthy of some subspecific rank, but on an examination of a series of specimens it appears the variation is only local. *Oreocarya cristata* has very narrow leaves and so has a slightly different aspect. On the same basis of leaf width *spatulata shockleyi*, and *castwoodae* were described. At the present time the author can see no difference on which to separate them.

ACKNOWLEDGMENTS

The author is particularly indebted to Dr. Stanley Welsh for his suggestion of the problem and his guidance and interest. Thanks is due my wife for her active cooperation. Appreciation is likewise extended to Dr. James Reveal for many valuable suggestions and constructive criticism; to Drs. Glen Moore, Stephen Wood, and Dayna Stocks for critical reading of the manuscript. Appreciation is also given to the Society of Sigma Xi, West Texas State University, The Kilgore Research Center, and Brigham Young University for their financial help which made it possible to do the necessary field work. Special thanks is given to the curators of the many herbaria for making specimens available for study. What authenticity this study may possess is due in large part to the 7,000 sheets they made available for study, including the vast majority of types.

APPENDIX

Synonyms

The names presented in the following list consist of the synonyms of the species treated in the foregoing work. The names in the left column are the synonyms; those in the column on the right are the names of the species in the present treatment.

CYNOGLOSSUM

C. glomeratum Nutt. ex Piursh	*C. celosioides* (Eastw.) Pays. p. 49

CRYPTANTHA

C. andina Johnst.	*C. subretusa* Johnst. p. 28
C. bradburiana Pays.	*C. celosioides* (Eastw.) Pays. p. 50
C. clemensae Pays.	*C. nubigena* (Greene) Pays. p. 27
C. confertiflora var. *flava* (A. Nels.) Brand	*C. flava* (A. Nels.) Pays. p. 22
C. confertiflora var. *lutescens* (Greene) Brand	*C. flava* (A. Nels.) Pays. p. 22
C. corei Johnst.	*C. palmeri* (Gray) Pays. p. 18
C. echinoides (Jones) Pays.	*C. fulvocanescens* var. *echinoides* (Jones) Higgins p. 42
C. jamesii var. *cinerea* (Greene) Pays.	*C. jamesii* var. *setosa* (Jones) Johnst. p. 16
C. macounii (Eastw.) Pays.	*C. celosioides* (Eastw.) Payson p. 50
C. modesta Payson	*C. abata* Johnst. p. 33
C. nana var. *commixta* (Macbr.) Pays.	*C. humilis* var. *commixta* (Macbr.) Higgins p. 37
C. nana var. *ovina* Pays.	*C. humilis* var. *ovina* (Pays.) Higgins p. 37
C. nana var. *shantzii* (Tidestr.) Pays.	*C. humilis* var. *shantzii* (Tidestr.) Higgins p. 37
C. nana var. *nana*	*C. humilis* var. *nana* (Eastw.) Higgins p. 37
C. pustulosa (Rydb.) Pays.	*C. jamesii* var. *pustulosa* (Rydb.) p. 18
C. sericea var. *perennis* (A. Nels.) Pays.	*C. sericea* (Gray) Pays. p. 45
C. shelbiana (Brand) Pays.	*C. celosioides* (Eastw.) Pays. p. 50

ERITRICHIUM

E. fulvocanescens Gray	*C. fulvocanescens* var. *fulvocanescens* p. 42
E. glomeratum A. DC.	*C. celosioides* (Eastw.) Pays. p. 49
E. glomeratum var. *fulvocanescens* S. Wats.	*C. fulvocanescens* var. *fulvocanescens* p. 42
E. glomeratum var. *hispidissimum* Torr.	*C. thyrsiflora* (Greene) Pays. p. 43
E. glomeratum var. *humile* Gray	*C. humilis* var. *humilis* p. 36
E. glomeratum var. *virgatum* Porter	*C. virgata* (Porter) Pays. p. 30
E. jamesii Torr.	*C. jamesii* var. *jamesii* p. 17
E. leucophaeum (Dougl.) A. DC.	*C. leucophaea* (Dougl.) Pays. p. 24
E. multicaule Torr.	*C. jamesii* var. *multicaulis* (Torr.) Pays. p. 15
E. setosissimum Gray	*C. setosissima* (Gray) Pays. p. 29
E. virgatum Porter	*C. virgata* (Porter) Pays. p. 30

HEMISPHAEROCARYA

H. cinerea (Greene) Brand	*C. jamesii* var. *setosa* (Jones) Johnst. p. 16
H. laxa (Macbr.) Brand	*C. jamesii* var. *laxa* (Macbr.) Pays. p. 16
H. oblata (Jones) Brand	*C. oblata* (Jones) Pays. p. 19
H. palmeri (Gray) Brand	*C. palmeri* (Gray) Pays. p. 18
H. paysonii (Macbr.) Brand	*C. paysonii* (Macbr.) Johnst. p. 19
H. abortiva (Greene) Brand	*C. jamesii* var. *abortiva* (Greene) p. 17
H. suffruticosa (Torr.) Brand	*C. jamesii* var. *jamesii* p. 17
H. suffruticosa var. *multicaulis* (Torr.) Brand	*C. jamesii* var. *multicaulis* (Torr.) p. 15
H. suffruticosa var. *pustulosa* (Rydb.) Brand	*C. jamesii var. pustulosa* (Rydb.) p. 18
H. suffruticosa var. *setosa* Jones) Brand	*C. jamesii* var. *setosa* (Jones) Johnst. p. 16
H. suffruticosa var. *typica*	*C. jamesii* var. *jamesii* p. 17

KRYNITZKIA

K. depressa Jones	*C. abata* Johnst. p. 33
K. echinoides Jones	*C. fulvocanescens* var. *echinoides* (Jones) Higgins p. 42
K. fulvocanescens Gray	*C. fulvocanescens* var. *fulvocanescens* p. 42
K. fulvocanescens var. *idahoensis* Jones	*C. propria* (Nels. & Macbr.) Pays. p. 40
K. glomerata Gray	*C. celosioides* (Eastw.) Pays. p. 49
K. glomerata var. *acuta* Jones	*C. wetherillii* (Eastw.) Pays. p. 54
K. glomerata var. *virginensis* Jones	*C. virginensis* (Jones) Pays. p. 32
K. jamesii (Torr.) Gray	*C. jamesii* var. *jamesii* p. 17
K. leucophaea (Dougl.) Gray	*C. leucophaea* (Dougl.) Pays. p. 24
K. leucophaea var. *alata* Jones	*C. confertiflora* (Greene) Pays. p. 21
K. multicaulis var. *abortiva* (Greene) Jones	*C. jamesii* var. *abortiva* (Greene) p. 17
K. multicaulis var. *setosa*	*C. jamesii* var. *setosa* (Jones) Johnst. p. 16
K. mensana Jones	*C. mensana* (Jones) Pays. p. 58
K. oblata Jones	*C. oblata* (Jones) Pays. p. 19
K. palmeri Gray	*C. palmeri* (Gray) Pays. p. 18
K. pustulata Blankenship	*C. celosioides* (Eastw.) Pays. p. 49
K. sericea Gray	*C. sericea* (Gray) Pays. p. 45
K. setosissima (Gray) Gray	*C. setosissima* (Gray) Pays p. 29
K. virgata (Porter) Gray	*C. virgata* (Porter) Pays. p. 30

MYOSOTIS

M. glomerata Nutt.	*C. celosioides* (Eastw.) Pays. p. 49
M. leucophaea Dougl. in Lehm.	*C. leucophaea* (Dougl. in Lehm.) Pays p. 24
M. suffruticosa Torr.	*C. jamesii* var. *jamesii* p. 17

ORTOCARYA

O. abortiva Greene	*C. jamesii* var. *abortiva* (Greene) Pays p. 17
O. affinis Greene	*C. celosioides* (Eastw.) Payson p. 49
O. affinis perennis A. Nels.	*C. sericea* (Gray) Pays. p. 45
O. alata (Jones) A. Nels.	*C. confertiflora* (Greene) Pays. p. 21
O. aperta Eastw.	*C. aperta* (Eastw.) Pays p. 46

O. argentea Rydb. — *C. sericea* (Gray) Pays. p. 45
O. bakeri Greene — *C. bakeri* (Greene) Pays. p. 57
O. breviflora Osterh. — *C. breviflora* (Osterh.) Pays. p. 40
O. caespitosa A. Nels. — *C. caespitosa* (A. Nels.) Pays. p. 34
O. cana A. Nels. — *C. cana* (A. Nels.) Pays. p. 40
O. capitata Eastw. — *C. capitata* (Eastw.) Johnst. p. 22
O. celosioides Eastw. — *C. celosioides* (Eastw.) Pays. p. 49
O. cilio-hirsuta Nels. & Macbr. — *C. spiculifera* (Piper) Pays. p. 49
O. cinera Greene — *C. jamesii* var. *setosa* (Jones) Johnst. p. 16
O. commixta Macbr. — *C. humilis* var. *commixta* (Macbr.) Higgins p. 30
O. confertiflora Greene — *C. confertiflora* (Greene) Pays. p. 21
O. cristata Eastw. — *C. flava* (A. Nels.) Pays. p. 58
O. crymophila (Johnst.) Jeps. & Hoover — *C. crymophila* Johnst. p. 28
O. depressa (Jones) Macbr. — *C. abata* Johnst. p. 33
O. distichа Eastw. — *C. jamesii* var. *distichа* (Eastw.) Pays. p. 17
O. dolosa Macbr. — *C. humilis* var. *shantzii* (Tidestr.) Higgins p. 37
O. dura Nels. & Macbr. — *C. thyrsiflora* (Greene) Pays. p. 43
O. eastwoodae Nels. & Kennedy — *C. flavoculata* (A. Nels.) Pays. p. 58
O. echinoides (Jones) Macbr. — *C. humilis* var. *humilis* p. 42
O. elata Eastw. — *C. elata* (Eastw.) Pays. p. 44
O. eulophus Rydb. — *C. bakeri* (Greene) Pays. p. 57
O. flava A. Nels. — *C. flava* (A. Nels.) Pays. p. 22
O. flavoculata A. Nels. — *C. flavoculata* (A. Nels.) Pays. p. 58
O. flavoculata spatulata A. Nels — *C. flavoculata* (A. Nels.) Pays. p. 58
O. fulvocanescens (S. Wats.) Greene — *C. fulvocanescens* (S. Wats.) Pays. p. 42
O. glomerata Greene — *C. celosioides* (Eastw.) Pays. p. 49
O. gypsophila Pays. — *C. paradoxa* (A. Nels.) Pays. p. 56
O. hispida Nels. & Kennedy — *C. humilis* var. *humilis* p. 36
O. hispidissima (Torr.) Rydb. — *C. thyrsiflora* (Greene) Pays. p. 43
O. hispidissima Wooton & Standl. — *C. oblata* (Jones) Pays. p. 19
O. hoffmannii (Johnst.) Abrams. — *C. hoffmannii* Johnst. p. 33
O. hormidula Greene — *C. longiflora* (A. Nels.) Pays. p. 54
O. humilis Greene — *C. humilis* (Gray) Pays. var. *humilis* p. 36
O. insolita Macbr. — *C. insolita* (Macbr.) Pays. p. 32
O. interrupta Greene — *C. interrupta* (Greene) Pays. p. 48
O. jonesiana Pays. — *C. jonesiana* (Pays.) Pays. p. 43
O. lemmonii Eastw. — *C. jamesii* var. *setosa* (Jones) Johnst. p. 16
O. leucophaea (Dougl.) Greene — *C. leucophaea* (Dougl.) Pays. p. 24
O. longiflora A. Nels. — *C. longiflora* (A. Nels.) Pays. p. 54
O. lutea Greene — *C. confertiflora* (Greene) Pays. p. 21
O. lutescens Greene — *C. flava* (A. Nels.) Pays. p. 22
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