UNIVERSITY OF CALIFORNIA

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A Revision of the Genus *Pectocarya* (Boraginaceae) Including Reduction to Synonymy of the Genus *Harpagonella* (Boraginaceae)

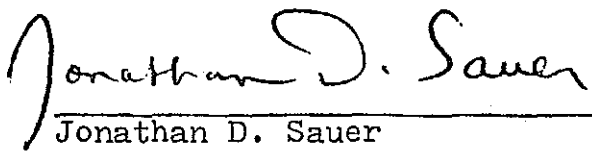
A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Biology

by

Barbara Ann Veno

1979

The dissertation of Barbara Ann Veno is approved.



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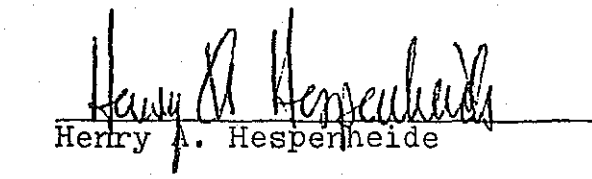

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ABSTRACT OF THE DISSERTATION

A Revision of the Genus Pectocarya (Boraginaceae)
Including Reduction to Synonymy of
the Genus Harpagonella (Boraginaceae)

by

Barbara Ann Veno
Doctor of Philosophy in Biology
University of California, Los Angeles, 1979
Professor Henry J. Thompson, Chair

Pectocarya and Harpagonella have long been considered very distinct and closely related genera of the Boraginaceae. As previously circumscribed, Pectocarya consisted of 11 species native to western North and South America, and Harpagonella was maintained as a monotypic endemic of of the southwestern United States and Mexico.

In contrast to their relatively uniform floral morphology, these taxa together exhibit great diversity in fruit morphology, especially in the following features: mature calyx structure and ornamentation; fruit, nutlet, and nutlet margin form. A general pattern of interspecific discontinuity coupled with intraspecific and intra-individual variability is evident. The preponderance of

biotypes often associated with autogamous plants is absent in Pectocarya and Harpagonella.

Previous classification did not satisfactorily account for the morphological variation of these annual plants or for their complete distributional ranges. Therefore, a revision of Pectocarya and Harpagonella was undertaken and employed field, herbarium, laboratory, and cultivation procedures.

As a result of this investigation, the following taxonomic changes and cytological data are reported: the reduction of Harpagonella to synonymy with Pectocarya under the new combination, P. palmeri (A. Gray) Veno; a realignment and redefinition of generic subdivisions to yield the sections Harpagonella, Gruvelia, and Pectocarya; the recognition of 15 species within Pectocarya including two new species, P. anisocarpa Veno and P. brachycera Veno, and one additional new combination, P. ferocula (I.M. Johnston) Veno; the first chromosome counts for nine species with confirmatory counts for three additional species.

A brief summary of these results is given in the following paragraphs.

Section Harpagonella is monotypic, and consists of Pectocarya palmeri, n = 12.

Section Gruvelia is composed of Pectocarya pusilla and P. setosa, both n = 12. Pectocarya pusilla is reportedly amphitropical; however, its primary distribution is

North American, and it is considered adventive in South America. Pectocarya setosa is exclusively North American.

Section Pectocarya consists of the remaining 12 species. The North American representatives are: Pectocarya penicillata, n = 12; P. heterocarpa, n = 12; P. peninsularis, n = 12; P. recurvata, n = 12; P. anisocarpa, n = 24; P. platycarpa, n = 24; and P. ferocula, n = 24. Pectocarya ferocula is also well established in South America along with the endemic species P. dimorpha, n = 12; P. linearis, n = 36; P. lateriflora, P. anomala, and P. brachycera.

INTRODUCTION

Pectocarya and Harpagonella, both diminutive, annual, autogamous plants, have long been considered very distinct, highly derived, and closely related genera of the Boraginaceae. Pectocarya, as previously circumscribed (Johnston, 1924-1939), consisted of 11 species distributed in the western regions of North and South America. Harpagonella had been historically maintained as a monotypic and endemic genus of the southwestern United States and Mexico.

In contrast to their relatively uniform floral morphology, the species comprising these two genera present an extensive array of diversity in fruit morphology. Although certain species of Pectocarya, e.g. the P. recurvata species group, show some intergradation in fruit features, a general pattern of interspecific discontinuity coupled with intraspecific and intra-individual variability is evident. The preponderance of biotypes often associated with autogamous plants is absent or obscured by subtle variation in characters which generally yields an intraspecific continuum of fruit forms rather than a number of morphologically distinctive associations.

Existing classification was based entirely on classical taxonomic methods, i.e. herbarium specimen and distributional analyses, and did not satisfactorily account for this complex variation pattern or the complete distributional ranges of the respective species, a situation which was reflected in numerous identification problems. Consequently, a biosystematic revision of Pectocarya and Harpagonella was undertaken to provide the following: new information on morphology, distribution, and cytogenetics; a reinterpretation of all available data in light of current biosystematic and evolutionary theory; a more useful classification of these taxa which more accurately reflects their relationships; and a more reliable means for species identification.

Based on an extensive investigation including field, herbarium, laboratory, and cultivation procedures, the following new information, taxonomic changes, and cytological data are reported: the location of type specimens and corrected literature citations; the reduction to synonymy of Harpagonella under Pectocarya; a realignment and redefinition of generic subdivisions within Pectocarya; a realignment of the component species within the genus, including two previously undescribed species and two new combinations; and the first chromosome counts for nine species with confirmatory counts for three other species.

A brief summary of the results of this study is given

below. I recognize 15 species comprising Pectocarya, and arrange them in 3 sections as follows:

Section Harpagonella		
P. palmeri	n=12	N. America
Section Gruvelia		
P. pusilla	n=12	N. & S. America
P. setosa	n=12	N. America
Section Pectocarya		
P. heterocarpa	n=12	N. America
P. peninsularis	n=12	N. America
P. dimorpha	n=12	S. America
P. anisocarpa	n=24	N. America
P. penicillata	n=12	N. America
P. recurvata	n=12	N. America
P. ferocula	n=24	N. & S. America
P. platycarpa	n=24	N. America
P. linearis	n=36	S. America
P. lateriflora	ND	S. America
P. anomala	ND	S. America
P. brachycera	ND	S. America

TAXONOMIC POSITION AND INTERGENERIC RELATIONSHIPS

Pectocarya, first described by de Candolle (1846) as a segregate from Cynoglossum, has historically been placed in the subfamily Boraginoideae and the tribe Cynoglosseae (Gürke, 1893; Dalla Torre and Harms, 1900-1907; Johnston, 1924) by virtue of its gynobasic style and apical or adradicular nutlet attachment.

The monotypic Harpagonella has been considered to be the nearest relative of Pectocarya (Gray, 1876; Johnston, 1924). It was initially placed in a separate tribe, the Harpagonelleae (Gürke, 1893; Johnston, 1924), on the basis of its unusual calyx structure, two nutlets, and presumed basal or abradicular nutlet attachment. A re-examination of Harpagonella revealed the nutlet attachment to be apical, justifying a tribal transfer to the Cynoglosseae and placement next to Pectocarya (Johnston, 1924). In the present paper, the relationship between Harpagonella and Pectocarya is reconsidered.

Affinities of Pectocarya to the genera Cynoglossum and Omphalodes have been alluded to; however, a discussion of their probable intergeneric relationships has not been published to date.

Table 1 summarizes the major characters of the taxa

Table 1. Intergeneric comparison of selected features.

Feature	Pectocarya		Cynoglossum	Omphalodes
	Sect. Harpagonella	Sect. Gruvelia Sect. Pectocarya		
Duration	annual	annual	perennial, biennial (to annual)	perennial (to annual)
Inflorescence	false bracteate	false bracteate	naked	naked (to sub-naked)
Flower shape	funnelform	funnelform	funnelform to salverform	campanulate to rotate
Flower size	small	small	large	large
Flower color	white	white	purple, blue (to white)	blue to white
Number mature nutlets	(1-) 2	(0-) 4	(1-) 4	4
Nutlet attachment	apical	apical	apical to apical-medial	entire ventral surface
Nutlet arrangement	geminate (unilateral)	geminate to equally divergent	equally divergent	equally divergent
Nutlet size (mm)	1 - 4	1 - 4 (-5)	(2-) 3 - 8 (- 12)	(2-) 3 - 6 (-9)

Table 1. Intergeneric comparison of selected features (continued).

Feature	Pectocarya		Cynoglossum	Omphalodes
	Sect. Harpagonella	Sect. Gruvelia Sect. Pectocarya		
Nutlet margin	narrow rim or absent	narrow rim (to absent), wing, or horn	narrow rim or absent	wing
Fruit vestiture	uncinate bristles and subuncinate to strigose hairs	uncinate bristles and hairs	glochidate appendages	hirsute (to uncinate) hairs
Basal leaves	sessile	sessile	petiolate	petiolate (to sessile)
Chromosome number	n = 12	n = 12, 24, 36	n = 12, 24	n = 12, 14 2n = 22, 30, 42
General distribution	N. America	N. and S. America	N. and S. America, Eurasia, Africa, and Australia	Eurasia and Mexico
Number of species	1	14	80 - 90	24

Harpagonella, Pectocarya, Cynoglossum, and Omphalodes.

Harpagonella and Pectocarya form a distinct and coherent unit, both taxa more similar to each other than to either of the other genera. They are virtually identical vegetatively, both small, strictly annual plants. In contrast, Cynoglossum and Omphalodes are larger and commonly biennial or perennial in duration. Harpagonella and Pectocarya also share several reproductive features particularly nutlet attachment, nutlet arrangement, and fruit vestiture. As the culmination of a trend from basal through apical nutlet attachment which is evident in the Boraginoideae (Johnston, 1924), Harpagonella and Pectocarya exhibit strictly apical nutlet attachment. In Cynoglossum the nutlets are apical to apical-medial in attachment, and in Omphalodes the nutlets are affixed along their entire ventral surface. Nutlet arrangement in the Cynoglosseae is commonly radially symmetrical with the nutlets equally divergent; however, Harpagonella and Pectocarya, with the exception of P. pusilla, possess unilaterally or bilaterally geminate nutlets. Well developed uncinate bristles are characteristic of the fruits of Harpagonella and Pectocarya, and occur either on the calyx or the nutlets or both. Cynoglossum and Omphalodes lack these bristles, and only approach them in either the short uncinate prickles investing the nutlet appendages of Cynoglossum, or in the short uncinate hairs occurring on the margins of some

species of Omphalodes, such as O. linifolium and O. kusinkyanae (Brand, 1921).

The close affinities of Harpagonella and Pectocarya have been demonstrated by discussion and tabulation of their similarities in both vegetative and reproductive characters. Since major differences between these two taxa, for example differences in calyx and nutlet features, are no greater than differences within Pectocarya, it is my inescapable conclusion that Harpagonella and Pectocarya are congeneric. In the present paper, I have placed Harpagonella in synonymy with Pectocarya, and have assigned it sectional status within the genus. The remainder of my discussions will refer to the taxon Harpagonella palmeri A. Gray under the new combination, Pectocarya palmeri (A. Gray) Veno.

Although Pectocarya shares certain features with both Cynoglossum and Omphalodes, it does not appear to be extremely closely related to either genus. However, based on similarities in nutlet attachment, patterns in chromosome number, and sympatry in western North and South America, it seems reasonable that, of the extant members of the Cynoglosseae, Pectocarya and Cynoglossum are the most closely related. The presence of a well developed margin on the nutlets of Omphalodes does not necessarily signify A close relationship with Pectocarya since the occurrence of this character may be variable or sporadic both

intergenerically and intragenerically.

COMPARATIVE MORPHOLOGY

Based on extensive herbarium and field observations, the following assessment of variation in the major morphological characters of Pectocarya is presented.

Habit and Branching Pattern

Pectocarya exhibits a variety of habits: prostrate, decumbent, ascending, or erect. One or more forms may be characteristic of a given species; however, the habit feature is consistent and diagnostic for some species.

The majority of the species of Pectocarya are basally branched; however, P. pusilla, P. setosa and P. palmeri are often basally simple and either unbranched or branched above.

Leaves

Foliage leaves show little interspecific variation in size, and only subtle changes in shape. In all species leaf size decreases acropetally, the leaves becoming bracteate in the inflorescence.

Cotyledonary leaves are usually more or less linear, and resemble foliage leaves except in P. setosa which possesses orbicular to suborbicular cotyledons.

Leaf arrangement follows a basic pattern as follows:

basal leaves opposite, decussate, and connate at their bases; cauline leaves alternate. The relative development of this pattern is diagnostic. In most species only the cotyledons and basalmost pair of foliage leaves are opposite. In P. pusilla, P. setosa, and to a lesser degree in P. palmeri both basal and basal-cauline leaves are opposite, and only the upper cauline leaves, i.e. those of the inflorescence, are alternate.

Calyx

Symmetry, investiture, and relative length of the five lobed calyx are among the most important taxonomic characters in Pectocarya.

Calyces are either radially symmetrical and regular with subequal lobes or bilaterally symmetrical, the two upper lobes longest and equal or subequal in length, the three lower lobes shorter and usually subequal in length. The most extreme modifications in calyx structure occur in P. heterocarpa and P. palmeri. In P. heterocarpa two of the lower three calyx lobes are distinctly reduced and laterally displaced due to partial fusion of the fruiting pedicel to the lower adaxial nutlet. The upper two calyx lobes of P. palmeri are basal-medially fused, indurate, somewhat galeate at maturity and partially enclosing a nutlet, and appendaged with 5 to 10 uncinately prickled horns.

Calyx investiture within Pectocarya is various; cinereous-strigose in the majority of the species, setose to hispidulous in P. setosa, uncinate bristled on the lobe apices of P. pusilla and P. palmeri, and uncinate prickled on the horns of P. palmeri.

The relative length of the calyx lobes to that of the nutlets offers a taxonomically useful distinction in some species groups according to the following scheme: calyx greatly exceeding the nutlets (P. palmeri, P. pusilla, and P. setosa); calyx slightly exceeding or equal to the nutlets (P. anomala, P. brachycera, P. dimorpha, P. lateriflora, and P. linearis); calyx shorter than (- equal to) the nutlets (all remaining species).

Flowers

Basic floral morphology is relatively uniform in Pectocarya, and seemingly constructed to facilitate autogamy. Corollas are very short, 0.5-3.0 mm long, white and funnelform with imbricate lobes. Yellow scales partially occlude the corolla throat, and conceal the epipetalous stamens within the corolla tube. The anthers are pendulous over the obscurely emarginate stigma which terminates a style that bearly exceeds the ovary. In the majority of the species all four lobes of the ovary are equal in size; however, P. palmeri possesses two large and two small lobes, with the smaller early abortive.

Basal cleistogamous flowers and cauline chasmogamous flowers occur in P. dimorpha, P. heterocarpa, and P. peninsularis. In all other species only chasmogamous flowers are produced.

Gynobase

Pectocarya pusilla exhibits a narrow, distinctly pyramidal (conical-pyramidal) gynobase. All remaining species possess flat, broad, centrally elevated (broad-pyramidal) gynobases.

Fruits

Fruit characters in the Boraginoideae exhibit a marked trend toward increased ornamentation and variability which culminates in the Cynoglosseae, specifically in Pectocarya. Among the most taxonomically useful fruit features are: fruit form and symmetry; nutlet number, shape and size, margin, and vestiture.

Fruit Form. Three species; namely, P. dimorpha, P. heterocarpa, and P. peninsularis, exhibit fruit dimorphism which is the consistent occurrence of two dissimilar fruit forms on one plant. Basal fruits, derived from cleistogamous flowers, are variable per species, but are generally characterized by greatly reduced or absent margins and some deflexion of all four nutlets. Cauline fruits, derived from chasmogamous flowers, are well developed, usually planar (biplanar in

P. heterocarpa), and exhibit the major distinguishing margin characters of the respective species.

The remaining species of Pectocarya are monomorphic, and produce per plant only one fruit form, i.e. well developed cauline fruits.

Fruit Symmetry and Nutlet Arrangement. Radial symmetry with the nutlets equally divergent is unique to P. pusilla. Bilateral symmetry with the nutlets geminate is characteristic of all other species of Pectocarya.

Nutlet Form. Heteromorphism, i.e. dissimilar nutlets in one fruit, is common throughout the genus; however, the relative degree and consistency of this phenomenon can be of diagnostic value. Pectocarya anisocarpa, P. dimorpha, P. heterocarpa, and P. peninsularis are distinctly heteromorphic with the margins of one or both adaxial nutlets greatly reduced or absent. The lower adaxial nutlets in the fruits of P. lateriflora and P. platycarpa exhibit a general reduction in size and margin width plus an increased density of pubescence.

Homomorphism, i.e. margin width per fruit variable but with only slight or no reduction, is characteristic of the remaining species.

Nutlet Number. All species of Pectocarya, with the exception of P. palmeri, regularly mature four nutlets per fruit, although the number may be zero to three by abortion. In P. palmeri only two nutlets regularly develop, the other

two are early abortive, and are obliterated during fruit maturation.

Nutlet Shape and Size. The most frequently occurring nutlet shape in Pectocarya is oblanceolate with qualification. Nutlets range from linear through linear-oblanceolate, oblanceolate, obovate, broadly obovate, and broadly or obliquely obtrullate.

The extensive variability in nutlet size negates its reliability as a character for specific delimitations; however, general trends in size are useful for characterizing certain taxa.

Nutlet Margins. Nutlet margin characters have been historically and extensively used in delimitation of taxa, both at the sectional and specific levels, within Pectocarya. While it is true that margin features are distinctive in some species, they are more variable than has been indicated in earlier literature; consequently, they are not always effective criteria for identifying closely related species.

Nutlet margins are commonly absent or reduced to a narrow, more or less entire rim in P. palmeri and in P. pusilla. A similar type of margin reduction is evident in one or more nutlets of the basal fruits and/or in the adaxial nutlets of the cauline fruits of the following species: P. anisocarpa, P. dimorpha, P. heterocarpa, and P. peninsularis. It is interesting that margin reduction

is often associated either with a shift of dispersal capabilities to the calyx via an increase in calyx ornamentation, e.g. in P. palmeri and P. pusilla, or with a reduction in dispersal necessity via early soil coverage, or planting in situ, of the clustered basal fruits of the dimorphic species.

Wing margins occur in the majority of the species of Pectocarya, and range from subentire through dentate to lacerate.

Pectocarya anomala and P. brachycera are unique in possessing modified marginal appendages, that is medial and/or lateral subulate, subterete horns.

Nutlet Vestiture. Uncinate bristles occur on the calyces or fruits of all species of Pectocarya, and are diagnostic for the genus. These bristles occasionally occur on the dorsal or ventral nutlet surface, but most commonly terminate margin teeth or nutlet appendages.

Short uncinate hairs occur on the nutlet body and margin of most species, but are replaced in P. palmeri and, to some extent, in P. pusilla with subuncinate to strigose hairs. This reduction of uncinate hairs in the latter two species correlates with margin reduction, and the transfer of dispersal capabilities to the calyx.

CYTOLOGY

Prior to the present study, Pectocarya was relatively unknown cytologically with only four published chromosome counts for 3 of the 15 species (Di Fulvio, 1965; Raven, Kyhos, and Hill, 1965). As the result of an extensive cytological investigation of the genus throughout its range, the first chromosome number determinations for nine species, together with confirmatory counts for the three previously examined taxa, are presented (Table 2). Cytological data for three South American species, P. anomala, P. brachycera, and P. lateriflora, remain unavailable. Numerous attempts to cultivate these plants have been unsuccessful.

Chromosome numbers in Pectocarya exhibit a polyploid series with haploid numbers of n=12, 24, or 36. Based on comparative morphology and the lack of meiotic abnormalities, it seems most probable that the higher ploidy levels are of allopolyploid origin.

Chromosome number determinations were obtained from diakinesis configurations of microsporocytes. Cytological material was collected in the field, or grown in the experimental garden of the University of California at Los Angeles (UCLA) from seed, either collected in the

Table 2. Chromosome numbers in *Pectocarya*.

P. palmeri (A. Gray) Veno

n=12 Arizona. Graham County. Swift Trail at entrance to Coronado National Forest, Pinaleno, *Pinkava et al.* 12874b(ASU), progeny, experimental garden, University of California, Los Angeles (UCLA), *Veno* 470.

n=12 Arizona. Maricopa County. McDowell Mt. Regional Park, *Lane* 1067(ASU), progeny, UCLA, *Veno* 463.

n=12 Arizona. Pima County. Roadside of Highway 86 between Tucson and Sells, 45 mi. sw of Tucson, *Veno* 290.

n=12 California. San Diego County. 1.7 mi. sw of Highway 94 on Maroon Valley Road, 2.5 mi. se of Delzura, *Veno* 305.

n=12 Mexico. Baja California Norte. Ridge 3 mi. w of Cerro San Miguel, *Moran* 20904(ASU), progeny, UCLA, *Veno* 467.

P. pusilla (Alph. DC) A. Gray

n=12 California. San Benito County. Highway J1, vicinity of Panoche Pass, 12 mi. nw of Panoche, *Veno* 361.

n=12 California. Santa Clara County. Frank Raines Regional Park, 17 mi. sw of Patterson exit off Interstate 5, *Veno* 480.

n=12 California. Tulare County. 11.2 mi. sw of Balch Park on road to Balch Park, *Veno* 478.

P. setosa A. Gray

n=12 California. Kern County. Roadside Highway 14, 1 mi. n of Red Rock Canyon, *Veno* 172.

n=12 California. Los Angeles County. Unpaved road off Sierra Highway, 4 mi. nw of Palmdale, *Veno* 475.

n=12 California. San Bernardino County. 3.5 mi. n of Highway 62 on road to Pioneer Town, *Veno* 321.

Table 2. Chromosome numbers in Pectocarya (continued).

P. setosa A. Gray (continued)

n=12 Mexico. Baja California Norte. Llano Colorado, Moran 20972(ASU), progeny, UCLA, Veno 473.

P. penicillata (Hook. & Arn.) Alph. DC

n=12 California. Los Angeles County. Unpaved road off Sierra Highway, 4 mi. nw of Palmdale, Veno 354.

n=12 Californis. Madera County. Foothill woodland, 7.6 mi. s of Coarsegold, Raven 18751(CAS-DS!), Aliso 6: 107, 1965.

n=12 California. San Bernardino County. San Bernardino, DiFulvio & Mosed 6311(CORD), Kurtziana 2: 132, 1965.

n=12 California. San Bernardino County. Unpaved road, 0.3 mi. e of Highway 62, 5-6 mi. s of Yucca Valley, Veno 132.

n=12 California. San Bernardino County. Cajon Pass, Cleghorn Road e of Interstate 91, 1 mi. s of Silverlake exit, Veno 178.

n=12 California. San Bernardino County. 1 mi. n of Etiwanda on Day Canyon Road, 0.25 mi. w of Etiwanda Boulevard, Veno 225.

n=12 California. San Bernardino County. Roadside, Etiwanda Boulevard, 0.75 mi. n of Etiwanda, Veno 388.

n=12 Mexico. Baja California Norte. Roadside 1.5-2.0 mi. s of Colonia Guerrero along Highway 1, Veno 213.

P. anisocarpa Veno

n=24 Arizona. Yavapai County. U.S. 93, 1.1 mi. n of Santa Maria River Bridge, Pinkava et al. 11380b (ASU), progeny, UCLA, Veno 485.

Table 2. Chromosome numbers in Pectocarya (continued).

P. anisocarpa Veno (continued)

n=24 California. Kern County. Wash, 300 ft. w of Highway 14, 21.5 mi. ne of Mojave, just s of Red Rock Canyon, Veno 357 (type collection) and Veno 445.

n=24 California. Los Angeles County. Roadside of Highway N2, 1.5 mi. nw of Palmdale, Veno 154.

n=24 California. Riverside County. Roadside, Highway 71, 11 mi. se of Corona, Veno 147.

n=24 California. Riverside County. Roadside, Indian Avenue, 0.5 mi. se of Highway 62, Veno 257.

n=24 California. San Bernardino County. Unpaved road 0.3 mi. se of Highway 62, 5-6 mi. sw of Yucca Valley, Veno 125.

n=24 California. San Bernardino County. Roadside, Highway 62, at Twentynine Palms, Veno 142.

n=24 California. Stanislaus County. 12 mi. w of Patterson on road to Mt. Hamilton, Breedlove 4859 (CAS-DS!), progeny, Raven 18752(CAS-DS!), Aliso 6: 107, 1965, as P. linearis var. ferocula.

P. heterocarpa (I.M. Johnston) I.M. Johnston

n=12 Arizona. Mohave County. Yucca, Alamo Road e of Interstate 40, Veno 299 and Veno 456.

n=12 Arizona. Mohave County. Roadside, Highway 68, 4-5 mi. w of Kingman, Veno 399.

n=12 Arizona. Yuma County. 12 mi. n of Highway 10 on Highway 95, 26 mi. s of Parker, Veno 286.

n=12 California. San Bernardino County. 0.25 mi. se of Highway 40 on Kelbaker Road, 8-10 mi. s of Essex, Veno 179 and Veno 233.

n=12 Texas. El Paso County. E slope of the Franklin Mts., on bajada at junction of Transmountain Road and Gateway South, Spellenberg 4610 (LA), progeny, UCLA, Veno 457.

Table 2. Chromosome numbers in Pectocarya (continued).

P. heterocarpa (I.M. Johnston) I.M. Johnston (continued)

n=12 Mexico. Sonora. 1 mi. n of Santa Ana, Almeda 2548(LA), progeny, UCLA, Veno 462.

P. peninsularis I.M. Johnston

n=12 California. Riverside County. Roadside, Indian Avenue, 0.5 mi. e of Highway 62, Veno 435.

n=12 Mexico. Baja California Norte. Roadside, 1.5-2.0 mi. s of Colonia Guerrero along Highway 1, Veno 209.

n=12 Mexico. Baja California Norte. 4.5 mi. e of village of Rosario, along s side of main channel, Wiggins 20,935(CAS-DS), progeny, UCLA, Veno 447.

P. dimorpha (I.M. Johnston) I. M. Johnston

n=12 Chile. Province Coquimbo. a La Serena, km. 4, Marticorena, Rodriquez, & Weldt 1545 (CONC), progeny, UCLA, Veno 447.

P. recurvata I.M. Johnston

n=12 Arizona. Mojave County. Yucca, Alamo Road e of Interstate 40, Veno 401 and Veno 466.

n=12 Arizona. Pima County. Roadside, Tucson Estates Road, 0.5 mi. n of Highway 86, 8 mi. sw of Tucson, Veno 296.

n=12 California. Kern County. Wash, 300 ft. w of Highway 14, 21.5 mi. ne of Mojave, just s of Red Rock Canyon, Veno 450.

n=12 California. Riverside County. Roadside of Indian Avenue, 0.5 mi. e of Highway 62, Veno 254.

n=12 California. San Diego County. Borrego Springs, DiFulvio & Molsed 6311(CORD), Kurtziana 2: 132, 1965.

Table 2. Chromosome numbers in Pectocarya (continued).

P. ferocula (I.M. Johnston) Veno

n=24 California. Kern County. Wash 300 ft. w of Highway 14, 21.5 mi. ne of Mojave, just s of Red Rock Canyon, Veno 455.

n=24 California. Riverside County. Roadside of Indian Avenue, 0.5 mi. e of Highway 62, Veno 440.

n=24 California. San Bernardino County. Unpaved road, 0.3 mi. se of Highway 62, 5-6 mi. sw of Yucca Valley, Veno 130.

n=24 California. San Bernardino County. Cajon Pass, Cleghorn Road, e of Interstate 91, 1 mi. s of Silverlake exit, Veno 176.

n=24 California. San Bernardino County. 1 mi. n of Etiwanda on Day Canyon Road, 0.25 mi. w of Etiwanda Boulevard, Veno 224.

n=24 California. San Diego County. 1.7 mi. sw of Highway 94 on Maroon Valley Road, 2.5 mi. se of Delzura, Veno 238.

n=24 Mexico. Baja California Norte. Roadside, 17 mi. s of Santo Thomas, Veno 404.

n=24 Chile. Province Valparaiso. In Quilpue', Zöllner 9410(MO), progeny, UCLA, Veno 484.

P. platycarpa (Munz & Johnst.) Munz & Johnst.

n=24 Arizona. Mohave County. Roadside, Highway 68, 4-5 mi. w of Kingman, Veno 400.

n=24 Arizona. Mohave County. 5 mi. s of Utah border along Highway 15, Higgins 6643(NY), progeny, UCLA, Veno 468.

n=24 Arizona. Mohave County. Yucca, Alamo Road e of Interstate 40, Veno 472.

n=24 Arizona. Yuma County. 12 mi. n of Highway 10 on Highway 95, 26 mi. s of Parker, Veno 287.

Table 2. Chromosome numbers in Pectocarya (continued).

P. platycarpa (Munz & Johnst.) Munz & Johnst. (continued)

n=24 California. Kern County. Wash, 300 ft. w of Highway 14, 21.5 mi. ne of Mojave, just s of Red Rock Canyon, Veno 352.

n=24 California. Riverside County. Roadside, Indian Avenue, 0.5 mi. e of Highway 62, Veno 439.

n=24 California. San Bernardino County. 0.25 mi. se of Highway 40 on Kelbaker Road, 8-10 mi. s of Essex, Veno 237.

n=24 New Mexico. Hidalgo County. 500 mi. n of US 80, low pass through Peloncillo Mts., Spellenberg 3037(NMC), progeny, UCLA, Veno 461.

n=24 Texas. El Paso County. Ne of El Paso, e slope of Franklin Mts., on bajada at junction of Transmountain Road and Gateway South, Spellenberg 4611 (LA).

P. linearis (Ruiz & Pav.) DC

n=36 Chile. Province Coquimbo. Parque Nacional Fray Jorge, margenes del bosque, Marticorena, Matthei, & Rodriguez 473, progeny, UCLA, Veno 483.

field or removed from herbarium specimens. Entire inflorescences were fixed in a 3:1 solution of absolute ethanol and glacial acetic acid for 24 to 48 hours, rehydrated to 70 per cent ethanol, and stored under refrigeration. The third or fourth discernible bud from the apical meristem was dissected from the inflorescence, and subjected to the following procedures: the calyx and as much corolla as possible were removed (Because of the extremely small bud size, whole anthers and some petal tissue were often necessarily contained in the preparation.); because of a tendency for pollen mother cells to agglutinate, the tissue was hydrolyzed on the slide in a 1:1 solution of 95 per cent ethanol and 1N hydrochloric acid for approximately 15 to 30 seconds; the acid solution was then carefully drawn off, the tissue squashed in acetocarmine plus iron stain, and viewed under a phase contrast microscope.

Voucher specimens for the chromosome numbers listed in Table 2 have been deposited in the herbarium of the California Academy of Sciences (CAS) and/or that of the United States National Herbarium (US).

All chromosome counts were repeated to insure accuracy. For each species, multiple populations were sampled, and their locations plotted on the distribution maps for each respective taxon.

Cytological information has proven very useful in ascertaining species limits and relationships within

Pectocarya. The tetraploid character of P. anisocarpa, together with its morphological intermediacy, has clearly delimited this species from its diploid relatives, P. penicillata and P. heterocarpa. The P. recurvata complex presents a more complicated situation with the occurrence of diploid, tetraploid, and hexaploid taxa. The species in this complex, P. recurvata, P. ferocula, P. platycarpa, and P. linearis, show varying degrees of morphological and distributional overlap; consequently, they have been variously synonomized by different monographers (Johnston, 1924-1939; Cronquist, 1959). Chromosome number determinations have shown that the similar and sometimes seemingly minor morphological differences between these taxa are significant. These plants are not merely variants or biotypes of one species, but represent separate genetic entities. Therefore, in the present paper, each taxon has been attributed specific status.

Only limited intergeneric comparisons within the Cynoglosseae can be made at this time. Cytological data are available for some genera; however, other taxa are virtually or completely unknown. The basic chromosome number in Pectocarya, and seemingly in the Cynoglosseae, is x=12. The published counts for other members of the tribe are as follows: Caccinia, n=12 and 2n=24; Cynoglossum, n=12,24 and 2n=24,48; Omphalodes, n=12,14 and

2n=22,28,30,42; and Paracaryum, n=12 and 2n=22 (Britton, 1951; Moore ed., 1973, 1975, 1977).

A review of the chromosome numbers in the tribes of the Boraginoideae, from the primitive Lithospermeae to the derived Cynoglosseae, does not readily reveal a trend from lower to higher ploidy levels; but does reveal the frequent occurrence of aneuploid series in each group which reach a minimum chromosome number of n=4 in Arnebia, Lithospermeae, and Amsinckia, Eritricheae (Ray and Chisaki, 1957; Raven, 1975). This pattern is not inconsistent with the projection by Raven (1975) that the basic original chromosome number for the Boraginaceae is x=12, with very frequent aneuploid reductions. Other estimates of the basic number for the family, based on limited correlations of chromosome number with presumed primitiveness, are x=8 (Britton, 1951) and x=7 (Ray and Chisaki, 1957).

INTRAGENERIC RELATIONSHIPS

Sectional Classification

Generic subdivisions within Pectocarya have previously been based on nutlet margin characters and nutlet arrangement. Using these features, Gray (1878) established two subdivisions which he designated § 1. Ktenospermum (margins undulate, toothed or laciniate; nutlets geminate) and § 2. Gruvelia (margins entire; nutlets equally divergent). This notational sequence, i.e. §-numeral-latin substantive, refers to subdivisions of the highest order or subgenera (Gray, 1878; Brizicky, 1969). Johnston (1924) basically agreed with the earlier character delimitations; however, he revised the subdivisional names to § Eupectocarya and § Gruvelia without clear indication of their taxonomic rank, either subgenera or sections.

A re-examination of character variation in Pectocarya has shown that other features, principally calyx characters, are more reliable and consistent diagnostic criteria than are margin characters in assigning subdivisional limits. Consequently, a realignment and redefinition of subdivisions within Pectocarya have been undertaken. In the current paper, three sections are recognized within the genus including Section Harpagonella which represents

a transfer from generic to sectional status. The characters of each section and a discussion of the interspecific relationships of their component taxa are presented below.

Section Harpagonella

The distinguishing features of Section Harpagonella are as follows: calyx appendaged with 5 to 10 subterete horns which are armed with subretrorse uncinate prickles; upper two calyx lobes elongate, basal-medially fused, indurate, and galeate; mature nutlets two.

This monotypic section is represented by Pectocarya palmeri which has long been regarded as a very distinct taxon. In attributing generic status to this entity, earlier monographers have placed greater emphasis on its particular anomalies, i.e. calyx characters and nutlet number, and thus its differences from, rather than its similarities to other closely related taxa.

As noted previously, the unusual calyx structure and less ornate nutlets of P. palmeri represent a transfer of dispersal mechanism from the nutlets to the calyx. This trend, though reaching its most extensive development in P. palmeri, is not unique in the genus since an intermediate, or less well developed, condition exists in P. pusilla.

Although P. palmeri regularly matures only two nutlets, it is not incongruous within Pectocarya since other species which regularly mature four nutlets may produce one to four nutlets by abortion. Genera composed of

species differing in nutlet number are not unprecedented in the Boraginaceae; Cynoglossum pringlei frequently matures only one nutlet (Johnston, 1924), and at least eight of the approximately 65 species of Cryptantha normally produce only one or two nutlets (Johnston, 1925).

Table 3 compares major morphological characters in selected species of Pectocarya. Pectocarya palmeri is a natural addition to the genus, sharing several major features and a comparable degree of divergence from the generalized plan, exemplified by P. recurvata, with other species, particularly P. pusilla and P. heterocarpa.

Johnston (1924) expresses the opinion that P. palmeri is the most highly evolved member of the Cynoglosseae. He also cites a series of morphological trends which are transitional from the more primitive to the more advanced tribes of the Boraginoideae, and culminate in the Cynoglosseae. Pertinent to this discussion are the trends from smooth to roughened, margined, or appendaged nutlets; from basal to apical nutlet attachment; and from variable to uniform corollas. It is consistent with these trends that Pectocarya be considered the most highly evolved genus of the Cynoglosseae. However, it is reasonable to consider the very ornate, laterally and medially appendaged nutlets of P. anomala, rather than the very narrowly margined and relatively smooth nutlets of P. palmeri, as the culmination of the central evolutionary trend in the

Table 3. Comparative features of selected species of *Pectocarya*.

Feature	Sect. Pectocarya			Sect. Harpagonella	Sect. Gruvelia
	anomala	*recurvata*	*heterocarpa*	*palmeri*	*pusilla*
Calyx symmetry	bilateral, regular	bilateral, regular	bilateral, obliquely distorted	bilateral, longitudinally distorted	radial, regular
Calyx ornamentation	setulose bristles	setulose bristles	setulose bristles	horns, uncinate bristles	uncinate bristles
Fruit form	monomorphic	monomorphic	dimorphic	monomorphic	monomorphic
Number mature nutlets	(0-) 4	(0-) 4	(0-) 4	(1-) 2	(0-) 4
Nutlet form	homomorphic	homomorphic	heteromorphic	heteromorphic	homomorphic
Nutlet arrangement	geminate	geminate	geminate	geminate, unilateral	equally divergent
Nutlet margin	subulate horns	divided dentate	subentire to cleft dentate	entire	entire
Nutlet vestiture	uncinate	uncinate	uncinate	strigose to subuncinate	uncinate and subuncinate
Gynobase	broad pyramidal	broad pyramidal	broad pyramidal	broad pyramidal	conical pyramidal

genus, the tribe, and perhaps even the family. Pectocarya palmeri is more appropriately considered as a highly derived offshoot from the major evolutionary pathways in the genus.

Johnston's (1924) assessment of a close relationship between P. palmeri and P. heterocarpa seems justified by their common exhibition of elongate, heteromorphic nutlets; broad flat gynobase; distorted calyx; and overlapping distributional ranges. The uncinately pubescent calyx P. palmeri shares with P. pusilla may be the result of convergence between two different evolutionary branches within the genus.

Section Gruvelia

Section Gruvelia is characterized by the following features: calyx unappendaged, radially symmetrical with the lobes equally divergent and subequal in length; mature nutlets four; basal and basal-cauline leaves opposite, decussate, and connate at the base; upper cauline leaves alternate; nutlet margins spreading, usually entire or subentire, i.e. sinuate or lobed or rarely cleft.

Pectocarya pusilla and P. setosa, comprising Section Gruvelia, are two of the most distinctive and easily recognizable species of the genus. P. pusilla is unique by virtue of its radially symmetrical fruits with equally divergent nutlets, and its elevated or conical-pyramidal gynobase. Both of these characters occur in other genera

of the Cynoglosseae, and may indicate that P. pusilla is somewhat transitional between Cynoglossum, for example, and the remaining species of Pectocarya. Pectocarya setosa shares calyx and foliage features with P. pusilla; however, it is distinctive in exhibiting somewhat hispid or setose pubescence and geminate nutlets with broad, spreading, biwinged margins.

Pectocarya pusilla is reportedly amphitropical in distribution. Although the type specimen of this species was collected at Valparaiso, Chile, the South American element is represented by only seven collections from the early 1830's; and was probably only a transient introduction, perhaps resulting from shipping traffic between the western coasts of North and South America. Pectocarya pusilla is primarily North American in distribution, an inhabitant of the coastal northwestern United States; and is replaced by P. setosa in the deserts of the southwestern United States and Mexico. Where the geographical distributions of these two species do overlap, an ecological isolation exists whereby P. pusilla is restricted to moister habitats, and P. setosa is limited to drier sites.

Section Pectocarya

The following characters distinguish Section Pectocarya: calyx unappendaged, bilaterally symmetrical with the upper two lobes longest and subequal in length, lower

three lobes shorter and either subequal in length or irregularly reduced and laterally displaced; mature nutlets four; only cotyledons and basalmost pairs of leaves opposite, remaining cauline leaves alternate; nutlet margins involute, erect, ascending, or spreading and either subentire, dentate, or lacerate.

This largest and most variable section of Pectocarya consists of 12 species, and is most conveniently discussed as three species associations: the P. penicillata group, the P. recurvata group, and the P. lateriflora group.

The Pectocarya penicillata Group (Table 4). Five species similar in nutlet shape and form, margin dissection, and margin vestiture comprise the P. penicillata group.

Pectocarya penicillata bears the most common and generalized characters of the genus; for example, prostrate habit, monomorphic fruits, and homomorphic nutlets which are planar and oblong with erect margins. It appears to be the most primitive of the extant species of Pectocarya, and is interpreted to have contributed to the allopolyploid origin of at least two other species.

Pectocarya dimorpha, P. heterocarpa, and P. peninsularis are the only dimorphic species in the genus; and are variations on a common theme, differing in margin characters and calyx structure. A general trend from margined to nonmargined nutlets, planar to biplanar

Table 4. Comparative features of the *Pectocarya penicillata* group.

Feature	Species				
	penicillata	*anisocarpa*	*heterocarpa*	*peninsularis*	*dimorpha*
Habit	prostrate	prostrate	prostrate to ascending	prostrate	prostrate to erect
Mean fruiting calyx length (mm)	3.2 ± 0.4	3.3 ± 0.3	3.5 ± 0.3	3.0 ± 0.3	3.7 ± 0.5
Mean fruit length(mm)	4.1 ± 0.3	4.1 ± 0.2	4.0 ± 0.25	3.0 ± 0.2	3.5 ± 0.2
Fruit form	monomorphic	monomorphic	dimorphic	dimorphic	dimorphic
Nutlet form	homomorphic	heteromorphic	heteromorphic	heteromorphic	heteromorphic
Nutlet outline	oblong	oblong	oblong	elliptic to obovate	oblong to obovate
Margin type	bidentate to lobed	subentire to bidentate	cleft to bidentate	cleft	cleft to parted
Mean abaxial margin width (mm)	0.5 ± 0.1	0.5 ± 0.1	0.6 ± 0.2	0.5 ± 0.1	0.7 ± 0.2
Mean adaxial margin width (mm)	0.4 ± 0.1	0.15 ± 0.1	0.03 ± 0.02	0.06 ± 0.03	0.3 ± 0.1

Table 4. Comparative features of the Pectocarya penicillata group (continued).

Feature	Species				
	penicillata	anisocarpa	heterocarpa	peninsularis	dimorpha
Mean margin reduction(mm)	0.1 ± 0.1	0.4 ± 0.1	0.6 ± 0.1	0.5 ± 0.1	0.4 ± 0.2
Basal nutlets	4 margined, unreduced	4 margined some reduced	2 to 4 unmargined	1 to 3 unmargined	4 margined, reduced
Haploid chromosome number	12	24	12	12	12
General distribution	N. America	N. America	N. America	N. America	S. America

fruits, and regular to distorted calyx occurs from P. dimorpha through P. peninsularis, and culminates in P. heterocarpa. Pectocarya dimorpha is a South American endemic, while P. heterocarpa and P. peninsularis are exclusively North American; and are geographically isolated, P. heterocarpa occurring to the northeast of P. peninsularis. Speculation based on the exclusive nature of the dimorphic fruit form, identical chromosome numbers, and great morphological similarity of taxa endemic to two different continents suggests that these species differentiated as a result of long distance dispersal and subsequent geographical isolation. Pectocarya peninsularis is the most generalized of the three species, and may be the progenitor of the other two.

Pectocarya anisocarpa, a tetraploid, is apparently an allopolyploid derivative of P. heterocarpa and P. penicillata, both diploids. This newly described species has been repeatedly identified as either P. heterocarpa, P. penicillata, or P. peninsularis; however, it is clearly distinct in morphology, distribution, and chromosome number. Pectocarya anisocarpa is morphologically intermediate between its putative parent species. It possesses the heteromorphism of P. heterocarpa, the nutlet planarity and calyx characters of P. penicillata; and expresses margin features transitional between, but occasionally overlapping, both of these species. Although P. anisocarpa

is not distinctly dimorphic, it does exhibit some margin reduction of the basalmost fruits. Based on nutlet shape and margin characters, P. peninsularis is considered to be a less likely contributor to the origin of P. anisocarpa.

The Pectocarya recurvata Group (Table 5). The P. recurvata group consists of a polyploid complex of four very similar and closely related species: Pectocarya recurvata and P. platycarpa, North American endemics; P. linearis, a South American endemic; and P. ferocula, amphitropical in distribution. Overlap in nutlet characters among all four species is often extensive, and as many as three species may occur sympatrically making precise identification difficult. Johnston (1924-1939) recognized three species comprising four taxa. Jones (1895) and Cronquist (1959) recognized one species, P. linearis, and even included P. penicillata as a variety. Each of these authors based their taxonomic decisions primarily on morphological criteria, the variation of which was misunderstood and misinterpreted. An extensive cytological survey of the P. recurvata group has clarified this confusing situation, and necessitated the recognition of four species including one new combination.

Based on all available data, it seems most probable that the North and South American representatives of this species group arose according to the events described below.

Table 5. Comparative features of the *Pectocarya recurvata* group.

Feature	Species			
	recurvata	*ferocula*	*platycarpa*	*linearis*
Habit	erect to ascending	prostrate to decumbent	erect to ascending	prostrate to decumbent
Mean fruiting calyx length (mm)	4.1 ± 0.3	3.7 ± 0.4	5.8 ± 0.5	5.6 ± 0.6
Mean fruit length(mm)	6.5 ± 0.5	5.6 ± 0.5	6.4 ± 0.5	5.5 ± 0.3
Nutlet form	homomorphic	homomorphic to heteromorphic	heteromorphic	heteromorphic (to homomorphic)
Nutlet recurvature	strongly recurved (to coiled)	slightly recurved (to subplanar)	moderately recurved	moderately recurved
Nutlet length / Nutlet width	6 (-5) / 1 (1)	5 (-4) / 1 (1)	4 / 1	4 (-3) / 1 (1)
Nutlet margin dissection	divided dentate	divided (to cleft) dentate	cleft to parted dentate	cleft to divided dentate
Margin teeth: mean length / mean width	2.5	1.4	2.1	2.2

Table 5. Comparative features of the Pectocarya recurvata group (continued).

Feature	Species			
	recurvata	ferocula	platycarpa	linearis
Haploid chromosome number	12	24	24	36
General distribution	N. America	N. and S. America	N. America	S. America

Pectocarya recurvata is a very distinctive species characterized by strongly recurved nutlets with narrow, erect margin teeth. This species and P. penicillata, both diploids, have apparently given rise to an allopolyploid progenitor which has diversified to form the coastal P. ferocula and the interior P. platycarpa, both tetraploids. The combined distributional ranges of these derivative species completely overlap, and may exceed those of the parental types. While remaining distinct from each other, P. ferocula and P. platycarpa both exhibit morphological intermediacy between P. recurvata and P. penicillata.

Pectocarya platycarpa possesses the ascending to erect habit characteristic of P. recurvata, and occasionally produces a subentire nutlet margin resembling that of P. penicillata. It exhibits intermediacy in the moderate recurvature of its nutlets and in its broadly cleft nutlet margins.

Pectocarya ferocula exhibits the prostrate habit and planar or subplanar nutlet attitude of P. penicillata, and occasionally approaches the latter species by producing oblong nutlets with somewhat subentire margins. However, P. ferocula most commonly displays a slight apical recurvature of the nutlets, linear-oblanceolate nutlet shape, and deeply toothed or occasionally cleft nutlet margins which resemble those of P. recurvata.

The relationship between P. ferocula and P. platy-

carpa is less easily discernible. These species have the same chromosome number, may approach each other in fruit morphology, and overlap somewhat in distribution. Despite their similarities, P. ferocula and P. platycarpa do not exhibit clinal variation; but, aided by an autogamous breeding system, maintain their specific integrity. The two species can generally be distinguished by a series of characters which are comparable in magnitude with characters used to differentiate other species in the P. recurvata group. When compared to P. platycarpa, P. ferocula is differentiated by its prostrate habit, less broad and less strongly recurved nutlets, narrower and more deeply pectinate nutlet margins, and its predominantly coastal distribution.

Pectocarya ferocula is also well established in South America; occurring primarily in Argentina and secondarily in Chile in the vicinity of, and somewhat north of, Santiago. This species probably reached the southern continent via long distance dispersal from North America. Easy establishment may have been aided by the weedy nature of P. ferocula, and reinforced by its autogamous breeding system. Dispersal over the Andean Cordillera probably occurred at the lower elevations near Mendoza, Argentina; and, as Johnston (1932) suggests, may have been accomplished by pack trains which were common traffic over the Andean passes.

Pectocarya ferocula is sympatric with P. linearis in northern Chile. Although these plants are often strikingly similar, they differ in chromosome number; and can be distinguished by differences in degree of nutlet recurvature, nutlet heteromorphism, nutlet margin dissection, and general distribution. Consequently, it is untenable to maintain the taxon P. linearis var. ferocula originally established by Johnston (1932). Therefore, a new combination, P. ferocula (I.M. Johnston) Veno, is made in the present paper. Specific recognition of this taxon more accurately reflects its relationships with the other species in the P. recurvata group by taking into account the comparable differences between each of these taxa and their respective genetic complements.

Pectocarya linearis, a hexaploid, is presumed to have arisen as a derivative of P. ferocula, a tetraploid, and P. dimorpha, a diploid. It repeats the pattern of morphological intermediacy between, and some overlap of, the parental forms. Pectocarya linearis approaches P. ferocula by exhibiting a prostrate habit, linear-oblanceolate to oblanceolate nutlet shape, moderate nutlet recurvature, and well dissected margins; but resembles P. dimorpha in possessing generally broader and irregular margin teeth, and exhibiting nutlet heteromorphism. Distributionally, P. linearis occurs to the south of P. dimorpha and to the east of P. ferocula; all three species occurring together

in northern Chile.

In considering polyploid taxa with very similar morphologies and distributions, the question of autoploid origin arises. It seems improbable that this genetic phenomenon was an active process in the P. recurvata group due to the high degree of correlation in morphological features between the polyploid species and their putative parental species.

The Pectocarya lateriflora Group (Table 6). This endemic South American species group is composed of three very distinctive species: P. lateriflora, P. anomala, and P. brachycera.

Pectocarya lateriflora is easily identified by its relatively large, planar, broad obovate or subdeltoid nutlets; and its spreading, lacerately dentate nutlet margins.

The nutlets of P. anomala are deeply rugose, recurved, and possess lateral and unique medial subulate appendages.

The newly described P. brachycera exhibits characters common to both of the other species in the group. In gross habit, nutlet recurvature, and lateral subulate nutlet horns, it resembles P. anomala; however, it lacks the dorsal-medial appendages characteristic of the latter species. Pectocarya brachycera often displays the smooth, glabrous dorsal nutlet surface and occasional medial papillae observed in P. lateriflora; but may also possess a rugose nutlet surface which is typical of P. anomala.

Table 6. Comparative features of the Pectocarya lateriflora group.

Feature	Species		
	lateriflora	brachycera	anomala
Mean fruiting calyx length(mm)	7.5 ± 0.8	3.6 ± 0.3	4.0 ± 0.4
Mean fruit length (mm)	4.9 ± 0.4	3.6 ± 0.2	3.8 ± 0.3
Nutlet form	heteromorphic	homomorphic (to heteromorphic)	homomorphic
Nutlet attitude	planar	recurved	recurved
Nutlet shape	obovate to subdeltoid	obovate to oblanceolate	obovate to oblanceolate
Nutlet surface	smooth to rugose	smooth to rugose	rugose
Nutlet ornamentation	wing margin, lacerate	horns, lateral	horns, lateral and medial
Mean nutlet margin width(mm)	1.0 ± 0.2	NA	NA
Mean nutlet horn length(mm)	NA	0.6 ± 0.3	lateral: 0.9 ± 0.4 medial: 0.5 ± 0.2
General distribution	Peru and Chile	Peru, Chile, Bolivia, Argentina	Peru and Chile

In distribution, P. brachycera generally replaces P. lateriflora to the south and P. anomala to the east. All three species are sympatric in southernmost Peru and northernmost Chile.

Without chromosome counts for the species of the P. lateriflora group, one can only speculate concerning interspecific relationships. Based on the occurrence of similar variation patterns in the other species groups discussed and in the present group, it can reasonably be predicted that the morphological intermediacy of P. brachycera reflects its status as a polyploid derivative of P. lateriflora and P. anomala.

TAXONOMY

Pectocarya DC. ex Meisner

Gen. 1: 279, 1840; Gen. 2: 188, 1840. Meisner cites the basis of the name as Cynoglossum lateriflorum Lam., ill. t. 92, f. 2, 1786. This plate clearly establishes the identity of the taxon as Pectocarya lateriflora (Lam.) DC., a distinctive species which exhibits the basic features characteristic of the genus as here circumscribed.

Ktenospermum Lehm., Del. Sem. Hort. Hamb. 17, 1838, nom. nud. Fide de Candolle the page number is 7. I have not seen the original publication; however, de Candolle (1946) cited Ktenospermum in synonymy with Pectocarya with the comment that the earlier name was published without description. Gray (1878) noted that Ktenospermum was published without characters. Subsequent authors (Brand, 1921; Johnston, 1924 and 1927) have cited the name as a nomen nudum.

Gruvelia Alph. DC., Prodr. 10: 119, 1846. Type species: Gruvelia pusilla Alph. DC. l.c. = Pectocarya pusilla (Alph. DC.) A. Gray. This taxon, though unique in nutlet arrangement within Pectocarya, possesses basic features of the genus, and is considered congeneric.

Harpagonella A. Gray, Proc. Am. Acad. Arts 11: 88-89, 1876.

Type species: Harpagonella palmeri A. Gray l.c. = Pectocarya palmeri (A. Gray) Veno comb. nov. The major morphological characters of this taxon are congruous within Pectocarya. The unusual calyx structure of this species represents an extreme morphological variant rather than a distinction worthy of generic recognition.

Late winter to spring annual herbs; branched from the base or basally simple and either unbranched or branched above. Stems slender, cinereous-strigose to setose or hispidulous, and prostrate, decumbent, ascending, or erect. Leaves sessile, narrow, and linear, linear-oblanceolate, or linear-spatulate; acropetally decreasing in size and becoming bracteate in the inflorescence; basalmost leaves or both basal and baso-cauline leaves opposite, decussate, and connate at the base; all cauline or upper cauline leaves alternate. Inflorescence an elongate scorpioid cyme. Flowers minute, chasmogamous or basally cleistogamous; pedicels short, erect; calyces erect, cleft to divided into lanceolate or elliptic-lanceolate lobes, unarmed or appendaged with a tuft of subterete horns, invested with strigose to setose or uncinate trichomes; corollas white, funnelform, equal to or slightly exceeding the calyx, lobes inbricate, throat partially occluded by the intrusion of yellow scales opposite the

corolla lobes; stamens epipetalous; anthers sagittate before dehiscence or elliptical after dehiscence, pendulous over the stigma; style very short, barely exceeding the ovary; stigma emarginate; ovary four lobed, lobes equal or two greatly reduced and regularly abortive. Fruiting pedicels ascending to recurved, free or partially fused to the lower adaxial nutlet. Fruiting calyces accrescent, erect to divaricate, radially symmetric with the lobes equally divergent or bilaterally symmetric with two upper and three lower lobes, regular with subequal lobes or irregular with upper lobes exceeding the lower lobes; upper lobes planar or galeate, often basal-medially fused; lower lobes subequal or irregularly reduced and displaced due to fusion of the pedicel to the lower adaxial nutlet. Fruits monomorphic, i.e. all similar and derived from chasmogamous flowers, or dimorphic, i.e. dissimilar basal and cauline fruits derived from cleistogamous and chasmogamous flowers respectively. Nutlets regularly two or four or occasionally fewer by abortion, apically attached to a broad-pyramidal or conical-pyramidal gynobase, commonly geminate or equally divergent, divaricate or erect, planar or biplanar or recurved; nutlet form homomorphic, i.e. nutlet size and margin width per fruit approximately equal, or heteromorphic, i.e. nutlet size and margin width per fruit unequal with one or both adaxial nutlets and/or nutlet margins obviously reduced;

nutlet shape linear, oblanceolate, narrowly or broadly obovate, or broadly obtrullate to subdeltoid; nutlet surface commonly smooth, but occasionally rugose or medially appendaged, papillate, or keeled; nutlet vestiture uncinate, subuncinate, or strigose; nutlets commonly wing margined with wing well developed or partially reduced, occasionally unmargined, or appendaged with subulate horns; nutlet margin attitude involute, erect, ascending, or spreading; margin form entire, subentire, dentate, or lacerate; margin vestiture uncinate bristles and hairs. (Name from Greek pektos, combed, and karyon, nut, descriptive of the pectinate margins of some nutlets.)

Type species. Pectocarya lateriflora (Lam.) DC. Designated (Meisner, 1840) by reference to the following plate: Lam. ill. t. 92, f. 2, 1786.

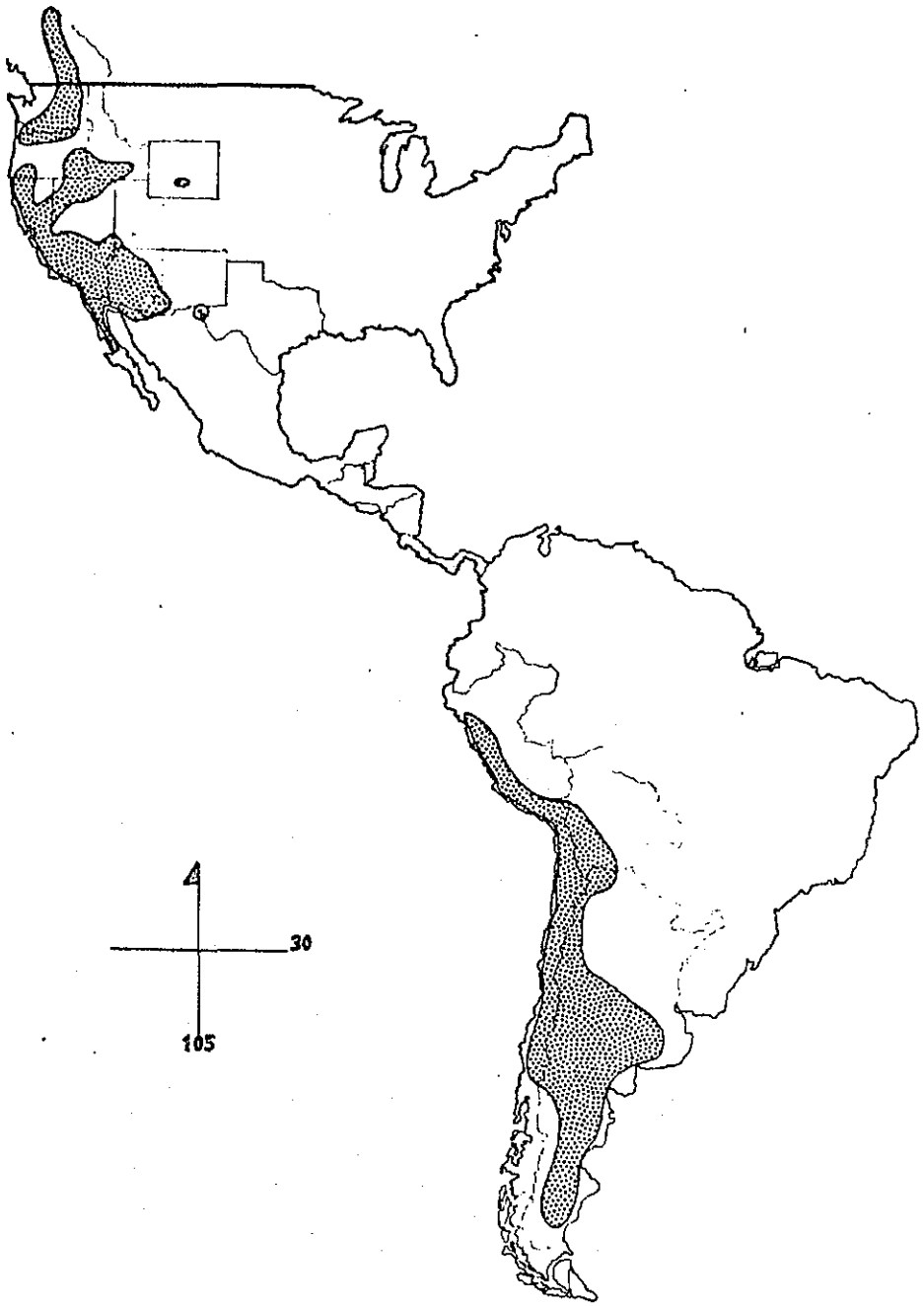
Pectocarya is a genus of 15 species divided into three sections based on differences in calyx structure, leaf arrangement, and margin dissection.

Distribution

The disjunct amphitropical distribution of Pectocarya is illustrated in Figure 1. In North America the genus ranges from British Columbia through Mexico. In South America Pectocarya occurs from Peru through Argentina.

This disjunct distribution pattern evokes consideration of the probable place of origin and the migratory history

Figure 1. Distribution of *Pectocarya*.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of the genus. A brief account, inferred from a correlation of available data on paleogeography with data on Pectocarya, is given below.

Pectocarya, an inhabitant of semi-arid and arid regions, occurs in the major desert areas of North America (Great Basin, Mohave, and Sonoran) and South America (Pacific Coastal Desert, Monte, Patagonia, and Puna). These habitats were created as a result of the rapid expansion of dry climates in the late pliocene and pleistocene due to glaciation events, and the uplifting of the major mountain chains of the western North and South American continents (Axelrod, 1950, 1979; Solbrig, 1976). Because of the unavailability of a suitable habitat for Pectocarya prior to the late pleistocene and the highly derived nature of the genus, it is reasonable to assume a recent origin for Pectocarya.

On the basis of the following trends, it seems most probable that Pectocarya originated in North America, as a derivative of Laurasian stock, and subsequently migrated to South America:

1. The Boraginaceae are of Laurasian descent (Raven and Axelrod, 1974). The Cynoglosseae are predominantly Eurasian in distribution with only two indigenous American genera, Pectocarya and Mimophytum (Johnston, 1924 to 1939).

2. Pectocarya, as circumscribed in the current paper, consists of 10 North American species and 5 South American

species. Two taxa, P. ferocula and P. pusilla are amphitropical. This relative predominance of North American over South American species is also exhibited by other Boraginaceous genera, e.g. Cynoglossum, Cryptantha, and Amsinckia (Johnston, 1924 to 1939; Raven, 1963).

3. Pectocarya anomala, the presumedly most derived species, is a South American endemic.

4. Available chromosome data reveal the highest number from the South American P. linearis.

The actual transport of Pectocarya from North to South American was aided by the very ornate fruits which are extremely well adapted for avian or mammalian dispersal. These fruits are easily and firmly attached on contact, and removed with difficulty, usually with extensive grooming.

Intracontinental disjuncts are also exhibited by many species of Pectocarya. This distribution pattern is attributable to their highly effective dispersal mechanism, the weedy nature of many species, and the autogamous breeding system which may allow establishment of a population from only one or a few seeds.

Key to the Species of Pectocarya

1. Calyx appendaged with 5 to 10 subterete, subulate horns armed with subretrorse uncinate prickles; upper two calyx lobes elongate, indurate, and galeate, par-

tially enclosing a nutlet; mature nutlets two. (Section Harpagonella)..... P. palmeri.

1. Calyx not as above; mature nutlets four..... 2.

2. Calyx radially symmetrical; lobes equally divergent, subequal in length, greatly exceeding the nutlets; basal and basal-cauline leaves opposite, decussate, and connate at the base; upper cauline leaves alternate; nutlet margins a narrow rim or spreading wing, entire or subentire or rarely cleft. (Section Gruvelia) ..... 3.

2. Calyx bilaterally symmetrical; upper lobes two, exceeding the lower three lobes, subequal or the lower lobes irregularly reduced and displaced by fusion of the pedicel to the lower adaxial nutlet, only slightly exceeding or equal to or shorter than the nutlets; only basalmost leaves opposite, remaining cauline leaves alternate; nutlets wing margined or appendaged with subulate horns; margins involute, erect, ascending, or spreading; margin form subentire, dentate, or lacerate. (Section Pectocarya)..... 4.

3. Calyx lobes apically uncinate bristled; nutlets equally divergent, broadly obtrullate to subrhomboidal, homomorphic (rarely heteromorphic); margins

narrow rims (rarely absent), entire; stems slender, strigose..... P. pusilla.

3. Calyx lobes setose-hispid; nutlets geminate, broadly obovate, heteromorphic (rarely all four nutlets unmargined); margins broad wings, entire to subentire (rarely cleft); stems stiff, setose-hispidulous..... P. setosa.

4. Nutlets wing margined..... 5.

4. Nutlets appendaged with subterete, subulate horns..... 14.

5. Fruits dimorphic, dissimilar basal and cauline fruits; nutlets distinctly heteromorphic, opposing pairs of nutlets dissimilar..... 6.

5. Fruits monomorphic, basal and cauline fruits similar; nutlets homomorphic, opposing pairs of nutlets similar, or heteromorphic..... 8.

6. Fruiting pedicel partially fused to the lower adaxial nutlet; calyx obliquely distorted, lower adaxial and medial lobes greatly reduced, and alternately displaced along the pedicel; nutlet pairs usually somewhat biplanar, abaxial nutlets ascendingly curved, adaxial nutlets deflexed and somewhat descendingly curved; nutlet outline oblong to oblanceolate..... ..... P. heterocarpa.

6. Fruiting pedicels free; calyx ± regular, three

lower lobes subequal; nutlets ± planar to slightly deflexed; nutlet outline elliptic to orbicular obovate or oblong to broadly obovate..... 7.

7. Nutlet outline elliptic to orbicular obovate; margins of lower or, most commonly, both adaxial nutlets distinctly reduced to absent, to 0.4 mm wide, entire to subentire; margins of abaxial nutlets well developed, ascending-spreading, cleft (to parted) dentate, 0.25 - 0.75 mm wide; one to four nutlets of basal fruits unmargined, often yellowish; North America..... P. peninsularis.

7. Nutlet outline oblong to broadly obovate; margin of lower or, occasionally, both adaxial nutlets reduced, to 1.0 mm wide, parted to divided dentate with teeth often intermittent; margins of abaxial nutlets well developed, involute to erect to ascending-spreading, irregularly cleft to divided into broad dentate segments, 0.35 - 1.2 mm wide; all nutlets of the basal fruits narrowly margined, parted to divided dentate with teeth occasionally intermittent; South America..... P. dimorpha.

8. Nutlet margins bilobed, bidentate, subentire, or shallowly dentate; nutlet outline oblong, oblanceolate, or obscurely panduriform... 9.

8. Nutlet margins pectinate-dentate or lacerate-den-

tate; nutlet outline linear, linear-oblanceolate to oblanceolate or obovate to broadly obovate..... 10.

9. Nutlets distinctly heteromorphic; margins of lower or, most commonly, both adaxial nutlets reduced, entire (-subentire); margins of abaxial nutlets well developed, ascending to erect, subentire (lobed to cleft) or rarely bidentate; all nutlet margins of basalmost fruits slightly reduced.... ..... P. anisocarpa.

9. Nutlets homomorphic; margins of all nutlets well developed or adaxial margins only slightly reduced, involute to erect (- ascending), commonly bidentate into broad segments or occasionally subentire; nutlet margins of basalmost fruits well developed..... P. penicillata.

10. Nutlet margin pectinate-dentate, erect to ascending; nutlet outline linear to oblanceolate; nutlets homomorphic to heteromorphic, nutlet surface smooth..... 11.

10. Nutlet margin lacerate-dentate, spreading; nutlet outline broad obovate to subdeltoid; nutlets heteromorphic, lower adaxial nutlet reduced in size, more densely pubescent and deeply rugose than the three remaining nutlets; nutlet surface dorsal-medially ridged or short

papillate, smooth to rugose, pubescent to glabrous..... P. lateriflora.

11. Nutlets strongly recurved to scorpiod (- coiled), narrow, linear, ± homomorphic, length/width= 6/1 (- 5/1); margin erect; margin teeth narrow, two or more times longer than wide.... P. recurvata.

11. Nutlets only slightly to moderately recurved, linear-oblanceolate to oblanceolate, homomorphic to heteromorphic, length/width = 5/1 to 4/1 (-3/1); margin erect to ascending; margin teeth narrow and less than two time longer than wide, or teeth wide and two or more times longer than wide..... ..... 12.

12. Nutlets ± planar or with apices somewhat recurved, linear-oblanceolate, homomorphic to slightly heteromorphic, length/width = 5/1 (-4/1); margin erect to strictly ascending, (cleft-) divided dentate; margin teeth less than two times longer than wide; North America, coastal California and Baja California Norte, Mexico; South America, Argentina (± rare Chile)..... ..... P. ferocula

12. Nutlets moderately recurved, oblanceolate, heteromorphic with the lower or both adaxial nutlet margins and/or nutlet size reduced, length/width = 4/1 (-3/1); margin sub-

involute to ascending; margin teeth wide, two or more times longer than wide..... 13.

13. Plants erect to ascending (- decumbent); nutlet margins strictly to widely ascending, broadly and regularly cleft to parted dentate; North America, southeastern California, Arizona, and Sonora, Mexico. ..... P. platycarpa.

13. Plants prostrate to decumbent; nutlet margins subinvolute to erect to ascending, often medial-laterally constricted, irregularly parted to divided dentate; South America, Chile, rare Argentina..... P. linearis.

14. Nutlet horns lateral and dorsal-medial; nutlet surface deeply rugose to convoluted..... ..... P. anomala.

14. Nutlet horns lateral only; nutlets dorsal-medially naked or intermittently short papillate; nutlet surface smooth to obscurely or moderately rugose..... P. brachycera.

Section Harpagonella (A. Gray) Veno, stat. nov. Basionym: Harpagonella A. Gray, Proc. Am. Acad. Arts 11: 88-89, 1876.

Calyx armed with 5 to 10 subterete horns, each invest-with subretrorse uncinate prickles; upper two calyx lobes elongate, basal-medially fused, indurate, galeate and en-

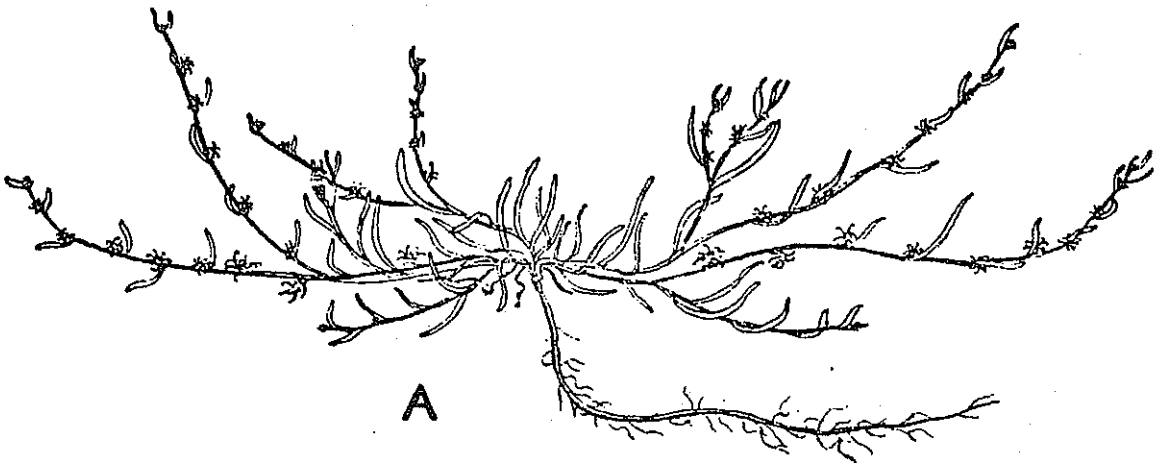
closing a nutlet; lower three calyx lobes shorter, free, subtending a nutlet; mature nutlets two. TYPE: Harpagonella palmeri A. Gray = Pectocarya palmeri.

1. Pectocarya palmeri (A. Gray) Veno comb. nov. Figure 2.
——Harpagonella palmeri A. Gray, Proc. Am. Acad. Arts 11: 88-89, 1876.——TYPE: Mexico. Guadalupe Island off Lower California, 1875, Palmer 70 (holotype: BM!; isotypes: G!, GH!, MO (2)!, NY (2)!).

Harpagonella palmeri A. Gray var. arizonica I.M. Johnston, Contr. Gray Herb. 73: 75-76, 1924.——TYPE: Arizona. Plains, Lowell, 3 May 1884, Parish 162 (holotype: GH!). This variety refers to the interior element of the species which was distinguished from the coastal type variety by a single character, i.e. larger fruit size. This feature is variable and somewhat clinal, and does not provide a significant or reliable basis for taxonomic delimitation. Therefore, var. arizonica is considered synonymous with P. palmeri.

Plants branched from the base, or basally simple and either unbranched or branched above. Stems erect or ascending, cinereous-strigose, 3.0 - 30.0 cm ($\bar{X}$ = 12.1 $\pm$ 8.6 cm) long. Leaves linear, setulose, 0.5 - 3.5 cm ($\bar{X}$ = 1.6 $\pm$ 0.8 cm) long, 1.0 -2.0 mm ($\bar{X}$ = 1.4 $\pm$ 0.5 mm) wide. Flowers chasmogamous; pedicels 0.5 - 1.0 mm ($\bar{X}$ = 0.6 $\pm$ 0.2 mm) long; calyces unilaterally armed with a tuft of short

Figure 2. Morphological characters of Pectocarya palmeri. A. habit, X 1/2. B. corolla, X 10. C. ovary, X 20. D. fruit, X 5. E. dissected calyx showing position of nutlets, X 5. F. nutlet, dorsal and ventral surface, X 20.



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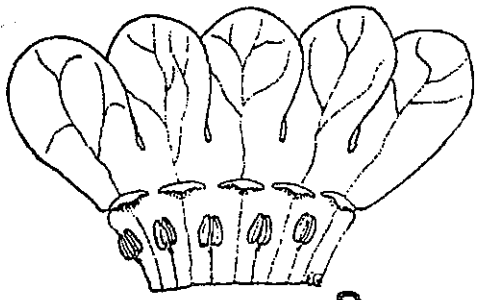

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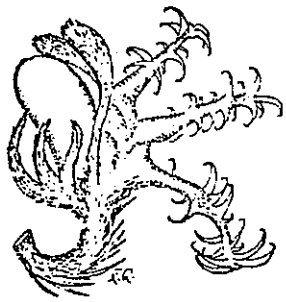

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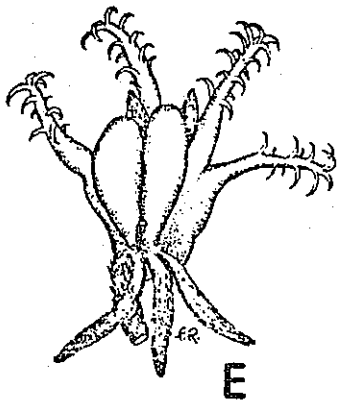

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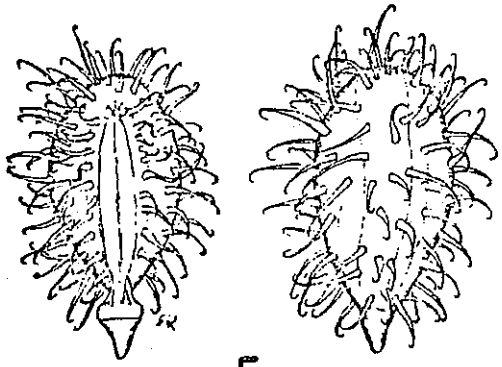

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subterete appendages, 1.0 - 1.75 mm ($\bar{X}$ = 1.3 $\pm$ 0.3 mm) long; corollas 1.25 - 2.0 mm ($\bar{X}$ = 1.6 $\pm$ 0.4 mm) long; ovary unequally four lobed, two lobes large and unequal, two lobes reduced, early abortive and obliterated during fruit development. Fruiting pedicels free, very strongly recurved to coiled, 2.0 - 3.5 ($\bar{X}$ = 2.7 $\pm$ 0.3 mm) long. Fruiting calyces $\pm$ erect, exceeding the nutlets, bilaterally symmetric and longitudinally distorted; calyx lobes apically uncinate bristled; two upper lobes basal-medially fused, indurate and somewhat bur-like, $\pm$ gibbous over one nutlet, and dorsally appendaged with 5 to 10 subterete horns, free portion of the upper lobes 1.75 - 4.5 mm ($\bar{X}$ = 2.6 $\pm$ 0.9 mm) long and 0.75 - 1.25 mm ($\bar{X}$ = 1.0 $\pm$ 0.2 mm) wide; three lower calyx lobes free, subtending a nutlet, 1.5 - 4.3 mm ($\bar{X}$ = 2.8 $\pm$ 0.8 mm) long, 0.5 - 0.75 mm ($\bar{X}$ = 0.6 $\pm$ 0.1 mm) wide; calyx horns $\pm$ erect, armed with subretrorse uncinate prickles, 1.0 - 5.0 mm ($\bar{X}$ = 3.0 $\pm$ 0.9 mm) long, 0.25 - 0.7 mm ($\bar{X}$ = 0.4 $\pm$ 0.1 mm) wide. Fruits monomorphic. Mature nutlets (1-) 2, both or inner nutlet only fertile, erect with dorsal surfaces juxtaposed, heteromorphic, obliquely obtrullate or oblanceolate, subclavate; inner nutlet larger, 1.2 - 4.0 mm ($\bar{X}$ = 3.1 $\pm$ 0.8 mm) long, 0.5 - 1.6 mm ($\bar{X}$ = 1.1 $\pm$ 0.2 mm) broad, partially enclosed by upper calyx lobes, dorsally pubescent; outer nutlet smaller, 1.0 - 3.5 mm ($\bar{X}$ = 2.7 $\pm$ 0.7 mm) long, 0.5 - 1.5 mm (X = 1.1 $\pm$ 0.2 mm) broad, cradled by lower calyx lobes,

narrowly margined, often appearing somewhat angled, pubescent on all faces. Nutlet margins entire, 0.05 - 1.00 mm wide. Nutlet pubescence strigose to subuncinate. Gynobase broad pyramidal. Chromosome number, n = 12.

Flowering Period. Maximum flowering time for P. palmeri is from March through mid April, although the species may occur form mid January through June.

Distribution (Figure 3) and Ecology. Pectocarya palmeri is localized or rare between 200 ft (60 m) and 4500 ft (1400 m). It occurs from coastal southern California through Baja California Norte and Sur, Mexico; and from southern Arizona through northernmost Sonora, Mexico.

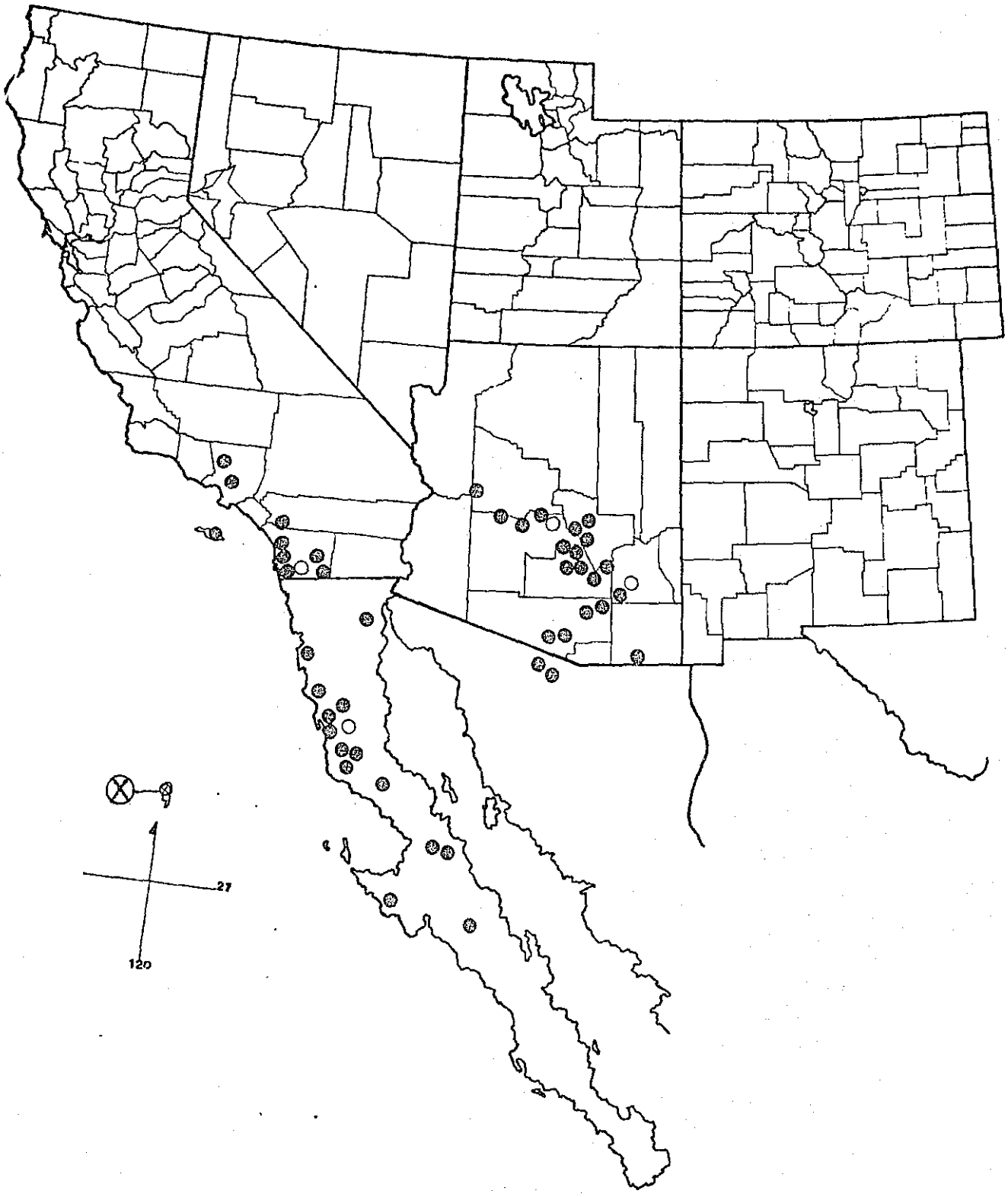
This species is an inhabitant of semi-arid regions, commonly occurring in desturbed areas, e.g. roadcuts and washes, in chaparral clearing, semi-desert scrub, and on grassy slopes. Pectocarya palmeri is adapted to various substrates: sandy or loamy soils, rocky or gravelly soils, and commonly very hard clay soils.

Specimens Examined. ARIZONA. Cochise County. Lowell, 3 May 1884, Parish s.n. (NY,US). Gila County. 10 mi S of Parker Experimental Station, Maguire, Richards, & Moeller 10084 (F, GH, MO, UC); Lower Park Creek, Pase 1599 (ASU). Graham County. Pineleno Mts., Lower Gillespie Wash, Bingham 1402 (ASU); Swift trail at entrance to Coronado National Forest, Pinkava et al. 12874b (ASU, NY); Thatcher,

Figure 3. Distribution of Pectocarya palmeri  .

⊗ type locality.

○ chromosome voucher populations.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Thornber 4683 (ARIZ). Maricopa County. Hieroglyphic Canyon, Gillespie 5429 (CAS-DS, GH, NY, UC, US); Cave Creek, Halvorson 379 (ASU); 2 mi S of Rock Springs, Keil 1051 (ASU); White Tank Mts. Regional Park, Keil 2864 (ASU); W of White Tank Mts., Keil 4082 (ASU); jeep trail, White Tank Mts. Regional Park, Keil 4168 (ASU); Thunderbird Regional Park, Keil K11216 (ASU); Lake Pleasant Regional Park, Keil & Lehto 10389 (ASU); Lake Pleasant Regional Park, W of Upper Lake, Keil & Lehto 10408 (ASU); McDowell Mts. Regional Park, Lane 1035 (ASU); McDowell Mts. Regional Park, Lane 1067 (ASU); South Mt. Park, Lehto 181 (ASU); Lake Pleasant Regional Park, Lehto 7766 (ASU); San Domingo Wash between Morristown and Wickenburg, Lehto 10122 (ASU); South Mt. Park, Lehto 17494 (ASU); McDowell Mt. Regional Park, Lehto 17504 (ASU); Lake Pleasant Regional Park, Lehto 17541 (ASU); Cave Creek Dam, Peebles, Harrison, & Kearney 3693 (ARIZ, US); Lake Pleasant Regional Park, Pinkava, Keil, & Lehto 11733 (ASU); 15 mi N of Phoenix, Russell 11167 (OSU); Cave Creek, E. Smith 1577 (ASU); 32 mi N of Gila Bend, Wiggins 8420 (CAS-DS, GH, US). Mohave County. 5.3 mi NE of Mohave-Yavapai County line, Nash et al. 10261 (ASU). Pima County. Mt. Tucson, Benson 9302 (POM); Tumamoc, Tucson, A. Carter 7132 (ARIZ); Flat Top Mt., 7 Mar 1937, Darrow s.n. (GH, UC); Tucson, Eastwood 8130 (CAS); Colossal Cave, Fosberg 10605 (CAS, GH, MO, UC); 8 mi NE of Sells, Fosberg 10664 (CAS, GH, MO, UC); Tucson

Mountains, Griffiths 3488 (US); Superstition Mts., Harrison & Fulton 6608 (ARIZ, GH, POM); 30 mi E of Florence, Kearney & Harrison 6654 (ARIZ, POM); Tucson, Keck 2998 (CAS-DS, GH, MO, UC); Tanque Verde Road, Lehto, Hensel, & Pinkava 10893 (ASU); Santa Catalina Mts., Lemmon 206 (UC); Tucson, Mason 1663 (ARIZ); Tucson, McLaughlin & McManus 109 (ARIZ); Tucson, Orcutt 173 (US); Sabino Canyon, Peebles et al. 1426 (ARIZ); Sierra Tucson, 15 Mar to 15 Apr 1884, Pringle s.n. (NY); 12 mi NE of Tucson, Shreve 10113 (ARIZ, CAS-DS, UC); Tucson, Swingle S26,S24 (ARIZ); Tucson Mts., Thornber 2562 (ARIZ, ASU, CAS, MO, NY); Tucson Mts., Thornber 2581 (ARIZ); Tucson Mts., Thornber 5488 (ARIZ); Sabino Canyon, 19 Apr 1913, Thornber s.n. (ARIZ); Tucson, Toumey 234 (ARIZ, US); Tucson Mts., Toumey 234a (US); Tucson Mts., Toumey 234b (ARIZ, US); Highway 86, 45 mi SW of Tucson, Veno 290 (CAS); Desert Research Laboratory, Warren & Turner 68-25 (ARIZ); Desert Research Laboratory, Warren & Turner 68-51 (ARIZ); 32 mi N of Gila Bend, Wiggins 8420 (ARIZ, GH, UC); Coyote Mts., 48 mi W of Tucson, Wiggins 8690 (CAS-DS, GH, US). Pinal County. 6 mi N of Apache Junction, Abrams 12944 (CAS-DS); 25 mi SE of Florence, 23 Mar 1968, Freeman s.n. (ASU); 10 mi S of Winkelman, Hitchcock 25598 (CAS-DS, NY, OSU, POM, UC, US); Sabino Canyon Road, Keil, Pinkava, & Lehto 10687 (ASU, NY); Lake Pleasant Regional Park, Lehto L19732 (ASU); SW of Lake Pleasant Regional Park, Cottonwood Creek, Lehto L19740 (ASU); Whitlow

Ranch Dam, Lehto & Keil 1648 (ASU); 2 mi W of Florence Junction, Lehto & Keil 1652 (ASU); 5 mi W of Superior, Maguire, Richards, & Moeller 10269 (GH, MO, UC, US); S of Florence, Newlon 606 (UC); 30 mi E of Florence, Peebles, Harrison, & Kearney 6654 (ARIZ, US); Superstition Mts., M. Schmidt 15 (ARIZ); San Tan Mts., E. Smith 10696 (US); 3.5 mi S of Superior, 19 Feb 1973, C. Wood (ASU). Yavapai County. US 93, near Santa Maria River, Barr 67-78 (ASU) and 67-82 (ARIZ, ASU); Joshua Tree Parkway, NW of Wickenburg, Higgins 6480 (NY). CALIFORNIA. Los Angeles County. Catalina, Fosberg S4384/670 (GH, POM); Catalina, Fosberg S4557/689 (NY, POM); Catalina, Fosberg 4766/707 (POM); Avalon, Grant 12060 (CAS-DS); Santa Catalina Island, Grant & Wheeler 540 (MO, UC); Los Angeles County, F.W. Johnson 1437 (NY); Pasadena, M.E. Jones 3026 (POM); Catalina, Cherry Valley, Thorne 35949 (POM, UC); Catalina, Cottonwood Canyon, Thorne 35873 (POM); Catalina, Rancho Escondido, Thorne & Everett 35023 (POM); Santa Catalina Island, Salta Verde, Thorne et al. 36729 (POM); Avalon, Apr 1896, Trask s.n. (MO, US); Avalon, Mar 1901, Trask s.n. (NY). Riverside County. 5 mi NE of Murietta, Munz & Johnston 5335a (CAS, POM, UC); 2.5 mi NE of Murietta, Peirson 3029 (POM). San Diego County. Junction of Telegraph Canyon Road with L Street, E of Chula Vista, Bacigalupi, Heckard, & Hutchison 8261 (UC); San Diego, 2 May 1906, K. Brandegee s.n. (UC); San Diego, 15 Apr 1894, K. Brandegee s.n. (NY,

UC); University Heights, San Diego, T.S. Brandegee 824 (CAS, GH, POM, UC, US); San Diego, 12 Apr 1894, T.S. Brandegee s.n. (CAS-DS, US); El Cajon, 8 Apr 1895, T.S. Brandegee s.n. (UC); vacant lot, San Diego, Gander 1128 (CAS-DS, GH, POM, UC,); Emerald Hills, Gander 3057 (GH); Otay, Gander 3112 (GH, UC); 3/4 mi W of Delesa School, Gander 5072 (ARIZ, GH, POM, UC); near Olivenhain, Gander 6968 (GH); Sweetwater, Gander 6878 (GH); E end of Sweetwater Lake, Gander 6988 (GH); Rancho Sante Fe, Gander 7010 (GH); Box Canyon near Mason Valley, Gander 7025 (GH); Black Canyon, Otay Ranch, Gander 7235 (GH); San Diego, Apr 1885, E.L. Greene s.n. (UC); Table Mt., NE of Jacumba, Harbison & Higgins 44144 (GH); San Diego, M.E. Jones 3066 (ARIZ, CAS, CAS-DS, NY, POM, UC, US); border of U.S. and Mexico, 5 Apr 1882, M.E. Jones s.n. (POM); San Diego, Orcutt 170 (UC); San Diego, 21 Mar 1885, Orcutt s.n. (MO); San Diego, 17 Mar 1882, Parry s.n. (CAS-DS);San Diego, 1882, Parry s.n. (MO); San Diego, 6 May 1882, Pringle s.n. (NY, US); Mission Gorge, SE of San Diego, Purer 6178 (GH); Camp Kearney, Purer 6870A (GH); College Park, E of San Diego, Purer 6903 (GH); Talmadge Park, Purer 6927 (GH, UC); San Diego, May-Oct 1898, Purpus s.n. (UC); SW of Highway 94 on Maroon Valley Road, Veno 305 (CAS). MEXICO. Baja California Norte. San Simon, Bacigalupi 3067 (CAS-DS, POM, UC); San Julio, 19 Apr 1889, T.S. Brandegee s.n. (UC); San Estaban, 17 Apr 1889, T.S. Brandegee s.n. (UC); Santa

Cruz, 4 May 1893, T.S. Brandegee s.n. (UC); Guadalupe Island, Juniper Canyon, Carlquist 463 (POM); 1 mi E of Rancho Arenoso, Chisaki 520 (CAS); 26 mi E of Rosario, Dressler 668 (MO); San Jacinto near Telmo Abajo, 9 Apr 1936, Epling & Stewart s.n. (CAS-DS, NY, US); near Calmalli, 7 Feb 1935, Haines & Stewart s.n. (CAS-DS); Guadalupe Island, J.T. Howell 8306 (CAS); Ensenada, 11 Apr 1882, M.E. Jones s.n. (POM); SE of Mt. Augusta, Moran 6677 (CAS, UC); El Picacho, Moran 6750 (CAS-DS, POM); Sierra Juarez, Moran 10982 (CAS-DS); peninsular divide at the Barril Road, Moran 12682 (CAS-DS); Rancho la Huerta, Moran 12770 (UC); 3 mi W of Cerro San Miguel, Moran 20904 (ASU); Lower California, 5 Apr 1882, Pringle s.n. (GH, NY); Santo Domingo, Purpus 8 (NY, UC); San Jacinto Rancho, Wiggins 4265 15 mi inland from Santa Catarina Landing, Wiggins 4415 (CAS-DS, NY, POM, US); between El Marmol and Rosario, Wiggins 4463 (CAS-DS, GH, POM, US); S of Jaraguay, Wiggins 7600 (CAS-DS, GH, UC, US); between S end of Cypress Grove and Lobster Camp, Guadalupe Island, Wiggins & Ernst 120 (CAS-DS, GH, UC, US); 8 mi E of El Aguajito, Wiggins & Thomas 67 (CAS-DS). Baja California Sur. 2.7 km S of Rancho Ybarra, Carter, Chisaki, & Moran 1056 (UC, US); Cerro Azul, Moran & Reveal 19992 (ASU, MO). Sonora. 7 mi S of Sasabe, Keck 3963 (CAS-DS, GH, POM); 5 mi S of Sasabe, Shreve 7497 (ARIZ, F, GH).

Section Gruvelia (Alph. DC.) Veno, stat. nov.

Basionym: Gruvelia Alph. DC., Prodr. 10: 119, 1846.

Subgenus Gruvelia (Alph. DC.) A. Gray, Synop. Fl. N. Amer. 2, pt. 1: 187, 1878.

Calyx unappendaged, radially symmetrical; lobes equally divergent, subequal in length, greatly exceeding the nutlets; basal and basal-cauline leaves opposite, decussate, and connate at the base; upper cauline leaves alternate; nutlet margins a narrow rim or spreading wing, entire or subentire or rarely cleft. TYPE: Gruvelia pusilla Alph. DC. = Pectocarya pusilla.

2. Pectocarya pusilla (Alph. DC.) A. Gray, Proc. Am. Acad. Arts 12: 81, 1876. Figure 4.——Gruvelia pusilla Alph. DC., Prodr. 10: 119, 1846.——TYPE: Chile. Locis arid. collium ad Concon, Poeppig 276 diar. (holotype: LE; isotypes: BM!, W!).

Pectocarya chilensis DC. var. californica Torr., Pacific Railroad Reports 4: 124, 1857.——TYPE: Los Angeles, May 1853-1854, Bigelow s.n. (holotype: NY!). The type specimen of this variety is not discernibly different from that of P. pusilla, and thus the two taxa are considered conspecific.

Pectocarya pusilla (Alph. DC.) A. Gray var. flagillaris Brand, Pflanzenreich 4, 252(78): 96, 1921. Type undesignated. LECTOTYPE: Washington. Klickitat County.

18 May 1883, Suksdorf 410 (GH!). This name was applied by Brand to the North American element of P. pusilla which I consider indistinguishable from the South American representatives of the species. The lectotype selected was the first specimen cited by Brand, and is considered representative of the taxon.

Plants branched from the base, or basally simple and either unbranched or occasionally branched above. Stems erect to widely ascending, cinereous-strigose appressed, 3.0 - 38.0 cm ($\bar{X}$ = 12.0 $\pm$ 6.5 cm) long. Leaves linear, 0.3 - 2.0 cm ($\bar{X}$ = 0.8 $\pm$ 0.3 cm) long, 0.5 - 2.0 mm ($\bar{X}$ = 1.1 $\pm$ 0.3 mm) wide; basal and basal-cauline leaves opposite, decussate, and connate at the base; cauline leaves alternate. Flowers chasmogamous; pedicels 0.25 - 1.0 mm ($\bar{X}$ = 0.5 $\pm$ 0.2 mm) long; calyces 0.75 - 1.0 mm ($\bar{X}$ = 1.2 $\pm$ 0.2 mm) long; corollas 1.25 - 2.0 mm ($\bar{X}$ = 1.5 $\pm$ 0.2 mm) long. Fruiting pedicels free, recurved (- rarely ascending), 1.0 - 2.25 mm ($\bar{X}$ = 1.7 $\pm$ 0.3 mm) long. Fruiting calyces divaricate, radially symmetric, regular, greatly exceeding the nutlets, 4.25 - 7.5 mm ($\bar{X}$ = 5.5 $\pm$ 0.5 mm) in diameter; lobes subequal, apically uncinate bristled. Fruits monomorphic, 3.0 - 6.0 mm ($\bar{X}$ = 4.7 $\pm$ 0.3 mm) in diameter. Nutlets equally divergent, homomorphic to occasionally heteromorphic with 1 (-2) nutlets per fruit marginless and subglabrous, ventrally keeled, dorsally ridged, often

mottled, widely obtrullate to subrhomboidal, 1.5 - 3.0 mm ($\bar{X}$ = 2.3 ± 0.3 mm) long, 1.5 - 3.0 mm ($\bar{X}$ = 1.9 ± 0.3 mm) maximum breadth; nutlet margins a narrow rim, 0.05 - 0.4 mm ($\bar{X}$ = 0.15 ± 0.06 mm) wide, entire, ciliate with uncinate bristles. Gynobase conical-pyramidal. Chromosome number, n = 12.

Flowering period. Flowering of P. pusilla occurs from March through mid July with maximum flowering from April through May.

Distribution (Figure 5) and Ecology. Pectocarya pusilla is amphitropical with its primary distribution in pacific coastal North America from northern California through southwestern Washington. It is apparently adventive in South America, represented by only seven collections of the early 1800's from the vicinity of Valparaiso and Santiago, Chile.

Pectocarya pusilla is an inhabitant of woodland and grassland areas, occurring along roadsides, in open grassy fields, and on wooded slopes between 300 ft (100 m) and 6000 ft (1800 m).

Specimens Examined. NORTH AMERICA. CALIFORNIA. Calaveras County. Mokelumne Hill, Blaisdell s.n. (CAS, GH, MO); 3 mi W of Avery, Tracy 5718 (UC). Colusa County. Sand Creek, Hoover 3209 (CAS, NY, UC, US); 2 mi S of Lodoga, Kamb 1738 (UC, WS). Contra Costa County. Black

Hills, Bowerman 1896 (GH, UC); Fossil Ridge, Bowerman 2019 (GH, UC); peak E of Tassajero Creek, Hoover 3351 (CAS, UC); Briones Road to Antioch, Mason 5210 (GH, UC); road between March Creek and Livermore, Mason 5827 (GH, UC). El Dorado County. New York Ravine, May, T.S. Brandegee s.n. (UC); near Placerville, May 1907, T.S. Brandegee s.n. (UC); 4.4 mi from Kelsey, Raven & Robbins 9067 (CAS); Webber Creek, Robbins 1575 (GH, UC); W of Institute of Forest Genetics, 3 mi E of Placerville, Robbins 1605 (CAS, GH, UC, US). Fresno County. Kings River Canyon above Piedra, Hoover 3986 (CAS, UC, US); Pinehurst, Newlon 187 (UC); Humphrey cut-off Road, Quibell 1841 (POM, UC); Sierra Nevada, 2.8 mi above Dunlap, Wolf 4742 (CAS, UC). Glenn County. near Bennett Spring, Heller 11938 (CAS, CAS-DS, F, G, GH, MO, US). Humbolt County. Trinity River Valley, near Willow Creek, Tracy 5993 (UC, WS); Trinity River Valley, near South Fork, Tracy 7428 (UC); 1/2 mi W of Harris, Tracy 18003 (UC). Kern County. Woody--Glenville, Benson 3273 (CAS-DS, GH, POM, UC, US); above Howling Gulch, C.N. Smith 340 (ARIZ, UC). Lake County. Mt. Konocti, 25 Apr 1929, Blankinship s.n. (MO); 2.5 mi SE of Kelseyville, Crum 1973 (CAS-DS, UC, US); Clear Lake Park, Eastwood & Howell 5559 (CAS); 6 mi from Kelseyville, Eastwood & Howell 5749 Alder Creek, 22 May 1937, Jussel s.n. (CAS); Soda Creek auto camp grounds, Koch 959 (UC); 4.6 mi N of Lower Lake, J.H. Thomas 15006 (CAS-DS); 5.2 mi N of Upper Lake, Wiggins

12100 (CAS-DS). Madera County. North Fork, Bacigalupi 2316 (CAS-DS, UC); Thompson Meadow, Hormay H-134 (UC). Mariposa County. Mariposa, Apr 1883, Congdon s.n. (UC); Blockman's Ranch, Eastwood 4236 (CAS); Morman Bar, Jepson 12776 (UC). Mendocino County. Howard Park Forestry Headquarters, M.S. Baker 9542 (GH); Covelo Ranger Station, Duran 3392 (BM, CAS, CAS-DS, F, G, GH, K, MO, NY, POM, UC, US, WS); Potter Valley, Eastwood 12724 (CAS); Osborne Forest Reserve, Eastwood 15242 (CAS); Covelo, 15 Apr 1950, Erskin s.n. (UC); E of Willits, Hutchison 2414 (ARIZ, BM, CAS, CAS-DS, G, POM, US); Potter Valley, Purpus 34 (UC); headwaters of Eel River, 7 June 1884, Rattan s.n. (CAS-DS); 7 mi N of Laytonville, J.H. Thomas 14333 (CAS-DS); Ridgewood Summit, 5 mi S of Willits, Tracy 17084 (UC). Merced County. Pacheco Pass, Hoover 4024 (UC); Ortigalito Peak, Lyon 1532 (CAS, CAS-DS, UC); 1 mi SW of Piedra Azul Spring, Lyon 1354 (UC, WS). Monterey County. Goold Creek, 4 Apr 1901, Dudley s.n. (CAS-DS); between Los Bueyos Creek and the Nacimiento, Hardham 5296 (CAS, POM); Hastings Reservation, Howell 30243 (POM); W of Priest Valley, J.T. Howell 39011 (CAS); School Hill, Linsdale 79 (ARIZ, UC, WS); School Hill, Linsdale 266 (POM); above Corral Field, Linsdale 283 (UC); Greenhouse, Berkeley from Linsdale 117, Ray & Chisaki K-52 (UC). Napa County. E of St. Helena, Jepson 21091 (UC); Capell Valley, Raven 8271 (CAS); Moore's Creek, Tracy 1603 (UC) and Tracy 12120 (UC).

San Benito County. Tres Pinos River, 8 mi above Pacines, Abrams & Borthwick 7819 (CAS); Quien Sabe Road, Hesse 2171 (CAS-DS); Highway J1, vicinity of Panoche Pass, Veno 361 (CAS); Tres Pinos Creek, Wiggins & Ferris 9331 (CAS, CAS-DS, GH, POM, WS). San Louis Obispo County. Cuesta Grade, Ferris 7515 (CAS); Chimney Rock Road--Adelaida Road, Hardham 415 (CAS); Cypress Mts., Hardham 5338 (POM); N end of Cuesta Grade, Wiggins 3455 (CAS-DS, GH): Cuesta Grade, Wolf 3470 (POM). San Mateo County. Portola, Elmer 4676 (ARIZ, CAS, CAS-DS, EDH, G, MO, POM, UC, US, W); Jaspar Ridge, 11 May 1911, McMurphy s.n. (GH). Santa Clara County. Page Mill Road, Abrams 7352 (CAS-DS); Morganhill, Apr 1921, Clemens s.n. (CAS); Smith Creek, 20 May 1893, Dudley s.n. (CAS-DS); Grants Fork of the Permanente Creek, 23 Apr 1899, Dudley s.n. (CAS-DS); Mt. Hamilton, Eastwood 11227 (CAS); Alameda Creek, Ferris 8283 (CAS); Morgan Hill, Hoover 2953 (UC); Page Mill Road, 5 mi W of Los Altos, Keck 4350 (CAS, CAS-DS, GH, UC); Isabel Creek, Sharsmith 755 (GH, UC, WS); N of Arroyo Bayo, Sharsmith 3469 (GH, UC); Frank Raines Regional Park, Veno 402 (CAS); Frank Raines Regional Park, Veno 480 (CAS). Shasta County. Bear Springs Transition, Johnston 11130 (CAS, UC). Siskiyou County. Oro Fino, Butler 1215 (UC); Greka, Butler 1306 (CAS-DS, MO, NMC, UC, US); Mt. Shasta near Wagon Camp, Cooke 11130 (GH); Yreka, E.L. Greene 759 (GH, MO, NY); Yreka, June 1876, E.L. Greene s.n. (NY); Yreka, 1876,

Greene s.n. (F); Horse Creek and Klamath River, Rose 45104 (CAS); Yreka Creek, Wheeler 3453 (G, GH, MO, NY). Sonoma County. 2 mi SE of Bennett Mt., Raven 8280 (CAS). Stanislaus County. 8 mi E of Oakdale, Hoover 796 (UC); Las Garzas Creek Canyon, Hoover 4223 (UC); 10 mi above Oakdale, Mason 5180 (GH, UC). Tehama County. 2.1 mi N of Paskenta, Chisaki, Bacigalupi, & Robbins 679 (GH, UC, WS). Trinity County. 1.5 mi above Peanut, Ferris & Lorraine 11687 (CAS-DS, UC); 3 mi NE of Douglas City, J.T. Howell 29168 (CAS, NY, UC); Trinity County, 30 May 1880, Kleeberger s.n. (CAS); Three Forks of Mad River, Tracy 10180 (GH, UC). Tulare County. 3 mi W of California Hot Springs, Keck & Stockwell 3327 (CAS-DS, GH, UC); 6.2 mi NE of Milo, Thorne & Everett 37020 (GH); N of Milo, 26 Apr 1937, True s.n. (CAS); 11.2 mi SW of Balch Park, Veno 199 (CAS); Highway J37, 13 mi SW of Balch Park, Veno 478 (CAS); 14 mi NE of Springville, Veno 396 (CAS). Tuolumne County. 2 mi ENE of Groveland, Belshaw 1926 (GH, UC); Indian Creek, Ferris 1760 (CAS, CAS-DS, UC); between Rawhide and Melones Dam, Ferris 12723 (CAS-DS); Chinese Camp, Hoover 1971 (CAS, UC); French Flat Road, McNeal 833 (NY). Yuba County. 2 mi from Brownsville, Raven 5482 (CAS). OREGON. Douglas County. Gazley, Dettling 6182 (CAS-DS, UC WS); Canyonville, 16 May 1881, T. Howell s.n. (F). Jackson County. Ashland, May 1887, Drake & Dickson s.n. (F); Wimer, 28 Apr 1892, Hammond s.n. (GH); Wimer, Hammond 193 (US); Ashland,

Henderson 697 (OSU); Camp White, Peck 24863 (UC). Josephine County. Deer Creek to Kirby, Abrams & G.T. Benson 10321 (CAS-DS); 2 mi up Murphy Creek from Murphy, Buddenhagen & Steward 276 (OSU); Wolf Creek--Cave Creek Road, Chambers 3018 (OSU); Jumpoff Joe Road, N end of Grants Pass, Chambers 3877 (OSU); Grants Pass, Eastwood & Howell 1441A (CAS); Grants Pass, Henderson 5697 (CAS, CAS-DS, MO); Savage Creek, Henderson 5886 (CAS, CAS-DS, MO); Pacific Highway, N of Grants Pass, Henderson 13173 (UC); Grants Pass, Piper 5032 (CAS, WS); Grants Pass, 2 June 1921, Piper s.n. (UX, WS). Hood River County. Hood River County, Henderson 318 (MO); Hood River, J. Howell & T.J. Howell 340 (GH). Multnomah County. Woodsville, May 1888, Jos. Howell s.n. (WS). Polk County. Dallas, Lunell 18 (GH); Sheldon S10115 (CAS-DS, F, GH, MO, POM, WS). Wasco County. Wasco County, Henderson 14308 (CAS-DS); Maupin, Peck 17330 (CAS-DS, NY). Washington County. Timber, Apr and June 1881, J.T. Howell s.n. (CAS, OSU); Canyonville, 16 May 1881, J.T. Howell s.n. (F). SOUTH AMERICA. CHILE. Quillota. Valparaiso, Bertero 212 (BM, EDH, G, GH, LA, NY, W); Valparaiso to Concon, Bridges 234 (K); Valparaiso, Cumming 723 (BM, EDH, K); Concon, Aug-Sept 1827, s.coll. 276 (W). Santiago. Province Santiago, Phillipi s.n. (W). Province unspecified. Chile, Bertero s.n. (F); Chile, Grullenia s.n. (GH).

Figure 4. Morphological characters of *Pectocarya pusilla* and *Pectocarya setosa*. *P. pusilla*, A-C. A. habit X 1/2. B. fruit X 5. C. calyx X 5. *P. setosa*, D-F. D. habit X 1/2. E. fruit X 5. F. calyx X 5.

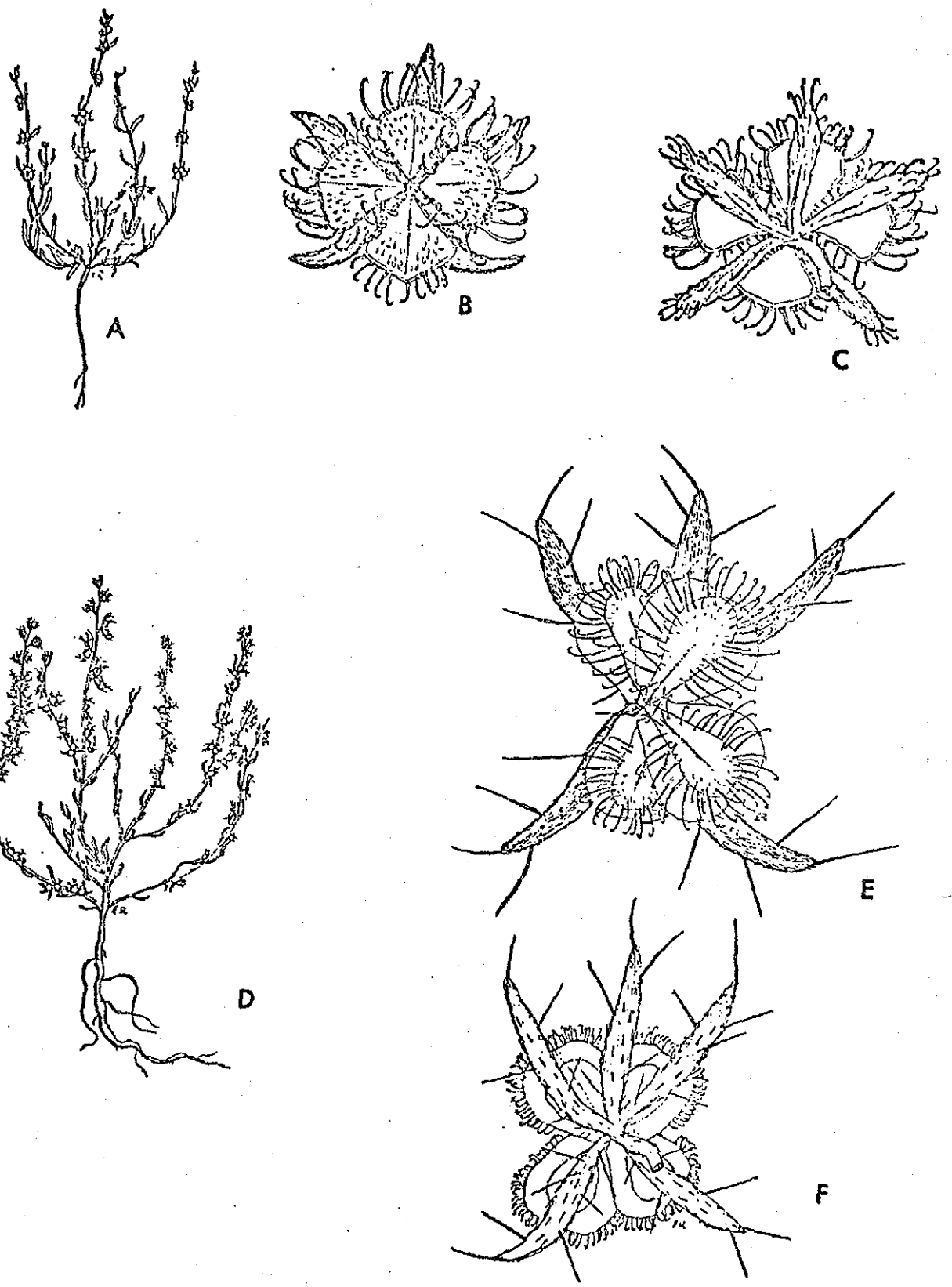
A
B
C
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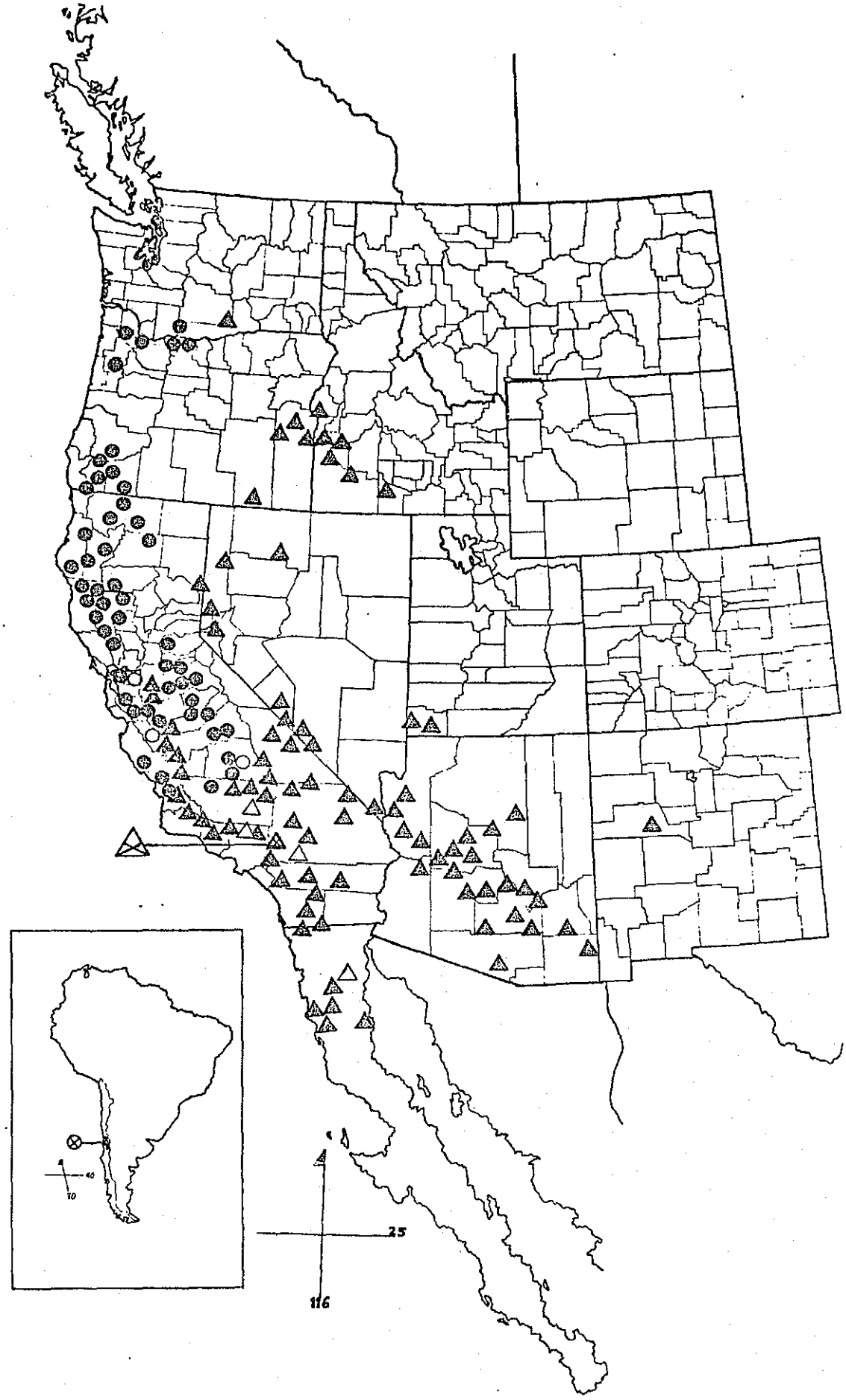
Figure 5. Distribution of Pectocarya pusilla ● and Pectocarya setosa ▲ .

⊗ and ⋀ type localities.

○ and △ chromosome voucher populations.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Pectocarya setosa A. Gray var. holoptera I.M. Johnston, Contr. Gray Herb. 70: 39, 1924.——TYPE: California. Granite Wells, Mohave Desert, 1922, Johnston 6489 (holotype: POM!). This variety was characterized by four margined nutlets per fruit, and represented by only the type specimen. Like var. aptera, var. holoptera is considered a morphological extreme, and is otherwise indistinguishable from either the type variety or var. aptera. Therefore, var. holoptera is considered synonymous with P. setosa.

Plants branched from the base, or basally simple and either unbranched or branched above. Stems few to many, erect to ascending, cinereous-strigose to hispidulous, 2.0 - 23.0 cm ($\bar{X}$ = 8.2 ± 4.2 cm) long. Leaves linear to linear-spatulate, setose to hispidulous, 0.5 - 3.0 cm ($\bar{X}$ = 1.0 ± 0.4 cm) long, 0.25 - 2.25 mm ($\bar{X}$ = 1.0 ± 0.1 mm) wide; basal and basal-cauline leaves opposite, decussate, and connate at the base; upper cauline leaves alternate. Flowers chasmogamous; pedicels 0.25 - 0.50 mm ($\bar{X}$ = 0.4 ± 0.1 mm) long; calyces 1.0 - 2.5 mm ($\bar{X}$ = 1.7 ± 0.4 mm) long; corollas 1.25 - 2.75 mm ($\bar{X}$ = 1.8 ± 0.4 mm) long. Fruiting pedicels free, ascending or deflexed, 0.75 - 2.8 mm (X = 1.5 ± 0.1 mm) long. Fruiting calyces divaricate, ± radially symmetric, regular, greatly exceeding the nutlets, 6.5 - 8.5 mm ($\bar{X}$ = 7.5 ± 0.4 mm) long; lobes subequal,

3. Pectocarya setosa A. Gray, Proc. Am. Acad. Arts 12: 81, 1876. Figure 4.——Gruvelia setosa (A. Gray) Rydberg, Bull. Torr. Bot. Club 40: 479, 1914.——Pectocarya setosa A. Gray var. genuina I.M. Johnston, Contr. Gray Herb. 70: 38, 1924.——TYPE: SE California-Arizona, Mojave, 1876, Palmer 379 (holotype: GH!; isotypes: F (2)!, MO!, NY!, US!). Gray (1876) cited the type locality as: SE California, on the desert plains of the upper Mohave River. According to McVaugh (1956), Palmer visited the upper Mohave River in southwestern San Bernardino County, California, during a collecting trip from Crafton to Stoddards Ranch (Well) which occurred from June 8-14, 1876.

Pectocarya setosa A. Gray var. aptera I.M. Johnston, Contr. Gray Herb. 70: 38-39, 1924.——TYPE: California. Dry canyon floors near Campo, 24 May 1903, Abrams 3571 (holotype: GH!; isotypes: CAS-DS!, EDH!, G!, US!). This variety, which Johnston represented by only the the type specimen, was distinguished because it possessed all marginless nutlets rather than two margined and two unmargined nutlets per fruit which are characteristic of the type variety. Variety aptera is one extreme in the range of variability in nutlet margin width, and is otherwise indistinguishable from var. setosa; therefore, it does not merit separate taxonom- recognition.

setose to hispidulous. Fruits monomorphic, 3.0 - 8.5 mm ($\bar{X}$ = 4.5 ± 0.5 mm) long. Nutlets geminate, heteromorphic or rarely all margined or all unmargined, widely obovate to ± orbicular in outline, ventromedially keeled, 1.5 - 4.3 mm (X = 2.3 ± 0.5 mm) long, 1.0 - 4.3 mm ($\bar{X}$ = 2.0 ± 0.3 mm) broad. Margined nutlets bilaterally winged; margin spreading, entire or subentire or rarely cleft. Nutlet body and margin dorsally armed with scattered uncinate bristles and sparse to dense uncinate hairs. Gynobase broad-pyramidal. Chromosome number, n = 12.

Flowering Period. Pectocarya setosa occurs from mid February through mid August with maximum flowering from April through May.

Distribution (Figure 5) and Ecology. Pectocarya setosa extends somewhat disjunctly from southernmost Washington through Baja California Norte, Mexico.

This species is an inhabitant of arid and semi-arid regions such as desert, sagebrush scrub, and grassland; and occurs in gravelly or sandy washes and vegetational clearings at elevations from 500 ft (150 m) to 7500 ft (2300 m).

Specimens Examined. ARIZONA. Cocconino County. Between Highway 15 and Silver Reef, Atwood 4815 (MO); Route 179, S of Sedona, Lehto, Brown, & Pinkava 11085

(ASU); 1.5 mi N of Pine Flat Campground, Pinkava & Lehto 4997 (ASU). Gila County. Apache Trail, 13 mi NW of Claypool, Benson 9581 (ARIZ, CAS-DS). Graham County. Pinaleno Mts., Lower Gillespie Wash, Bingham 1401 (ASU). Maricopa County. South Mountain Park, Phoenix, Darrow s.n. (ARIZ); Oracle, 25 Apr 1937, Darrow s.n. (ARIZ); 26 mi NE of Scottsdale, Higgins 6448 (NY); White Tank Mountains, Keil 4805 (ASU); Lower Dripping Springs Canyon, Keil 6241 (ASU); McDowell Mts. Regional Park, Lane 783 (ASU); Mc Dowell Mts. Regional Park, Lane 1038 (ASU); Arizona 88 at First Water Road, Lehto L18394 (ASU); 3 mi W of Wickenburg, Peebles 8477 (F, GH); near Roosevelt, Peebles 9137 (ARIZ); Wickenburg, Peebles & Fulton 8477 (ARIZ); Stewart Mt. Dam, Peebles & Fulton 10676 (F); Paradise Valley, Peebles, Harrison, & Kearney 5101 (US) and 5108 (ARIZ, US); road to Coon Bluff, Pinkava & Lehto 15601 (ASU); McDowell Mts. Regional Park, Smith, Pinkava & Lehto 1-33 (ASU). Mohave County. 20 mi N of Wikieup, 20 Apr 1938, Crooks & Darrow s.n. (ARIZ); Yucca, M.E. Jones 4628 (NY); Kingman to Chloride, Kearney & Peebles 11171 (ARIZ, US); Signal Road, Lehto 12870a (ASU); Hualapai Mt. Park Rd, Lewis et al. 12016 (NY); 10 mi SW of Kingman, Maguire 16243 (GH); 20 mi SW of Kingman, Maguire, Richards, & Moeller 10468 (ARIZ, F, GH, MO, UC, US). Pinal County. Oracle to Redington, Griffiths 3741 (US); Superstition Mt., Harrison & Fulton 6606 (ARIZ, GH, US); Oracle, Harrison & Kearney 6669

(ARIZ, GH, US); 4 mi W of Mammoth, Maguire, Richards, & Moeller 10889 (GH, MO); between Tucson and Oracle, Peebles 6879 (GH, US); Fresnal, Thackery 17 in part (US); Oracle, 12 May 1905, Thornber s.n. (ARIZ). Pima County. Santa Catalina Mts., May 1881, Lemmon s.n. (F, G, K, UC, US). Yakima County. Near the Columbia, T.S. Brandegee 985 (GH, NY, US); near the Columbia, Brandegee & Tweedy 691 (NY). Yavapai County. Congress Junction, 19 Apr 1938, Crooks & Darrow s.n. (ARIZ); between Burro Creek and Santa Maria River, Darrow & Benson 10884 (ARIZ); Santa Maria Canyon, Gould & Darrow 4200 (ARIZ); Joshua Tree Parkway, NW of Wickenburg, Higgins 6481 (NY); 1 mi NW of Black Canyon Freeway on Route 69, Keil, Pinkava, & Lehto 8007 (ASU); 1.6 mi N of Skull Valley, Keil, Pinkava, & Lehto 8174 (ASU); Prescott, Peebles & Harrison 4119 (ARIZ,US). Yuma County. Cunningham Pass, Keck 4316 (CAS-DS). CALIFORNIA. Fresno County. Monocline Ridge, 6 mi S of Big Panoche Creek, Lyon 995 (UC); Panoche Hills Plateau, Lyon 1206 (CAS); 7 mi SW of Coalinga, Munz 9152 (GH); Jacalitos Hills, J.H. Thomas 12591 (CAS-DS). Inyo County. 5.1 mi SE from Emigrant Spring, Balls 11669 (EDH); Highway 6, S of Olancha, Brenckle 51252 (NY, UC); Surprise Canyon, Coville & Funston 642 (US); Mill Creek Canyon, Coville & Funston 800 (US) and 809 (MO); Marble Fork of Black Canyon, Duran 2734 (UC); 5.1 mi SE of Emigrant Springs, Everett & Balls 23238 (UC); Surprise Canyon, Ferris 7944 (CAS-DS, UC);

Silver Canyon, Heller 8187 (CAS, CAS-DS, EDH, F, G, MO, US); 18 mi SE of Ryan, J.T. Howell 3668 (CAS); Hanapah Canyon, Jepson 7050 (UC); 2 mi E of Aberdeen, 18 Apr 1937, Kerr s.n. (CAS); Independence, 29 Apr 1937, Kerr s.n. (CAS); Greenwater, Munz 16476 (G, UC); 2 mi NE of Willow Springs, Roos 6420 (CAS-DS, UC); Alabama Hills, Rose 58058 Westgard Pass, Wiggins 8817A (CAS-DS). Kern County. El-paso Range, below Red Rock Canyon, Abrams 11918 (CAS-DS); Landsburg--Rand, May 1913, K.Brandegee s.n. (UC); 12 mi E of Mojave, Carter 1257 (BM, CAS-DS, F, G, GH, K, MO, NY, WS); Kern River Valley, Coville & Funston 1055 (US); California City, Holmgren 7704 (NY); Red Rock Canyon, J.T. Howell 4961 (CAS); 2 mi N of Mojave, J.T. Howell 24263 (CAS); Canebraker Creek, Keck & Stockwell 3270 (CAS-DS, GH); 1.5 mi E of Onyx, Keck 5725 (CAS-DS); Inyokern, 4 May 1938, Kerr s.n. (CAS); 3 mi NE of Garlock, Kirby 1135B (CAS); 5 mi S of Murco, Mason 6889 (UC); Toad Springs, Pollard s.n. (CAS); 7 mi S of Weldon, Raven 18794 (CAS); 8.9 mi S of Weldon, Raven 12793 (UC) and 12796 (CAS); 1 mi NE of Isabella, Robbins 3299 (WS); 2 mi N of Mojave, Rose 48077 (NY); 5 mi SE of Greenhorn Summit Store, C.N. Smith 382 (UC); Alec Cook Rocks, Cedar Canyon, Twisselmann 1190 (CAS); Lower Mesa Ridge, Twisselmann 1966 (CAS); Rand Mts. Twisselmann 6797 (CAS); Horse Canyon, Twisselmann 8181 (CAS); summit of Mesquite Canyon, Twisselmann 11882 (CAS); Piute Mts., Twisselmann 12129 (CAS); Highway 14, 1 mi N of

Red Rock Canyon, Veno 172 (CAS). King County. Kettleman Hills near Avenal, Hoover 3317 (GH, UC). Lassen County. Constantia, Eastwood & Howell 8356 (CAS, GH); 4 mi S of Almira, J.T. Howell 11853 (CAS). Los Angeles County. Oakgrove Canyon, Abrams & McGregor 346 (CAS-DS, EDH, US); Lancaster, June 1895, Davidson s.n. (UC); Manzana, Davy 25582 (UC); Mint Canyon, Eastwood & Howell 3953 (CAS); Los Angeles County, Elmer 3706 (CAS, EDH, G, K, MO, W); Antelope Valley, Ferris & Rossbach 9474 (CAS-DS, F, GH, UC, US); 3 mi NNW of Manzana, Gifford 9976 (UC); Little Rock Dam, Griesel 550 (OSU); between Valyermo and Mile High Ranch, Griesel 795 (OSU); Palmdale, Hall 3072 (UC); 1 mi N of Acton, J.T. Howell 4874 (CAS); Antelope Valley, Jepson 19239 (UC); San Gabriel Mts., above Little Rock, Kamb 935 (UC); Big Rock Creek, Raven 11964 (UC); San Gabriel Mts., Thorne & Tilforth 40665a (OSU); along road to Valyermo, Thorne et al. 39451 (NY); Sierra Highway, Veno 475 (CAS); E of Little Rock, 8 Apr 1947, Vestal s.n. (CAS-DS). Merced County. Piedra Azul Canyon, Hoover 4374 (UC). Monterey County. Between Jolon and Bradley, Eastwood & Howell 1982 (CAS). Riverside County. 2 mi from Cottonwood Springs, Ferris & Rossbach 9529 (CAS-DS, GH); Nigger Jim Hill, Hall 1183 (CAS-DS, MO, UC): Lytle Creek Canyon, Hall 1473 (CAS-DS, EDH) and 1475 (UC); Cottonwood Springs, Hitchcock 5910 (NY, UC); Aguanga, 12 Apr 1932, Jaeger s.n. (CAS-DS); Van Derventer's Ranch, Jepson 1420 (UC); Thomas

Valley, Jepson 1465 (UC); 1 mi E of Lake Elsinore, Terrell 105 (ASU). San Benito County. New Idria, 28 May 1893, Eastwood s.n. (CAS); Hernandez, 1 June 1899, Eastwood s.n. (CAS); San Carlos Creek, Eastwood & Howell 8356 (CAS, GH); Idria Road, Hesse 2460 (UC); between Lewis Creek and San Benito River, Mason 6922 (UC); San Carlos Canyon, Mason 14279 (UC); 17.6 mi from New Idria, Raven et al. 9239 (CAS). San Bernardino County. 8 mi N of Valley Well, Abrams 14069 (CAS-DS); 3/4 mi S of Excelsior Talc Mine, Abrams 14118 (GH, CAS-DS); Horse Springs Road, Abrams 14176 (GH, CAS-DS); New York Mts., Alexander & Kellogg 1302 (GH, CAS-DS, UC); Joshua Tree National Monument, Alexander & Kellogg 2096 (BM, CAS-DS, G, GH, MO, UC, US); 4 mi W of junction of U.S. 395 along road to Little Rock, Balls 9222 (EDH); Mitchells Caverns, Beal 210 (UC); Mitchells Caverns, Beal 482 (UC); Barnwell, May 1911, T.S. Brandegee s.n. (UC); W of Cajon Pass, Clokey 5826 (ARIZ, CAS-DS, GH, MO, NY, UC, WS); junction of the Mojave River, Clokey 5828 (GH, UC); 9.6 mi S of Daggett, Crampton 2660 (UC); between Barstow and Las Vegas, Eastwood 18788 (CAS); S of Wheaton Springs--Nipton Road, 11 mi N of Cima, Ferris & Bacigalupi 13290 (CAS-DS); 1 mi W of Cajon Station, Finfrock 51 (UC); 12 mi S of Victoville, Fosberg 10635 (UC); Victorville, Hall 6184 (UC); Highway 247, 1 mi N of Landers, Higgins 8471 (NY); Salt Wells Valley, Holmgren 7747 (NY); Mojave Desert, Howe 7 (US); road to Hesperia, J.T. Howell 2486

(CAS); New York Mts., Jepson 5457 (UC); Cajon Pass, Jepson (UC); "second summit" on road to Paradise Springs, Jepson 17227 (UC); Granite Mts., Jepson 17296 (UC); Hole-in-the-wall, Jepson 18319 (UC); 6 mi SW of Victorville, Jepson 20287 (UC); Sillow Springs, Jepson 20450 (UC); Mojave River Creek, Keck & Stockwell 3290 (CAS-DS, GH); Walker's Station, Parish 428 (F, NY); Mojave Desert, Parish 1324 (BM, CAS-DS, F, K, MO, US); Mojave Desert, Parish 1908 (F, MO, UC); San Bernardino Mts., Parish 3204 (MO, US); Mojave Desert, Parish 10909 (CAS-DS); Cajon Pass, Parish 19273 (UC); Mojave Desert, June 1886, Parish s.n. (UC); Mojave Desert, June 1887, Parish s.n. (UC); Cajon Pass, Peirson 363 (UC); Hesperia, Spencer 352 (UC); 1.4 mi N of Yucca Valley, J.H. Thomas 6623 (CAS-DS); E Mojave Desert, Thorne 43277 (NY); New York Mts., Caruthers Canyon, Thorne & Tilforth 43664 (NY); 5-6 mi S of Yucca Valley, Veno 194 (CAS); road to Pioneer Town, Veno 321 (CAS); Old Dad--Granite Mt. Range, Wolf 10142 (ARIZ); Kingston Mts., Wolf 10510 (NY); Granite Mts., Wolf 6571 (ARIZ). San Diego County. Campo, Abrams 3617 (BM); San Felipe Valley, Bacigalupi 5801 (UC); 9.5 mi E of Julian, Chisaki, Ingram, & Arnott 638 (GH, UC); Warner's Hot Springs, Eastwood 2620 (CAS, GH, UC, US); Jacumba, Eastwood 9499 (CAS); Jacumba Springs, Eggleston 19813 (US); Box Canyon near Mason Valley, Gander 7024 (GH); E of Jacumba, Gander 8065 (GH); 6 mi NW of Jacumba, Gander 8131 (GH); Montezuma View Point, Gander 9130;

10 mi N of Warner's Hot Springs, J.T. Howell 4820 (CAS); Indian Canyon, Collins Valley, Jepson 8850 (UC); Wagon Wash near Sentenac Canyon, Jepson 12490 (UC); 3.5 mi E of Banner, Keck et al. 6104 (NY); Coyote Well, Orcutt 237 (UC); SW part of Colorado Desert, Apr 1889, Orcutt s.n. (US); Jacumba Valley, 18 Apr 1889, Orcutt s.n. (US); Box Canyon, Purer 6292b (GH); San Diego County, Vasey 430 (CAS-DS, K, NY, US). San Joaquin County. Between Castle Rock and Black Butte, Hoover 3042 (CAS, GH, UC). San Luis Obispo County. 7 mi E of Pozo, Ferris 9097 (CAS-DS, UC); 5 1/4 mi WSW of El Dorado School, Hendrix 164 (UC); Toro Creek, N of Pozo, Hoover 7085 (CAS, UC). Santa Barbara County. Lyttle Creek, Leiberg 3345 (US); Ballinger Canyon, Twisselmann 7179 (CAS). Ventura County. Mt. Pinos, Abrams & McGregor 230 (CAS-DS, EDH, G, US); Ozena River, Breedlove 2431 (CAS-DS); Mt. Pinos, Hall 6423 (UC); Mutau Road, 13 mi SW of Frazier Park, Haller 1428 (ASU); 2 mi E of Ozena, Keator 363 (UC); Council Rock on the Ortega Hill Trail, 20 June 1962, Pollard s.n. (CAS); Ballinger Canyon, Twisselmann 2762 (CAS); Santa Ynez Mts., Wolf 6923 (ARIZ, CAS-DS, MO, NY, UC). IDAHO. Ada County. 15 mi SE of Boise, Christ & Ward 7833 (GH, NY, WS). Canyon County. Big Willow, MacBride 160 (MO). Owyhee County. Bruneau, Premeisel 258 (GH). Twin Falls County. Castleford, Nelson & MacBride 1740 (EDH, GH, MO, US); W of Buhl, Premeisel 272 (GH). Washington County. Weiser,

M.E. Jones 6467 (BM, MO, US). NEVADA. Clark County. Kyle Canyon, Clokey & Bean 7684 (UC); 11 mi SW of Searchlight, Gullion 358 (UC); 3.9 mi W of Davis Dam, Pinkava et al. 12618 (ASU). Esmeralda County. 3 mi SE of Lida, Maguire & Holmgren 25229 (GH, NY, UC). Humboldt County. NE of Winemucca, Gentry & Davidse 1624 (ASU, CAS-DS, MO, NY, UC, US, WS). Lincoln County. Meadow Valley Wash, 4.3 mi SE of Elgin, Holmgren 7813 (NY). Nye County. 1.5 mi N of intersection of Schocken and Saddle Roads, Beatley 3683 (CAS-DS); Ryolite, Heller 9660 (CAS-DS); Chloride Cliff, 7 May 1919, Jaeger s.n. (CAS-DS); Amargosa Desert, Jepson 19821 (UC); 10 mi S of Beatly, Maguire & Holmgren 25197 (NY). Ormsby County. 5 mi E of Carson City, Moore & Franklin 91 (GH). Washoe County. Highway 33, 4 mi N of Sparks, Bacigalupi & Heckard 9514 (UC); Wedekind Road, 2.5 mi N of Sparks, Bacigalupi & Heckard 8530 (CAS); 4.2 mi NNW of Sugarloaf, Hendrix 829 (UC); Empire City, M.E. Jones 3992 (BM, CAS, GH, MO, NMC, NY, UC, US); Highway 33, 17 mi N of Sparks, Mason 15160 (UC); Lemon Valley, McMillan & McKnight 83 (GH); 6.3 mi S of Tule Peak, Tillotson 219 (UC); Newmarker Canyon, Train 3537 (NY, UC). NEW MEXICO. Valencia County. Acoma Village, Aug 1884, Lemmon s.n. (UC). OREGON. Harney County. Pueblo Mts., Henderson 8323 (CAS). Malheur County. 1.9 mi NE of Harper, Chisaki & Tavares 835a (UC); 1 1/2 mi W of Juntura, Cronquist 8158 (GH, NY, UC, WS); Dry Creek, Cusick 2555 (EDH, F, G, GH,

MO, UC, US, W, WS); Harper Ranch, Leiberg 2114 (BM, F, GH, UC, US); 15 mi S of Adrian, Peck 20351 (UC). UTAH. Washington County. Diamond Valley, Goodding 815 (G, GH, MO, US); Diamond Valley, 10 mi N of St. George, Gould 1557 (ARIZ, CAS, CAS-DS, UC); 5.7 mi S of Gunlock, Gould 1596 (ARIZ); Welcome Springs, Maguire 20521 (GH, NY). WASHINGTON. Yakima County. Yakima County, Henderson 2560 (GH); Highway 97, 5 mi S of Toppenish Creek, Hitchcock & Martin 3407 (CAS); S of Mabton, Hoover 5685 (CAS); Donald Pass, Hoover 5791 (CAS). MEXICO. Baja California Norte. San Felipe, Apr 1899, R. Brandegee s.n. (UC); 3 mi W of Santa Catarina, Broder 638 (CAS-DS, US); Route 2, 70.5 mi of main route to Mexicali, McGill, Pinkava, & Lehto 8721 (ASU); Rancho San Rafael, Moran 10911 (CAS-DS, UC); 2 1/2 mi NW of El Rodeo, Moran 13896 (UC); Cerro Pinyon, 2 mi N of El Alamo, Moran 13902 (UC); Rancho Santa Clara, Moran 13910 (CAS, MEX); Llano Colorado, Moran 20972 (ASU); Topo, Orcutt 1112 (GH); Cantillas, 8 July 1884, Orcutt s.n. (F, NY); Pinones, 2 July 1885, Orcutt s.n. (MO); 1.4 mi W of Rancho Cerro de Castillo, J.H. Thomas 15727A (CAS-DS); between El Marmol and Rosario, Wiggins 4465B (GH); 2 1/2 mi NW of Valle Trinidad, Wiggins 16071 (ARIZ, CAS-DS, G).

Section Pectocarya

Subgenus Ktenospermum A. Gray, Synop. Fl. N. Am. 2, pt. 1: 187, 1878.

Eupectocarya I.M. Johnston, Contr. Gray Herb. 70: 34, 1924.

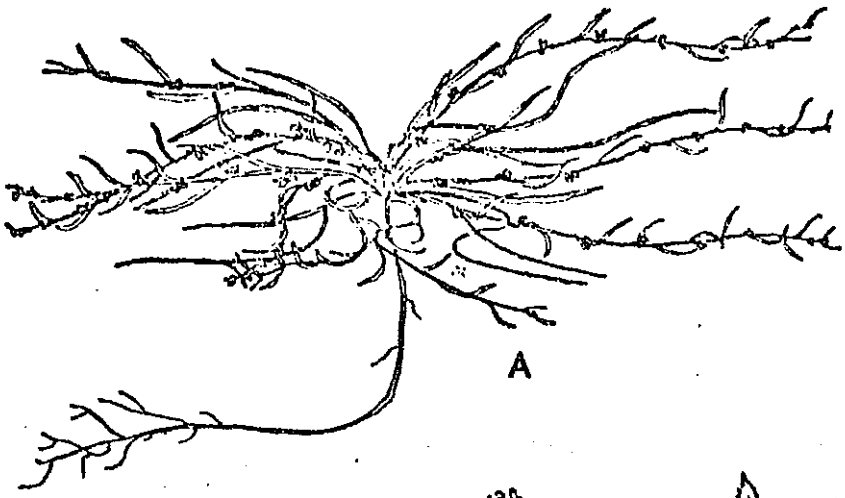
Calyx unappendaged, bilaterally symmetrical; upper lobes two and exceeding the lower three lobes, subequal or the lower lobes irregularly reduced and displaced by fusion of the pedicel to the lower adaxial nutlet, slightly exceeding or equal to or shorter than the nutlets; only basalmost leaves opposite, cauline leaves alternate; nutlets wing margined or appendaged with subulate horns; margins involute, erect, ascending, or spreading; margin form subentire, dentate or lacerate. TYPE: Cynoglossum lateriflorum Lam. = Pectocarya lateriflora.

4. Pectocarya heterocarpa (I.M. Johnston) I.M. Johnston, J. Arnold Arbor. 20: 399-400, 1939. Figure 6.—— Pectocarya penicillata (Hook. & Arn.) Alph. DC. var. heterocarpa I.M. Johnston, Contr. Gray Herb. 70: 37-38, 1924.——TYPE: Southern California. Vicinity of Corn Springs, Chuckwalla Mountains, Colorado Desert, shelter of rocks, 1500 ft, 9-12 Apr 1922, Munz & Keck 4870 (holotype: POM!; isotype: GH!).

Plants branched from the base. Stems (few-) many, slender to coarse, prostrate to widely ascending, cinereous-strigose appressed to hispidulous, 2.0 - 25.0 cm ($\bar{X}$ = 7.7 $\pm$ 4.2 cm) long. Leaves narrow, linear, $\pm$ setose, 1.0 - 5.0 cm ($\bar{X}$ = 3.0 $\pm$ 0.5 cm) long, 1.0 - 2.0 mm ($\bar{X}$ = 0.9 $\pm$ 0.15 mm) wide. Cauline flowers chasmogamous, basal

flowers cleistogamous; pedicels 0.25 - 0.6 mm ($\bar{X}$ = 0.3 $\pm$ 0.1 mm) long; calyces 0.75 - 1.25 mm ($\bar{X}$ = 1.0 $\pm$ 0.1 mm) long; corollas 1.0 - 1.5 mm ($\bar{X}$ = 1.4 $\pm$ 0.1 mm) long. Fruiting pedicels strongly recurved, laterally displaced, 1.25 - 2.75 mm ($\bar{X}$ = 2.0 $\pm$ 0.3 mm) long, fused to lower adaxial nutlet for the first 0.6 - 1.5 mm ($\bar{X}$ = 0.9 $\pm$ 0.4 mm) of its length. Fruiting calyces divaricate, equaling or shorter than the nutlets, 2.8 - 4.1 mm ($\bar{X}$ = 3.5 $\pm$ 0.3 mm) long, obliquely distorted; lower adaxial and medial lobes greatly reduced, laterally displaced, and somewhat pinnate due to pedicel-nutlet fusion. Fruits dimorphic. Cauline fruits geminate, 3.0 - 5.3 mm ($\bar{X}$ = 4.0 $\pm$ 0.25 mm) long, $\pm$ biplanar; abaxial nutlet pair level or more commonly ascendingly curved; adaxial nutlet pair straight or distally ascendingly curved, but deflexed to 90° from the abaxial pair; nutlet body oblanceolate, nutlet outline oblong; nutlet lengths unequal, abaxial nutlets shorter, 1.25 - 2.25 mm ($\bar{X}$ = 1.7 $\pm$ 0.2 mm) long, adaxial nutlets longer, upper nutlet 1.5 - 2.75 mm ($\bar{X}$ = 2.0 $\pm$ 0.25 mm) long, lower nutlet 1.8 - 3.0 mm ($\bar{X}$ = 2.3 $\pm$ 0.3 mm) long; nutlet widths $\pm$ equal, 0.4 - 0.75 mm ($\bar{X}$ = 0.6 $\pm$ 0.1 mm); nutlets heteromorphic, margins of (one -) usually both adaxial nutlets distinctly reduced (- absent), minimum margin width, that of the lower adaxial nutlet, 0 - 0.05 mm ($\bar{X}$ = 0.03 $\pm$ 0.02 mm), maximum margin width, that of the upper abaxial nutlet, 0.5 - 0.8 (- 1.3) mm ($\bar{X}$ = 0.6 $\pm$ 0.2

Figure 6. Morphological characters of Pectocarya heterocarpa and Pectocarya peninsularis. P. heterocarpa, A-E. A. habit X 1/2. B-C. cauline fruits X 5. D. back of fruit showing calyx X 5. E. basal fruit X 5. P. peninsularis, F-I. F. habit X 1/2. G. cauline fruit X 5. H. back of fruit showing calyx X 5. I. basal fruit X 5.



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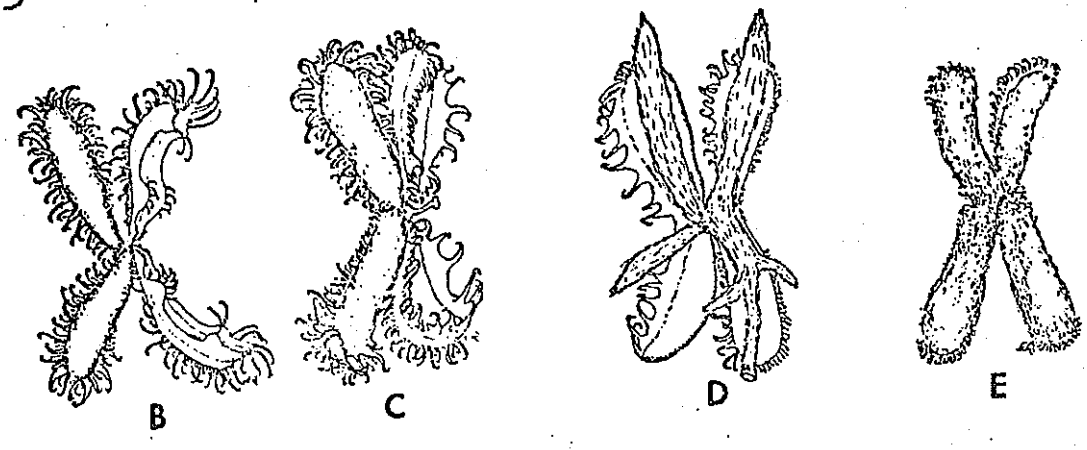
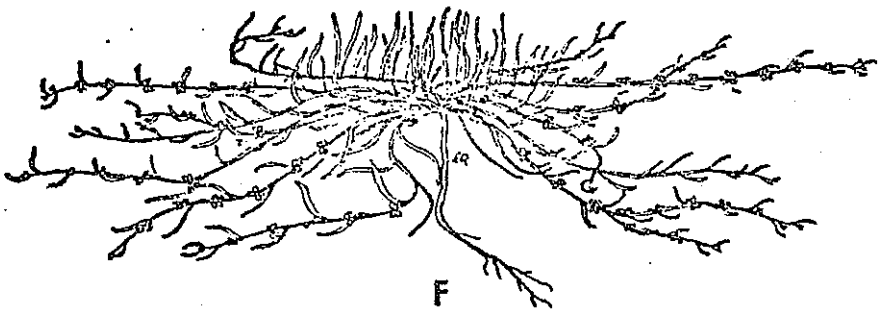


B C D E



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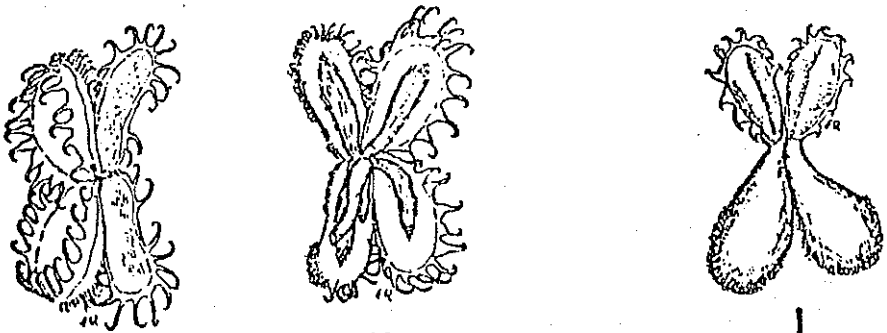


G H I

mm), maximum margin reduction 0.5 - 0.75 mm ($\bar{X}$ = 0.6 $\pm$ 0.1 mm); nutlet body invested with a dorsal-proximal fringe of retrorse uncinate bristles and a ventral-distal semicircular bristle tipped ridge; nutlet margins erect (- involute); abaxial nutlet margins bilobed, subentire, or irregularly and coarsely cleft; adaxial nutlet margins entire (- sparsely divided dentate); margin vestiture uncinate bristles, distal-pectinate, and lateral at apices of margin lobes or teeth. Basal fruits distinct, often densely clustered, 3.25 - 5.25 mm ($\bar{X}$ = 4.0 $\pm$ 0.3 mm) long; nutlets all somewhat (- strongly) reflexed, unequal in size, heteromorphic, 1 (- 2) nutlets unmargined, (2 -) 3 nutlets very narrowly margined; margins entire to continuously or discontinuously divided (- cleft) dentate. Gynobase broad-pyramidal. Chromosome number, n = 12.

Flowering Period. The peak flowering period of P. heterocarpa is from March through April; however, the plant may occur from mid January through mid June.

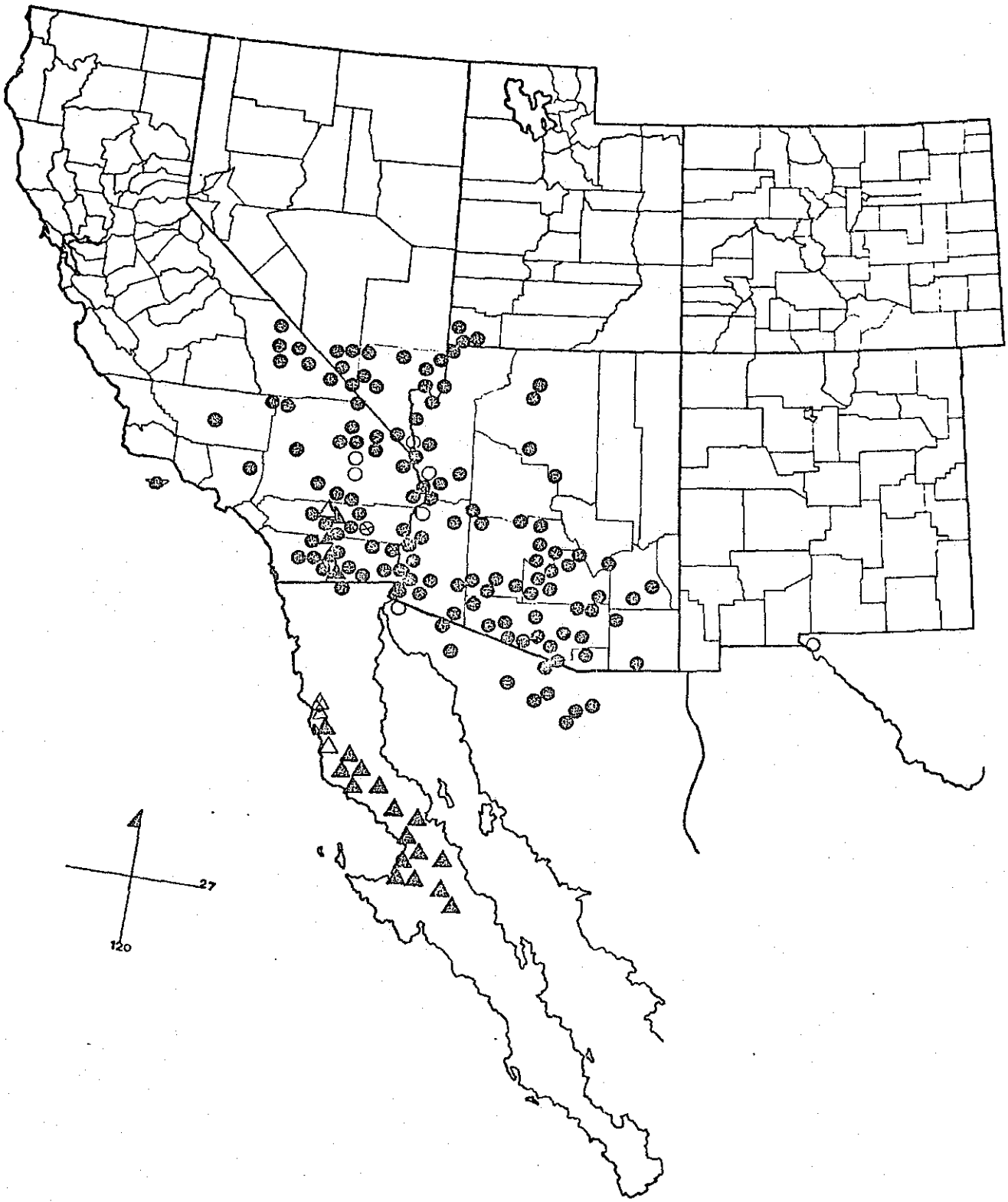
Distribution (Figure 7) and Ecology. Pectocarya heterocarpa occurs in southwestern North America from southern California to western Texas and from southern Utah to northern Mexico.

This species is predominantly a desert plant, an inhabitant of open areas, washes, and roadsides at elevations of -50 ft (-15 m) through 4500 ft (1400 m).

Figure 7. Distribution of Pectocarya heterocarpa ● and Pectocarya peninsularis ▲.

⊗ and ⊿ type localities.

○ and △ chromosome voucher populations.


27
120

Specimens Examined. ARIZONA. Cochise County. San Pedro River, Goodding 15-58 (ARIZ); Camp Lowell, 16 Apr 1881, Pringle s.n. in part (NY). Coconino County. Havasupi Falls, Deaver 3499 (ASU); Hermit Gulch, Eastwood 6020 (CAS); Havasu Canyon, J.T. Howell 26450 (CAS); Williams Fork, Palmer 380 (F, NY). Gila County. San Carlos River, Maguire, Richards, & Moeller 10490 (GH); San Carlos River, Maguire, Richards, & Moeller 10500 (GH). Graham County. Pinaleno Mts., Gillespie Wash, Bingham 1098 (ASU); Frye Canyon, Maguire et al. 11023 (GH); Thatcher, Thornber 4660 (ARIZ). Maricopa County. Biltmore Hotel, Phoenix, Abrams 12664 (CAS-DS); 25 mi N of Hassayampa, Benson 10023 (ARIZ); Turf Paradise, Demarce 42069 (ARIZ); Granite Reef Dam, Gillespie 8737 (UC, US); Chandler, Harrison & Kearney 6506 (ARIZ, GH); between Casa Grande and Gila Bend, Harrison & Kearney 6536A (CAS, GH); Aguila, M.E. Jones 25624 (CAS, CAS-DS); 4 mi E of Gila Bend, Keck 3911 (CAS-DS, GH); 18 mi N of Ajo, Keck 4237 (CAS-DS); 35 mi E of Salome, Keck 4260 (CAS-DS); Shea Boulevard, Keil 1577 (ASU); White Tank Mountains Regional Park, Keil 2883 (ASU); White Tank Mts., Keil 4067 (ASU); Thunderbird Regional Park, Keil & Lane K11273 (ASU); McDowell Mts. Regional Park, Lane 1131 (ASU); McDowell Mts. Regional Park, Lane 1196 (ASU); Phoenix, Lehto 429a (ASU); Hunt Highway, Chandler Heights, Lehto 450b (ASU); Lake Pleasant Regional Park, Lehto 4530 (ASU); Lake Pleasant Regional Park, Lehto 4751 (ASU); N of

Phoenix, Peebles, Harrison & Kearney 6800 (GH); Black Gap, Poindexter 5 (CAS-DS); Sierra Estrella Regional Park, Sundall 426 (ASU); 7 mi E of Aztec, Wiggins 8660 (GH, US). Mohave County. Willow Beach, Clokey 5936 (GH, NY, UC, WS); Hualapai Valley, Cronquist 10618 (CAS-DS, NY); Kingman, Eastwood 18069a (CAS); Pierce's Ferry, Grater 77 (UC); Willow Beach, Grater 134 (CAS-DS, UC); E of Littlefield, Higgins 6572 (NY); Beaverdam, M.E. Jones 5022 (MO, NY, UC, US, W); Mesquite to Littlefield, Kearney & Peebles 13203 (ARIZ, CAS); Fort Mojave, Apr 1884, Lemmon s.n. (ARIZ, BM); Beaver Dam Wash, Maguire 4950 (GH, MO, UC); Beaver Dam Wash, Maguire 4951 (GH, UC); 15 mi W of Kingman, Maguire 16245 (GH, UC); 2 mi up Grand Wash, Maguire 20636 (GH, NY); Grand Canyon, McClintok 52-286 (CAS); Route 93, 69 mi N of Chicken Spring Road junction in Wikieup, Nash et al. 10178B (ASU); Willow Beach Campground, Nash et al 10212 (ASU); above Pierce Ferry, Phillips & Van Devender 74-65a (ARIZ); 11.8 mi S of Temple Bar, Pinkava et al. 11134 (ASU); Hemenway Wash, Poyser 50 (GH); Kingman, Redinger 2177 (W); Tamarix Flats, 17 Apr 1973, Van Devender & Phillips s.n. (ARIZ); Yucca, Veno 299 (CAS); Yucca, Veno 456 (CAS); Highway 68, 4-5 mi W of Kingman, Veno 399 (CAS); between Sandy Road and Burrow Creek, Whitehead 73-405 (ARIZ); Alamo Crossing, Whitehead 73-608 (ARIZ). Pima County. Tucson, 3 Mar 1948, Beal s.n. (UC); 11 mi W of Sells, Benson 10641 (ARIZ, CAS-DS, NY, UC); Silverbell Mts,

Benson 10718 (ARIZ); Tumamoc Wash, Blumer T13 (US); Gunsight Pass, Fosberg 10653 (CAS, UC); 2 mi E of Sells, Fosberg 10659 (GH, UC); San Cristobal Wash, Fugate 660 (ARIZ); 10 mi N of Tucson, Gould 2937 (CAS, CAS-DS, GH, UC); Tucson, Griffiths 2229 (NY); Tucson, Griffiths 2249 (ARIZ, NY); Tucson, Griffiths 2266 (NY); Santa Cruz Bottoms, Griffiths 2396 (ARIZ, NY); Tucson, Griffiths 3527 (US); Fresnal Experiment Station, Harrison & Fulton 6819 (ARIZ); 1 mi S of Why, Hitchcock 25504 (NY, UC, WS); Altar Valley, Holmgren 6680 (NY); 3 mi N or Sasabe, Keck 3960 (GH); Organ Pipe National Monument, Keil & Lehto 15417b (ASU); Organ Pipe National Monument, Keil & Lehto 15447 (ASU); 0.3 mi E of Topawa, Lehto et al. 10763 (ASU, NY, US); Baboquivari Peak, Lehto et al. 10801 (ASU); 5.5 mi NW of of junction of Bear Canyon and Tanque Verde Roads, Lehto, Hensel, & Pinkava 10862 (ASU); Tucson, spring 1907, Loyd s.n. (F); Saguaro National Monument, Lund 66-13b (ASU); 9 mi N of Tucson, Maguire, Richards, & Moeller 10235 (GH); Baboquivari Mts., Maguire, Richards, & Moeller 10788 (GH); Wall's Well, Organ Pipe Cactus Monument, McDougall 40 (ARIZ); Quitovaquito, Mearns 2770 (US); Tucson Mts., Muenscher 14569 (MO); 6 mi NNE of Silver Bell, Nash 43 (ASU); 15 mi N of Tucson, Norvell 1793 (CAS-DS); Growler Valley, Shreve 6207 (ARIZ, F, GH); Tucson Mts., Shreve 9463 in part (ARIZ, GH, UC); University of Arizona campus, Tucson, Thornber 515 (ARIZ, CAS-DS, MO, NMC, UC, US);

Sabino Canyon, Toumey 84 (US); Tucson, Toumey 233 (ARIZ); Tucson, 15 Apr 1894, Toumey s.n. (GH, NY, UC, US); Desert Research Lab, Tumamoc Hill, Warren & Turner 68-77 (ARIZ); 59.8 mi W of Tucson, Wiggins 6517 in part (CAS-DS, GH, UC, US). Pinal County. Apache Junction, 14 Mar 1937, Darrow s.n. (MO); Sacaton, Eastwood 8022 (CAS); Casa Grande Monument, Elmore 1 (ARIZ); Oracle Road, Flagg & Ponomareff s.n. (ASU); 2 mi N of Olberg's, Gillespie 8748 (US); S of Sacaton, 21 Feb 1941, Gooding s.n. (ASU); Fresnal, Harrison 6819 (US); San Tan Mts., Harrison & Kearney 6462 (F, MO); Pinal Parkway, Keil, Pinkava, & Lehto 10873 (ASU); 2.3 mi S of Chuichu, Lehto et al. 10618 (ASU, NY, US); 1 mi NE of Mammoth, Maguire, Richards, & Moeller 10815 (UC); Superior, Nelson 11221a (NY, UC); 20 mi W of Casa Grande, Nelson 1231 in part (GH, K, NY, UC); Sacaton, Peebles 6513 (ARIZ, GH); San Tan Mts., Peebles 10688 (F, GH); Sacaton, Peebles 10700 (CAS, NY); 20 mi W of Casa Grande, Peebles & Harrison 9112 (ARIZ); 19 mi NW of Casa Grande, Shreve 10133 (ARIZ, CAS-DS, UC); Sierra Estrella Mts., Smith & Lehto S075 (ASU); 3 mi S of Florence Junction, Wiggins 9817 (CAS, CAS-DS, GH); Canyon of Santa Maria, Gould & Darrow 4202 (ARIZ); Lake Pleasant, Lehto L19753 (ASU); U.S. 93, 2.9 mi NW of Congress Junction Road, Pinkava et al. 11484 (ASU, NY); U.S. 93, 3.5 mi N of Joshua Forest, Pinkava et al. 11503 (ASU). Yuma County. 10 mi N of Quartzsite, Barr & Lange 64-207 (ARIZ); Mohawk, 6 Apr 1912, Bird s.n.

(CAS); Kofa Game Range, Dobson & Lehto 25 (ASU); Gila River, near Welton, Fosberg 10603 (GH, UC); Yuma, Goldman 1073 (US); Aztec, Harrison & Kearney 6549 (GH); 10 mi E of Blythe, Higgins 6368 (NY); 7 mi N of Dome, Hitchcock 25765 (G, NY, UC); 28 mi S of Quartzsite, Hitchcock 25804 (G, NY); Havasu Natural Wildlife Refuge, Kobetich & Lehto 73-92BW (ASU); 4.1 mi N to Alamo Crossing from junction of Route 60 at Wenden, McLeod & Pinkava 10306 (ASU, NY); Gila Crossover below Imperial, McMurry & Phillips 2679 (GH); Gila Crossover below Imperial, McMurry & Phillips 2681 (ARIZ); Highway 95, milepost 95, 4 Apr 1976, Robinson s.n. (ARIZ); Yuma, Swingle 5219 (ARIZ); New Water Mts., 26 Mar 1973, Van Devender s.n. (ARIZ); Highway 95, 26 mi S of Parker, Veno 286 (CAS); 2 mi S of Quartzsite, Wiggins 6632 (CAS-DS, GH, UC, US); N of Dome, Wiggins 8582 (CAS-DS, GH, UC, US); 19.5 mi NW of Tyson, Wiggins 8636 (ARIZ, GH, UC, US). CALIFORNIA. Imperial County. 7 mi NW of Ogilby, Alexander & Kellogg 1904 (UC); Picacho Wash, Bacigalupi, Heckard & Hutchison 8309 (UC); Burro Wash, Bacigalupi, Heckard, & Hutchison 8327 (UC); Box Canyon, 4.5 mi S of Picacho, Bacigalupi, Heckard, & Hutchison 8329 (UC); 1 1/2 mi S of Gold Rock Ranch, Bacigalupi & Hutchison 6135 (UC); arroyo, 4.5 mi S of Palo Verde, Bacigalupi & Hutchison 6168 (UC); Calexico, Davy 8014 (UC); Araz Stage Station, Gander 8986 (GH); E of Holtville, Howe B (GH); N of San Felipe Wash, Salton Sink, McGregor 755c (CAS-DS); Fort

Yuma, G.H. Thomas s.n. (NY); Chocolate Mts., Wiggins 9642 (CAS-DS, GH, UC); 5.4 mi W of Plaster City, Wiggins 14065 (CAS-DS). Inyo County. Panamint Valley, Coville & Funston 675 (US); Surprise Canyon, Coville & Funston 721 (MO, NY, US); Furnace Creek Canyon, Coville & Gilman 2 (US); Boundary Canyon, Gilman 1228 (GH); Wildrose Camp, Gilman 2836 (GH, US); Wildrose Camp, Gilman 2837 (GH, US); Death Valley, Holmgren 6331 (ASU, NY); Death Valley, Keck 5757 (CAS-DS); N of Shoshone, Muenscher 14820 (NY); Death Valley, Pinkava et al. 12138 (ASU); 3 mi W of Ballard, J.H. & H.A. Thomas 465 (CAS-DS). Kern County. U.S. 6, N of Mojave, Alava, Bacigalupi, & Tryon 1726 in part (UC); E of Ridgecrest, Twisselmann 11839 in part (CAS). Los Angeles County. 4 mi E of Pearblossum, Higgins 8445 (ASU). Riverside County. Big Maria Mts., Bacigalupi & Hutchison 6197 (UC); 6.7 mi E of Mecca, Balls 8309 (EDH); U.S. 95, 11.3 mi N of Blythe, Ferris & Bacigalupi 13249 (CAS-DS, NY, UC); U.S. 95, 11.3 mi N of Blythe, Ferris & Bacigalupi 13251 (CAS-DS, UC); 2 mi from Cottonwood Springs, Ferris & Rossbach 9530 (CAS-DS); Palm Spring, Grant 6779 (CAS-DS); Coachella, Greata 419 (CAS-DS); near Colorado River, Hall 5921 (CAS, UC); Coxcomb Mts., 30 Mar 1939, Jaeger s.n. (CAS-DS); Painted Canyon, Mecca Hills, Jepson 11647 (UC); Hayfields, M.E. Jones 25623 (CAS-DS); Hidden Springs Canyon, Mason 4229 (GH, K, UC); Deep Canyon, Munz 11993 (CAS-DS, F, MO, UC); Cottonwood Spring, Munz 13065 in part

(UC); Pinto Basin, Munz 15725 (CAS, CAS-DS, GH, UC); Hayfields, Munz & Keck 4804 (GH); Palm Springs, Nelson 3212 (UC); Mecca, Parish 8448 (UC); La Quinta, Rose 55022 (CAS); N of Indio, Wiggins 8768 (CAS-DS). San Bernardino County. Junction of U.S. 66 and 95, 10 mi NW of Needles, Alava, Bacigalupi, & Tryon 1757-B (CAS); Twentynine Palms, Alexander & Kellogg 893 in part (CAS-DS, UC, US); SW of Dale Dry Lake, Bacigalupi & Ferris 6234 (UC); Salt Wells Canyon, Ferris 3895 (CAS-DS); Pinto Mts., Ferris & Bacigalupi 13214 (CAS-DS); 11 mi N of Cima, Ferris & Bacigalupi 13284 (CAS-DS, UC); Bristol Valley, Holmgren 7459 (NY); N of Essex, Hoover 10968 (UC); Barstow, Jepson 5829 (UC); Essex, Jepson 18162 (UC); Amboy Crater, Jepson 20311 (UC); Needles, 8 May 1884, M.E. Jones s.n. (ARIZ, CAS-DS, NMC, NY, UC); Twentynine Palms, J. Keck 3799 (CAS-DS, GH); Vontrigger Spring, Munz 13697A (GH); Kessler Spring, Munz 13749 (GH); Needles, Parish 9611 (CAS-DS); 12 mi S of Needles, Shreve 7882 (ARIZ, CAS-DS, GH); 10 mi NE of Amboy, J.H. Thomas 7581 (CAS-DS); 2 mi SW of Kelso, Thomas 7590 (CAS-DS); Tunnel Ridge, Van Devender & Phillips 74-8 (ARIZ); Baker, Veno 100 (CAS); Kelbaker Road, 10 mi S of Essex, Veno 179 (CAS); Kelbaker Road, 10 mi S of Essex, Veno 233 (CAS); Kelbaker Road, vicinity of Amboy, Veno 275 (CAS); E. Colorado Desert, Hank's Well, Wolf 3206 (CAS-DS, GH, US); Mojave Desert, Kelso Sand Dunes, Wolf 10233 (CAS); Amboy to Kelso Road, Wolf 10041 in part (CAS, CAS-DS, NY);

Kingston Mts., Wolf 10436 in part (CAS, CAS-DS, NY); San Diego County. SE of Imperia, 25 Jan 1902, Abrams s.n. (CAS-DS); San Felipe Creek, Eastwood 2633 (CAS); Vallecito, 3 Apr 1932, Epling & Robinson s.n. in part (GH); 2 mi SW of Carrizo Station, Gander 7062 (GH); 7 mi W of Carrizo Mt., Gander 7845 (GH); Vallecito Creek, Hitchcock & Muhlick 23172 (F); Yaqui Well, Jepson 17114a (UC). Santa Barbara County. W of Prisoner Harbor, Santa Cruz Island, Fosberg 10596 (GH, UC). NEVADA. Clark County. Lower Kyle Canyon, Clokey 752 (NY); Kyle Canyon, Clokey 7685 (ARIZ, BM, CAS, CAS-DS, EDH, F, G, GH, MO, NY, UC, US, WS); S of Indian Springs, Clokey 8465 (GH, NY, UC, WS); S of Trout Creek, Clokey & Anderson 8085 (NY, UC); Pierce Ferry, Clover 6017A (GH); Pierce Ferry, Clover 6040 (GH); Sheep Mountains, Cronquist 8922 (GH, NY, WS); 22 mi SW of Mesquite, Cronquist 9926 (NY); McCullough Mountains, 16 mi W of Searchlight, Cronquist 9979 (NY); 2 mi W of Corm Creek, Deming (ARIZ); Moapa, Goodding 2200 (EDH, GH, MO, NY, UC); Pahrump Valley, Holmgren 7970 (NY); 1 mi W of Meade Lake boat landing, Maguire 16246 (GH); vicinity of public camp, Maguire 16294 (GH, UC, US); Virgin River, Maguire & Blood 4461 (GH); Valley of Fire, Milner 9294 (US); near Las Vegas, Munz 14928II (GH); St. Thomas, Tidestrom 8642 (GH, NY, US); Moapa, Tidestrom 8681 (UC). Elko County. Victory Highway, 5 mi E of Elko, Eastwood & Howell 253 (CAS, GH). Lincoln County. Vegas Wash, Coville

& Funston 422 (US). Nye County. W of Frenchman Flat, Beatley 1328 (CAS-DS); 2.5 mi W of Mercury, Beatley 3879 (CAS-DS, NY); Amargosa Desert, Mason & Lehto 334 (ASU). TEXAS. El Paso County. War Road, Franklin Mts., Correl & Flyr 38334 (MO, UC); Franklin Mts., Spellenberg 2205 (NMC, UC); NE of El Paso, Spellenberg 4610 (LA); University of California, Los Angeles, from seed of Spellenberg 4610, NE of El Paso, Veno 457 (CAS). UTAH. Washington County. Hurricane Fault, Atwood & Higgins 4433 (MO); 4 mi W of Hurricane, 6 Apr 1965, Christensen s.n. (GH); 5 mi N of St. George, Gould 1559 (GH); Saint George, Gould 1573 (ARIZ, GH); 5.7 mi S of Gunlock, Gould 1597 (GH, NY); St. George, Harrison 6300 (MO); 5 mi E of Virgin, Hitchcock 3020 (GH); St. George, M.E. Jones 1622 (BM, F, NY, US). Unspecified County. Southern Utah-northern Arizona, Palmer 360 (NY); southern Utah, Parry 167 (MO). MEXICO. Baja California Norte. Cucopa Mts., MacDougal 162 (NY); Cantu Grade, Wiggins 13032-A (CAS-DS). Sonora. 1 mi N of Santa Ana, Almeda 2548 (LA); Sierra de las Tenajas Atlas, Breedlove 15978 (CAS-DS); 1 km S of km 71 on Mexican Highway 2, Drees et al. 20585 (ARIZ); 1/2 km N of Moon Crater, Felger 19255 (ARIZ); Arroyo de Tule, Felger et al. 18769 (ARIZ); 45 mi S of Nogales, Fosberg 10613 (CAS, GH, MO, UC); Sykes Crater, Hansen, de Rosa, & Felger 18947 (ARIZ); 1 mi S of Moon Crater, Hansen & Felger 19092 (ARIZ); 7 mi S of Sasabe, Keck 3965 (GH); Rio Seco, 26 mi

S of Sasabe, Keck 3979 (GH); 26 mi S of Sasabe, Keck 3980 (GH); Pitiquito, Keck 4017 (CAS-DS, GH); 4 mi W of Caborca, Keck 4035 (GH); 8 mi NW of Tajitos, Keck 4096 (CAS-DS, GH); 38.4 mi S of Sonoyta, Keck 4197 (CAS-DS, GH); 8 mi S of Estacion Llana, Shreve 7328 (ARIZ, F); 27 mi NNW of Hassayampa, Shreve 7616 (ARIZ); 27 mi NNW of Hassayampa, Shreve 7616a (ARIZ); N of Pinacate Mts., Turner, Hastings, & Mason 1823a (ARIZ, MEX, W); 11.5 mi NW of Caborca, Wiggins 8281c (GH, US); 41 mi SW of Sonoyta, Wiggins 8370 (UC); N of Bacoachic, Wiggins 11708 (CAS-DS).

5. Pectocarya peninsularis I.M. Johnston, J. Arnold Arbor. 20: 401-402, 1939. Figure 6.——TYPE: Mexico. Baja California Norte. Santa Maria Plains and low hills adjacent, 23.5 mi south of Hamilton Ranch, 100 ft, 3 March 1930, Wiggins 4305 (holotype: CAS!; isotypes: CAS-DS!, NY!, UC!, US).

Plants branched from the base. Stems prostrate, few to many, slender, cinereous-strigose (- hispidulous), 1.5 - 24.0 cm ($\bar{X}$ = 5.7 $\pm$ 4.1 cm) long. Leaves narrow, linear, setulose, 1.0 - 4.0 cm ($\bar{X}$ = 2.5 $\pm$ 0.5 cm) long, 0.5 - 1.0 mm ($\bar{X}$ = 0.6 $\pm$ 0.1 mm) wide. Cauline flowers chasmogamous, basal flowers cleistogamous; pedicels 0.25 - 0.5 mm ($\bar{X}$ = 0.3 $\pm$ 0.1 mm) long; calyces 0.75 - 1.5 mm ($\bar{X}$ = 1.0 $\pm$ 0.1 mm) long; corollas 1.1 - 2.0 mm ($\bar{X}$ = 1.5 $\pm$ 0.2 mm) long. Fruiting pedicels free, ascending, 1.25 - 2.25 mm ($\bar{X}$ = 1.7

± 0.2 mm) long. Fruiting calyces divaricate, bilaterally symmetric, equaling or shorter than the nutlets, 2.25 - 4.1 mm ($\bar{X}$ = 3.0 ± 0.3 mm) long, ± regular; lobes subequal. Fruits dimorphic. Cauline fruits geminate, planar or the adaxial nutlet pair only slightly deflexed, 2.5 - 4.0 mm ($\bar{X}$ = 3.0 ± 0.2 mm) long; nutlet outline elliptic to orbicular obovate; nutlet body oblanceolate, 1.1 - 2.0 mm ($\bar{X}$ = 1.5 ± 0.1 mm) long, 0.4 - 0.75 mm ($\bar{X}$ = 0.55 ± 0.15 mm) broad; nutlets heteromorphic, one or both adaxial nutlet margins distinctly reduced; minimum margin width, that of the lower adaxial nutlet, 0 - 0.15 mm ($\bar{X}$ = 0.06 ± 0.03 mm); maximum margin width, that of the upper abaxial nutlet, 0.3 - 0.75 (-0.8) mm ($\bar{X}$ = 0.5 ± 0.1 mm), maximum margin reduction 0.3 - 0.6 mm ($\bar{X}$ = 0.5 ± 0.1 mm); nutlet margins spreading to ascending (-erect); lower adaxial nutlet margins entire to sparsely cleft or divided, remaining nutlet margins cleft (- parted) dentate or rarely subentire; margin armed all around with uncinate bristles, distally forming a pectinate fringe, laterally terminating margin segments. Basal fruits distinct, commonly densely clustered, occasionally suprabasal and occurring for a short distance along stems, 2.5 - 4.5 mm ($\bar{X}$ = 3.5 ± 0.3 mm) long; nutlets all somewhat (- strongly) reflexed, unequal in size, heteromorphic, 1 - 3 (-4) nutlets unmargined and often somewhat yellowish, (0-) 1 - 3 nutlets narrowly margined; margin dissection as in cauline fruits.

Gynobase broad-pyramidal. Chromosome number, n = 12.

Flowering Period. Pectocarya peninsularis occurs from January through March with maximal flowering from February through mid March. The species has occasionally been collected in mid October and mid December following rains.

Distribution (Figure 7) and Ecology. The primary center of distribution of P. peninsularis is Baja Californ Norte and Sur. It also extends, somewhat disjunctly, into southernmost California.

Pectocarya peninsularis occurs at elevations of 100 ft (30 m) through 1000 ft (300 m) in predominantly zeric habitats; clearings in scrub vegetation, silty to rocky washes, and along roadsides.

Specimens Examined. CALIFORNIA. Imperial County. Between Coyote Wells and Cement Bridge, McGregor 844 (CAS-DS). Riverside County. La Quinta Canyon, Clary 1965 (UC); Thousand Palms Canyon, Fosberg 10629 (CAS, UC); Morongo Valley Canyon, Hoover 11213 (CAS); Thousand Palms, J.T. Howell 3282 (CAS); Hayfields, M.E. Jones 25623 (BM); Aqueduct Road, 5 mi E of Garnet, Kamb 887 (UC); W of La Quinta, McKelvey 5068 (GH); Deep Canyon, Munz 11993 (CAS, Palm Springs, Rateaver 65 in part (GH); Box Canyon, Raven 11838 (CAS, UC); La Quinta, Rose 55022 (G); Indian Avenue, 0.5 mi E of Highway 62, Veno 435 (CAS); Mecca-Blythe Road, Wolf 3041 (CAS-DS, GH, US). San Diego County. 0.2 mi NW

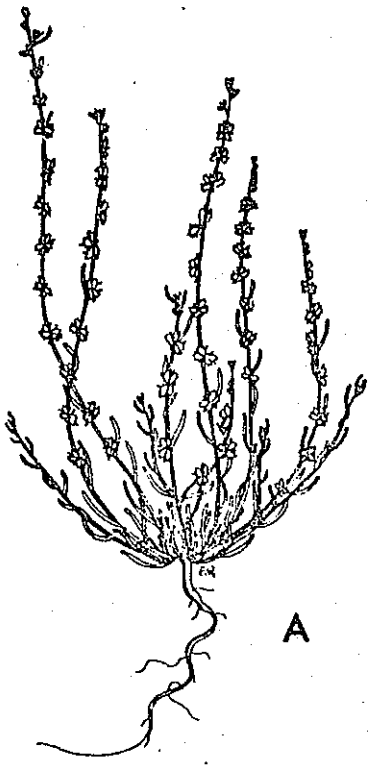
of Highway 78 on Narrows Road, Breedlove 1870 (CAS-DS); Borrego State Park, Hitchcock & Muhlick 22182 (F). MEXICO. Baja California Norte. Bahia San Quintin, Bacigalupi 3027 (UC); Bahia de Los Angeles, Gould 11885 (UC); Cedros Island, 7 Mar 1939, Haines & Hale s.n. (UC); 2 mi N of Miller's Landing, Haines & Stewart 160 (GH); 2 mi N of Miller's Landing, 10 Feb 1935, Haines & Stewart s.n. (ARIZ, CAS-DS); 11 mi SE of Mesquital, 8 Feb 1935, Haines & Stewart s.n. (ARIZ, CAS-DS, GH, K, UC); Bahia de Los Angeles, Moran 12301 (POM, UC, US); San Quintin Bay, Palmer 628 (F, K, NY, UC); San Quintin Bay, Palmer 733 (US); seed from Bacigalupi 3027, grown at University of California, Berkeley, Ray & Chisaki K-51A (UC) and K-51B (UC); 7 mi E of Santo Tomas, Shreve 6826 (GH); between La Espinita and Laguna de Guerrero Negro, J.H. Thomas 8236 (CAS-DS, UC); 2 mi S of Colonia Guerrero, Veno 209 (CAS); Bahia de Los Angeles, Wiggins 234 (CAS-DS); 18 mi W of Bahia de Los Angeles, Wiggins 300 (CAS-DS); 8 mi N of Hamilton Ranch, Wiggins 4291 (ARIZ, CAS-DS, GH, POM, UC, US); junction of El Marmol and San Fernando Roads, Wiggins 4345 (CAS-DS, GH, POM, UC, US); Playa Santa Catarina, Wiggins 4442 (CAS-DS, GH, OSU, POM, US); 9 mi E of Punta Prieta, Wiggins 7647 (CAS-DS, GH, UC, US); 27 mi N of Punta Prieta, Wiggins 7619A (CAS-DS, GH, UC, US); 9 mi E of Punta Prieta, Wiggins 7648 (CAS-DS); 27 mi E of Pozo Aleman, Wiggins 7839 (CAS-DS, GH, UC, US); 11 mi S of Miller's

Landing, Wiggins 15111B (CAS-DS); 6 mi S of Rancho Los Angeles, Wiggins 15175 (CAS-DS); 6 mi N of Rancho Mesquital, Wiggins 16762 (CAS-DS, MEX); 4-5 mi N of Rancho Mesquital, Wiggins 16771 (CAS-DS, MEX); 0.4 mi S of Rancho Tres Enriques, Wiggins 20920 (CAS-DS); 4.5 mi E of Rosario, Wiggins 20935 (CAS-DS); Arroyo del Rosario, Wiggins & Thomas 39 (CAS-DS); Arroyo del Rosario, Wiggins & Thomas 40 (CAS-DS); Mission San Fernando, Wiggins & Thomas 73 (CAS-DS); 7 mi toward Cerro Blanco from San Augustin--Laguna Chapala Road, Wiggins & Thomas 111 (CAS-DS); Bahia de Los Angeles, Wiggins & Thomas 263 (MEX). Baja California Sur. 26 mi S of Pozo Aleman, Shreve 7004 (ARIZ, F, GH, MO); 12 mi SW from El Arco, J.H. Thomas 8269 (UC); 18 mi E of Laguna Guerrero Negro along road to El Arco, Wiggins 16822 (CAS).

6. Pectocarya dimorpha (I.M. Johnston) I.M. Johnston, Contr. Gray Herb. 78: 115, 1927. Figure 8.—— Pectocarya gracilis (Ruiz & Pav.) I.M. Johnston var. dimorpha I.M. Johnston, Contr. Gray Herb. 70: 37, 1924. ——TYPE: Chile. Desert of Atacama, September-October, 1890, Morong 1282 (holotype: GH!; isotypes: NY, US).

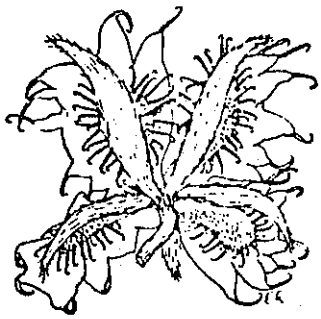
Plant multi-branched from the base. Stems slender, prostrate to ascending to erect, cinereous-strigose appressed, 1.0 - 24.0 cm ($\bar{X}$ = 7.8 $\pm$ 4.0 cm) long. Leaves narrow, linear, setulose, 1.0 - 3.0 cm ($\bar{X}$ = 2.1 $\pm$ 0.5 cm)

Figure 8. Morphological characters of Pectocarya dimorpha.
A. habit X 1/2. B, D, E. cauline fruits X 12.
C. back of fruit showing calyx X 12.



A

B



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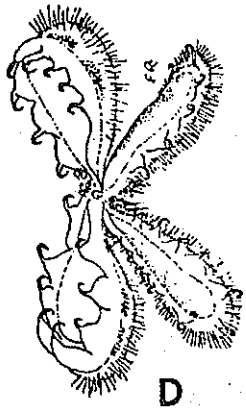

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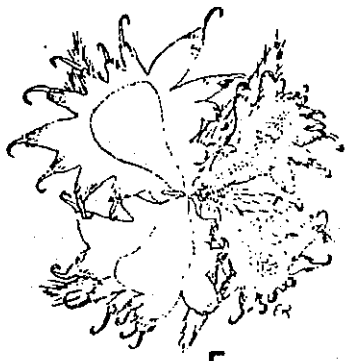


E

long, 0.5 - 1.0 mm ($\bar{X}$ = 0.75 $\pm$ 0.2 mm) wide. Cauline flowers chasmogamous, basal flowers cleistogamous; pedicels 0.25 - 0.5 mm ($\bar{X}$ = 0.36 $\pm$ 0.09 mm) long; calyces 1.0 - 1.8 mm ($\bar{X}$ = 1.2 $\pm$ 0.2 mm) long; corollas 1.0 - 2.0 mm ($\bar{X}$ = 1.5 0.3 mm) long. Fruiting pedicel free, ascending, 1.5 - 2.5 mm ($\bar{X}$ = 1.7 $\pm$ 0.3 mm) long. Fruiting calyces divaricate, bilaterally symmetrical, equal to or slightly exceeding the nutlets, 2.8 - 4.6 mm ($\bar{X}$ = 3.7 $\pm$ 0.5 mm) long, $\pm$ regular; lobes subequal. Fruits dimorphic. Cauline fruits geminate, planar, 2.45 - 4.75 mm ($\bar{X}$ = 3.5 $\pm$ 0.2 mm) long; nutlet outline obovate; nutlet body oblanceolate, 1.2 - 2.5 mm ($\bar{X}$ =1.7 $\pm$ 0.2 mm) long, 0.4 - 1.0 mm ($\bar{X}$ = 0.6 $\pm$ 0.1 mm) broad; nutlets heteromorphic, margins of adaxial nutlets distinctly to somewhat reduced; minimum margin width, that of the lower adaxial nutlet, 0.05 - 0.60 mm ($\bar{X}$ = 0.3 $\pm$ 0.1 mm); maximum margin width, that of the upper abaxial nutlet, 0.35 - 1.2 mm ($\bar{X}$ = 0.7 $\pm$ 0.2 mm), maximum margin reduction 0.3 - 0.6 mm ($\bar{X}$ = 0.4 $\pm$ 0.2 mm); nutlet margin dissection irregular, segments often discontinuous and variable; abaxial nutlet margins (rarely sinuate -) lobed or cleft (- parted) into broad lacerate-dentate segments; adaxial nutlet margins lobed to lacerately cleft, parted, or divided; margins armed both distally and laterally at the apices of margin segments with uncinate bristles. Gynobase broad-pyramidal. Chromosome number, n = 12.

Flowering Period. The growth period for P. dimorpha is from August through January with maximal flowering from mid September through mid October.

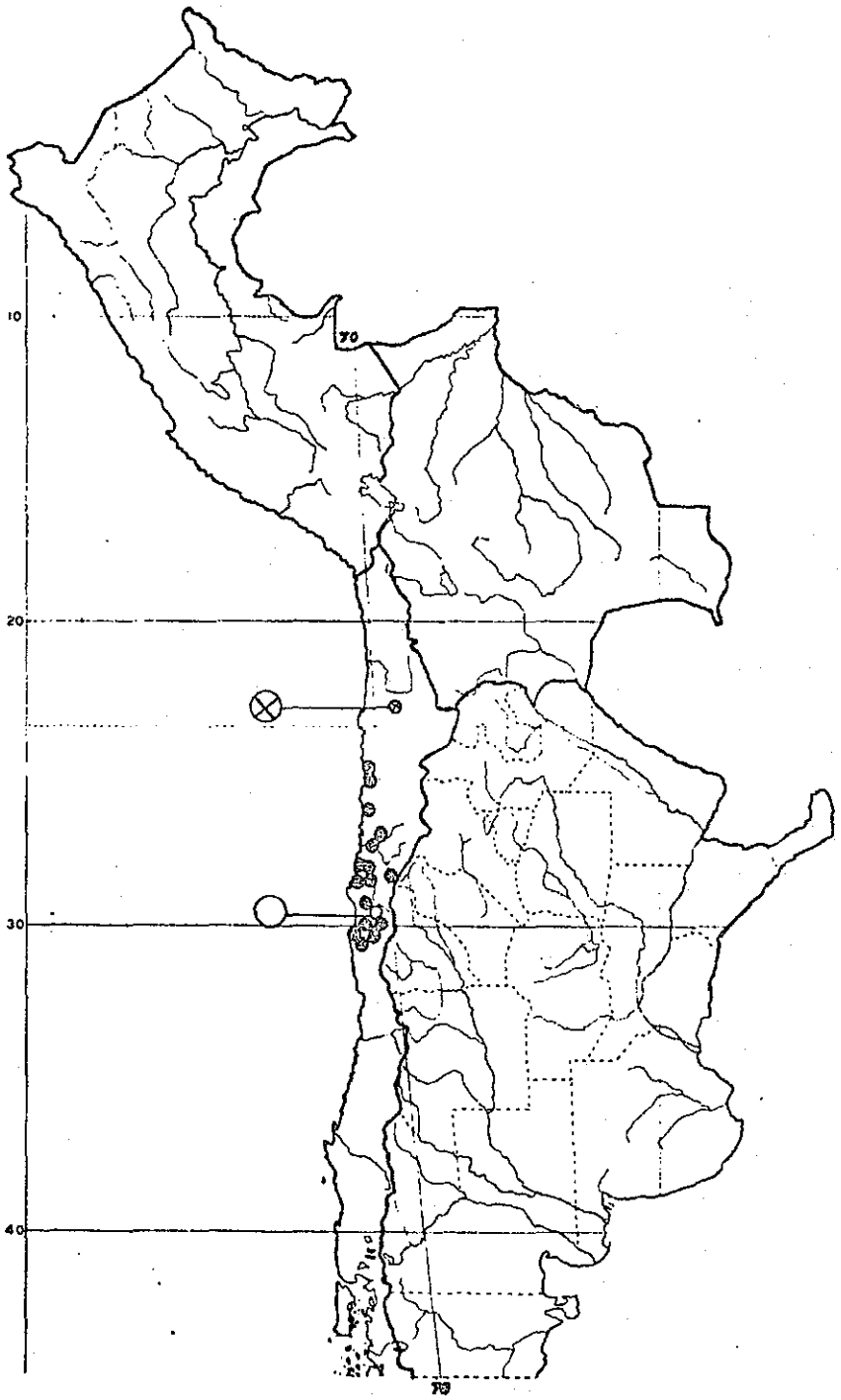
Distribution (Figure 9) and Ecology. Pectocarya dimorpha is endemic to Chile, and ranges from the extremely dry Desert of Atacama through the more temperate areas of central Chile. The plant is most common in the semi-arid zone from Copiapo through Santiago, and occurs at elevations of 30 ft (10 m) to 7000 ft (2100 m).

Specimens Examined. CHILE. Antofagasta. Taltal, Barros 6296 (GH); Desert of Atacama, Geisse 59 (NY); Llano Colorado, Johnston 5656 (GH); El Rincon, Ricardi 2676 (CONC); Taltal, Ricardi 2692 (CONC); 5-6 km NE of Taltal, Worth & Morrison 15849 (GH, UC). Atacama. Estacion Domeyko, Barros 6304 (GH); Vallenar, 18 Sept 1949, Behn s.n. (CONC); Yerba Buena, Collao 38 in part (GH); Bandurrias, 1883, Geisse s.n. (GH); Estancia Castilla, Gleisner 35 (CONC); Travesia, Jiles 2171 (CONC); 6 km N of Copiapo, Johnston 5025 (GH); Rio de la Laguna Grande, Johnston 5891a (EDH, GH, US, W); Rio de la Laguna Grande, Johnston 5891b (GH); Rio de la Laguna Grande, Johnston 5891d (GH); Carrizal, King 45 (EDH); Vallenar, Kohler 511 (CONC); Carretera Panamericana, 1 km al sur de Cachiyuyo, Marticorena, Rodriques, & Weldt 1770 (CONC); Caldera, Feb 1888, Philippi s.n. (K); Yerba Buena, Philippi & Borchers s.n.

Figure 9. Distribution of Pectocarya dimorpha ● .

⊗ type locality.

○ chromosome voucher population.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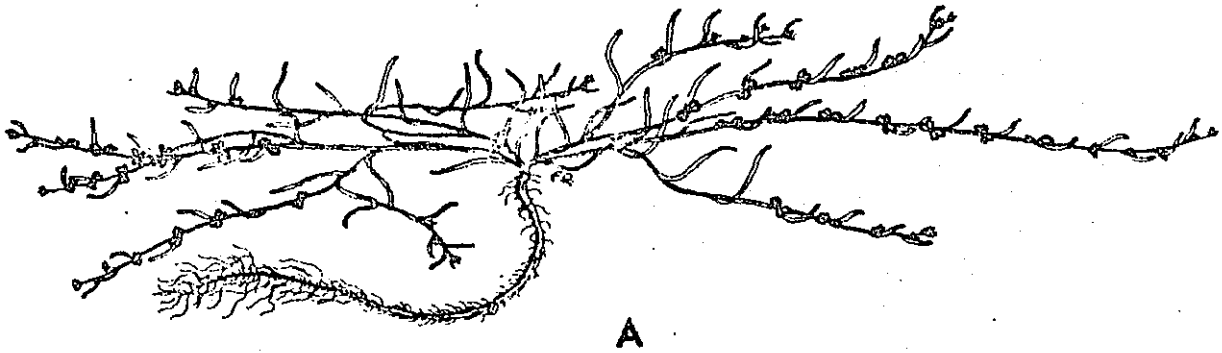
(BM); Carrizal Bajo, Ricardi 2285 (CONC); Estancia Manflas, Ricardi & Marticorena 3739 (CONC); Huasco, Ricardi & Marticorena 3925 (CONC); 30 km al norte de Vallenar, Ricardi & Marticorena 4400 (CONC); 5 km al sur de Vallenar, Ricardi & Marticorena 4853 (CONC); Carretera Panamericana, entre Caldera y Chanaral, Ricardi, Marticorena, & Matthei 1290 (CONC); Carretera Panamericana, 18 km al norte de Paipote, Ricardi, Marticorena, & Matthei 1460 (CONC); Vallenar, Rose 19331 (NY, US); Bandurrias, Zöllner 9801 (MO). Coquimbo. La Serena, 18 Sept 1952, Barros s.n. (CONC); Paiguano, Behn 8313 (CONC); Camino de Rivadavia-Paiguano, Behn 23670 (CONC); Seron, Jiles 3158 (CONC); Vicuna, Looser 4277 (GH); Arqueros, Marticorena & Matthei 302 (CONC); camino de Almirante Latorre a La Serena, Marticorena, Rodriques, & Weldt 1545 (CONC); Paiguano, 1884, Peralta s.n. (BM); Paiguano, Pfister 8341 in part (CONC); Fray Jorge, Ricardi 2092 (CONC); Anadocollo, Ricardi & Marticorena 4970 (CONC); grown from seed of Marticorena, Rodriques, & Weldt 1545, camino de Almirante Latorre a La Serena, at University of California, Los Angeles, Veno 483. Station Diaquitas, Wagenknect 18414 (F, GH, UC); Los Chiches, Wagenknect 18424 (F, G, GH, UC).

7. Pectocarya anisocarpa Veno sp. nov. Figure 10.

Herba annua ramosa basi. Caules gracilis, prostrati ad decumbentes, cinerei strigosa adpressi, 4.0 - 30.0 cm

($\bar{X}$ = 11.4 ± 5.7 cm) longi. Folia angusta linearia, cinerea-strigosa adpressa ad setulosa, 1.0 - 7.0 cm ($\bar{X}$ = 3.8 ± 0.6 cm) longa, 0.25 - 1.0 mm ($\bar{X}$ = 0.6 ± 0.1 mm) lata. Flores chasmogami; pedicelli 0.25 - 0.5 mm ($\bar{X}$ = 0.4 ± 0.1 mm) longi; calyces setulosi, lobi lanceolati, 0.75 - 1.4 mm ($\bar{X}$ = 1.0 ± 0.2 mm) longi; corollae infundibulares, 0.5 - 2.25 mm ($\bar{X}$ = 1.4 ± 0.3 mm) longae. Pedicelli fructiferi libri, ascendentes (- recurvi), 1.25 - 2.75 mm ($\bar{X}$ = 2.0 ± 0.2 mm) longi. Calyces fructiferi divaricati, bilateraliter symmetrici, ± regulares, breviores quam nuculae, 2.6 - 3.9 mm ($\bar{X}$ = 3.3 ± 0.3 mm) longi. Fructus monomorphi, margines nucularum basilarissimarum aliquantum diminuti, 3.0 - 5.0 mm ($\bar{X}$ = 4.1 ± 0.2 mm) longi; nuculae geminati; corpus nuculae oblanceolata, 1.5 - 2.5 mm ($\bar{X}$ = 2.0 ± 0.2 mm) longus, 0.4 - 0.75 mm ($\bar{X}$ = 0.6 ± 0.1 mm) latus; ambitus nuculae obovatus ad oblongus; nuculae heteromorphae, (unus -) ambo nuculae adaxiales marginibus diminutis distincte; latitudo margo minimum, ut nuculae infernae adaxialis, 0.05 - 0.25 mm ($\bar{X}$ = 0.15 ± 0.05 mm); latitudo margo maximus, ut nuculae superae abaxialis, 0.3 - 0.75 mm ($\bar{X}$ = 0.5 ± 0.1 mm); diminutio margo maxima 0.25 - 0.5 mm ($\bar{X}$ = 0.4 ± 0.1 mm); margines nuculae ascendentes (- erecti vel raro involuti), margo infernus adaxialis integer, margines nuculae reliquae subintegri ad dentati (- fissi) non profunde sed late; margo armatus circumcirca setis uncinatis, nucula omnis fimbria distali pectinata

Figure 10. Morphological characters of Pectocarya anisocarpa. A. habit X 1/2. B. fruit X 12. C. ventral view showing calyx X 12.



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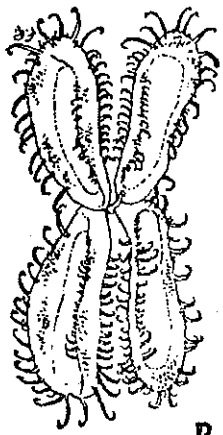

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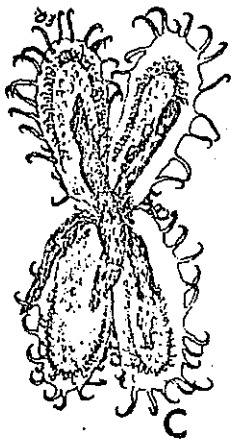


C

setarum et setis lateralibus intermittentibus (- sparsis) plerumque terminantibus lobis vel dentibus. Gynobasis latus-pyramidalis. Chromosomatum numerus, n = 24. TYPUS: California. Kern County. Gravel wash approximately 300 ft W of California State Highway 14, 0.25 mi S of Red Rock Canyon, 21.5 mi NE of Mojave, 3000 ft, 20 March 1977, Veno 357 (holotypus: CAS; isotypus: BM, CONC, GH, US).

Annual herb, branched from the base. Stems slender, prostrate to decumbent, cinereous-strigose appressed, 4.0 - 30.0 cm ($\bar{X}$ = 11.3 $\pm$ 5.7 cm) long. Leaves narrow, linear, cinereous-strigose appressed to setulose, 1.0 - 7.0 cm ($\bar{X}$ = 3.8 $\pm$ 0.6 cm) long, 0.25 - 1.0 mm ($\bar{X}$ = 0.4 $\pm$ 0.1 mm) wide. Flowers chasmogamous; pedicels 0.25 - 0.5 mm ($\bar{X}$ = 0.4 $\pm$ 0.1 mm) long; calyces setulose, lobes lanceolate, 0.75 - 1.4 mm ($\bar{X}$ = 1.0 $\pm$ 0.2 mm) long; corollas funnelform, 0.5 - 2.25 mm ($\bar{X}$ = 1.4 $\pm$ 0.3 mm) long. Fruiting pedicels free, ascending (- recurved), 1.25 - 2.75 mm ($\bar{X}$ = 2.0 $\pm$ 0.2 mm) long. Fruiting calyces divaricate, bilaterally symmetrical, $\pm$ regular, shorter than the nutlets, 2.6 - 3.9 mm ($\bar{X}$ = 3.3 $\pm$ 0.3 mm) long. Fruits monomorphic, margins of basalmost nutlets slightly reduced, $\pm$ planar, 3.0 - 5.0 mm ($\bar{X}$ = 4.1 $\pm$ 0.2 mm) long; nutlets geminate, nutlet body oblanceolate, 1.5 - 2.5 mm ($\bar{X}$ = 2.0 $\pm$ 0.2 mm) long, 0.4 - 0.75 mm ($\bar{X}$ = 0.6 $\pm$ 0.1 mm) broad; nutlet outline obovate to oblong; nutlets heteromorphic, (one -) both adaxial

nutlets with distinctly reduced margins; minimum margin width, that of the lower adaxial nutlet, 0.05 - 0.25 mm ($\bar{X}$ = 0.15 $\pm$ 0.05 mm); maximum margin width, that of the upper abaxial nutlet, 0.3 - 0.75 mm ($\bar{X}$ = 0.5 $\pm$ 0.1 mm); maximum margin reduction 0.25 - 0.5 mm ($\bar{X}$ = 0.4 $\pm$ 0.1 mm); nutlet margins ascending to erect (- rarely subinvolute), lower adaxial margin entire, remaining nutlet margins subentire to shallowly and broadly dentate (- cleft); margin armed all around with uncinate bristles which distally form a pectinate fringe, and are laterally intermittent to sparse, but commonly terminate margin lobes or teeth. Gynobase broad-pyramidal. Chromosome number, n = 24.

Flowering Period. Pectocarya anisocarpa occurs from February through mid May with maximal flowering from mid March through mid April.

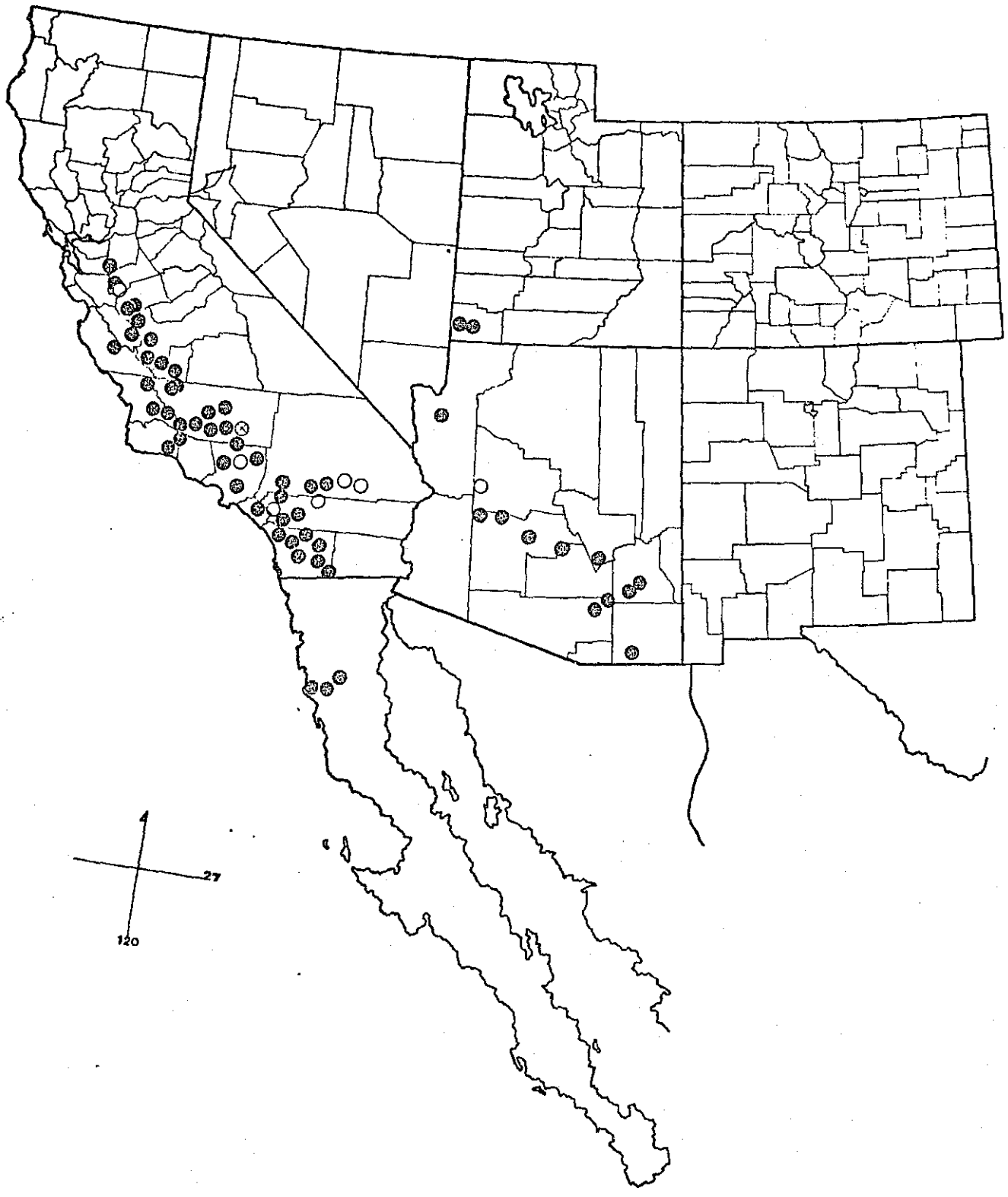
Distribution (Figure 11) and Ecology. Pectocarya anisocarpa has a primary distribution in southern California, and extends disjunctly into Arizona and Baja California Norte, Mexico.

This species is a widespread, weedy taxon of disturbed habitats; chaparral clearings, roadsides, and washes. It occurs from the more mesic central California foothills to the desert at elevations of 300 ft (90 m) to 5000 ft (1500 m).

Figure 11. Distribution of Pectocarya anisocarpa ● .

⊗ type locality.

○ chromosome voucher populations.


27
120

Specimens Examined. ARIZONA. Cochise County. Valley near Camp Lowell, 6 May 1883, Pringle s.n. (F); mesas, Camp Lowell, Apr 1881, Pringle s.n. (US); mesas near Camp Lowell, 16 Apr 1881, Pringle s.n. (MO). Gila County. 10 mi W of Coolidge Dam, Maguire, Richards, & Moeller 10469 (F, MO, UC, US); Six Shooter Canyon, Pase 1798 (ASU). Graham County. Pinaleno Mts., Bingham 1096 (ASU); 10 mi S of Safford, Maguire, Richards, & Moeller 10140 (GH, MO, US); 14 mi S of Pima, Maguire, Richards, & Moeller 10568 (GH). Maricopa County. Aguila, 3 Apr 1930, M.E. Jone s.n. (BM, MO); Wickenburg, 3 Apr 1921, W.W. Jones s.n. (K, MO); Peoria, 29 Apr 1896, Orcutt s.n. (UC); Wickenburg, Peebles 8478 (F, UC). Mohave County. 14 mi SW of Hackberry, Wiegand 1976 (GH). Pima County. 14 mi E of Tucson, Brass 14189 (GH, MO, NY); Reddington, Mar-Apr 1913, Kilgour s.n. (ARIZ); Rillito, 9 Mar 1902, Thornbur s.n. (ARIZ). Pinal County. 6 mi N of Apache Junction, Abrams 12943 (CAS-DS). Yavapai County. U.S. 93, 1.1 mi N of Santa Maria River bridge, Pinkava et al. 11380b (ASU); progeny of Pinkava et al. 11380b, 1.1 mi N of Santa Maria River bridge, University of California, Los Angeles, Veno 485 (CAS). Unspecified County. Arizona, Palmer 380 (US). CALIFORNIA. Fresno County. 0.1 mi E of Fresno-San Benito County line, Chisaki & Ray 2266 (ARIZ, BM, UC); Coalinga, Eastwood 13438 (CAS); 1 mi E of Fresno County line, Gould 231 (ARIZ); between Mendota and Coalinga, Hoover 427 (CAS, UC);

9 mi E of Coalinga, Hoover 2908 (UC); between Arroyo Hondo and Cantua Creek, Hoover 3292 (GH, UC); Kettleman Hills, Hoover 4250 (CAS, GH, UC); Coalinga, Jepson 15354 (UC); W of Hayes Station, Jepson 16979a (UC); SE of Coalinga, Jepson 17014 (UC); Coalinga, Jepson 17018 (UC); Waltham Creek, Keck 2152 (CAS-DS); Jacalitos Hills, J.H. Thomas 12558 (CAS-DS). Kern County. between Mojave and Calico, Abrams 11817 (CAS-DS); Kern River Canyon, 7 Apr 1900, Abrams s.n. (CAS-DS); U.S. 6, 16 mi N of Mojave, Alava, Bacigalupi, & Tyron 1730 (UC); Mt. Breckenridge Road, Benson 3081 (US); Rose Station, 28 Mar 1930, S. Benson s.n. (UC); Mojave Desert, Bright 9209 (US); Bakersfield, Davy 1726 (UC); Tehachapi Grade, Ferris 4062 (CAS-DS); 2 mi NE of Caliente, Higgins 8380 (NY); Maricopa Hills, Hoover 3104 (ARIZ, GH, UC, US); 3 mi S of Blackwell's Corner, J.T. Howell 5896 (CAS); Sand Canyon, Howell & True 49131 (CAS); Tejon Ranch, Keck & Clausen 3170 (CAS-DS, GH); 12 mi E of Maricopa, Keck 5868 (CAS-DS); Taft High School, Keck & Clausen 3115 (CAS-DS, GH); 3 mi SE of McKittrick, Johannsen 1474 (UC); 5 mi S of Muroc, Mason 6888 (GH, UC); Caliente Creek, Munz 13658 (GH, UC); Wheeler Ridge, Rose 37053 (UC); 1/4 mi NW of Poso Mine, C.N. Smith 47 (UC); Adobe Canyon, C.N. Smith 1172 (UC); North Lost Hills, Twisselmann 870 (CAS); Annette Road, Antelope Valley, Twisselmann 920 (CAS); Middlewater Plain, Twisselmann 973 (CAS-DS); Poso Creek Road, Twisselmann 4199 (CAS); Silver Queen Road, Twissel-

mann 6839 (CAS); E of Ridgecrest, Twisselmann 11839 (CAS); Highway 14, 0.25 mi S of Red Rock Canyon, Veno 445 (CAS); San Joaquin Valley, Wolf 6327 (ARIZ, W); Mojave, 13 Mar 1913, Wooton s.n. (US). King County. Highway 41, 10 mi SW of Kettleman City, Brenckle 51206 (UC); Kettleman City, Hoover 2915 (CAS, UC); Kettleman Hills, Hoover 2929 (GH, UC, US). Los Angeles County. Santa Susanna Mts., Brewer 210 (GH, US); San Francisquito Canyon, Clokey & Templeton 4674 (NY, UC in part); Pueblo de Los Angeles, 7 Mar 1884, Gamble s.n. (GH); Pasadena, Grant 914 (UC); W of Lancaster, 24 Mar 1962, Griesel s.n. (CAS-DS); Neenach School, Jepson 19236 (UC); Lovejoy Buttes, Kamb 801c (UC); Colton, Vasey 331 (BM); Highway N2, 1.5 mi NW of Palmdale, Veno 150 (CAS); Highway N2, 1.5 mi NW of Palmdale, Veno 154 (CAS). Merced County. N of Ortigalita Creek, Hoover 4298 (CAS, GH, UC, US); Laguna Seca Hills, Lyon 1627 (CAS). Monterey County. San Lorenzo Creek, J.T. Howell 39236 (CAS); Old Metz Road, Howitt 1456 (CAS). Orange County. Santiago Creek, 27 Mar 1902, Geis s.n. in part (CAS-DS). Riverside County. Winchester, Amstall 398 (UC); Double Buttes, Bacigalupi & Heckard 8418 (UC); Hemet, C.F. Baker 4139 (CAS-DS, UC); Riverside, Hall 2943 (CAS-DS, UC); Riverside, Hall 2964 (UC, US); Whitewater, Shreve 8156 (ARIZ); 6.5 mi SE of Banning, J.H. Thomas 50 (CAS-DS); Highway 71, 11 mi SE of Corona, Veno 147 (CAS); Indian Avenue, Veno 218 (CAS); Indian Avenue, Veno 257 (CAS); 11 mi SE of Corona,

Veno 398 (CAS); Highway 71, 11 mi SE of Corona, Veno 458 (CAS); 5 mi S of Winchester, 30 Mar 1947, Vestal s.n. (CAS-DS). San Benito County. 25 mi S of Dos Palos, Ferris 6956 (CAS-DS); 3 mi from Panoche, Ferris 6979 (CAS-DS, NY); Mendota-Panoche Road, Ferris 9737 (CAS-DS, GH); Panoche Valley, Jepson 18123 (UC); Griswold Hills, Quibell 903 (CAS-DS). San Bernardino County. Hackberry Mt., Ferris 7267 (CAS-DS); Morongo Valley, J.T. Howell 3405 in part (CAS); Saltdale, Jepson 19513a (UC); San Bernardino Valley, Parish 41 (CAS-DS, NY, US); San Bernardino, May 1888, Parish s.n. (F); San Bernardino County, Vasey 696 (K, NY, US); 5 mi SW of Yucca Valley, Veno 125 (CAS); Twentynine Palms, Veno 142 (CAS); 6 mi NE of Morongo Valley, Veno 249 (CAS); 6 mi NE of Morongo Valley, Veno 259 (CAS); 6 mi SW of Yucca Valley, Veno 425 (CAS). San Diego County. Ramona, Apr 1899, T.S. Brandegee s.n. (UC); Fallbrook, M.E. Jones 3123 (CAS, US); Mountain Springs Grade, Orcutt 236 (UC); Mason Valley, Purer 6322 (GH); Lilac Road, 7 mi SE of Pauma Valley, Veno 118 (CAS); 0.6 mi NW of Lake Jean, Veno 149 (CAS); 0.6 mi NW of Lake Jean, Veno 459 (CAS); 4.3 mi E of Banner, Wiggins 14098 (CAS-DS). San Joaquin County. Corral Hollow, Eastwood & Howell 2103 (CAS); Corral Hollow, Ferris 9398 (CAS-DS, GH, NY, UC); Corral Hollow, Hoover 6078 (UC). San Luis Obispo County. Carrizo Plain, Breedlove 2087 (CAS-DS); San Luis Obispo County, Clokey 5829 (ARIZ, BM, CAS-DS, F, G, GH, MO, NY, UC, US, W); Cuyama

Valley, 13 Apr 1935, Essau s.n. (CAS); 1 mi N of Spanish Ranch, French 878 (UC); Cottonwood Pass, Hoover 6883 (CAS, UC); San Juan River, Hoover 7463 (CAS); Panorama Hills, Hoover 9776 (CAS); Temblor Range, Hoover 10306 (CAS); Carrizo Plain, Jepson 16216a (UC); Elkhorn Plain, Robbins & Bacigalupi 3450 (UC); 11.5 mi S of Shandon, Twisselmann 1767 (CAS). Santa Barbara County. Santa Barbara, Nuttall s.n. (K); Ballinger Canyon, Twisselmann 1815 (CAS). Stanislaus County. S of Del Puerto Canyon, Hoover 4291 (UC); Crow Creek Canyon, Hoover 4312 (CAS, GH, UC, US); 12 mi W of Patterson, grown at Stanford from Breedlove 4859 (CAS-DS), Raven 18752 (CAS-DS, US). Tulare County. Pixley Natural Area, 25 Mar 1967, McClintok s.n. (CAS). Unspecified county. Southern California, Coulter 516 (EDH, GH). UTAH. Washington County. 5.7 mi S of Gunlock, Gould 1597 (GH, NY, WS); Diamond Valley, Gould 1701 (ARIZ, CAS-DS, GH, NY, UC, US). MEXICO. Baja California Norte. San Rafael Ranch, 14 May 1886, Orcutt s.n. (UC); Valle Trinidad, Wiggins 16055 (CAS, CAS-DS, US).

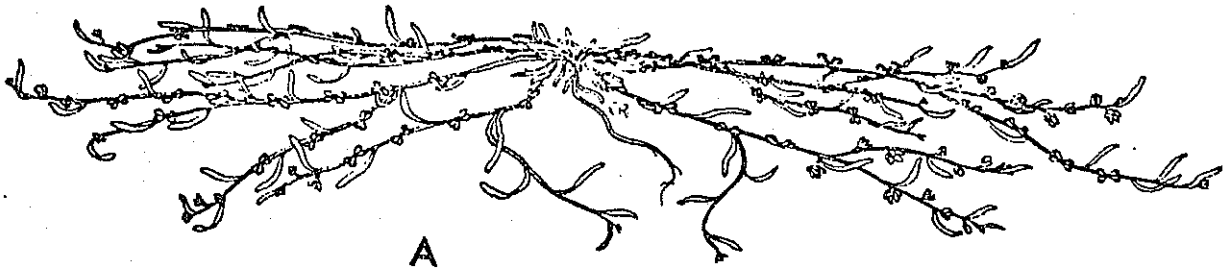
8. Pectocarya penicillata (Hook. & Arn.) Alph. DC., Prodr. 10: 120-121, 1846. Figure 12.——Cynoglossum penicillatum Hook. & Arn., Bot. Beechy's Voyage: 371, 1839. ——Pectocarya linearis (Ruiz & Pav.) DC. var. penicillata (Hook. & Arn.) M.E. Jones, Proc. Cal. Acad. Bot. ser. 2, vol. 5: 709, 1895.——Pectocarya penicillata

(Hook. & Arn.) Alph. DC. var. genuina I.M. Johnston, Contr. Gray Herb. 70: 37, 1924.——TYPE: Nova California, 1833, Douglas s.n. (holotype: BM!). Hooker and Arnott (1840) reported that the California collections of Douglas were made chiefly in the Monterey and San Francisco areas.

Pectocarya miser Nelson, Bot. Gaz. (London) 37: 278, 1904. ——TYPE: Wyoming. Point of Rocks, 15 June 1898, Nelson 4741 (holotype: RM; isotypes: GH!, MO!, NY (2)!, UC!, US!). Pectocarya miser represents the northern element of P. penicillata, and one extreme of clinal variation in nutlet form within the species. The nutlets of P. miser often possess a subentire rather than the typical bilobed margin, and an apical-lateral rather than apical distribution of margin bristles; however, the existence of transitional forms between the northern and southern elements of P. penicillata confirms that they are conspecific.

Plants branched from the base. Stems slender, prostrate to decumbent, cinereous-strigose appressed, 2.0 - 25.0 cm ($\bar{X}$ = 8.2 $\pm$ 3.8 cm) long. Leaves narrow, linear, cinereous-strigose appressed (- setulose), 1.0 - 4.0 cm ($\bar{X}$ = 3.0 $\pm$ 0.3 mm) long, 0.5 - 2.0 mm ($\bar{X}$ = 0.9 $\pm$ 0.2 mm) wide. Flowers chasmogamous; pedicels 0.2 - 0.4 mm ($\bar{X}$ = 0.3 $\pm$ 0.05 mm) long; calyces 0.7 - 1.25 mm ($\bar{X}$ = 1.0 $\pm$ 0.1

Figure 12. Morphological characters of Pectocarya penicillata. A. habit X 1/2. B. corolla X 20. C. ovary X 20. D. fruit X 10. E. ventral view of fruit showing calyx X 10.



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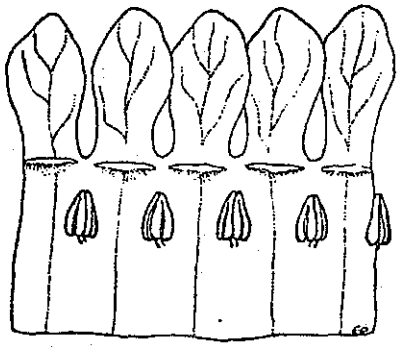

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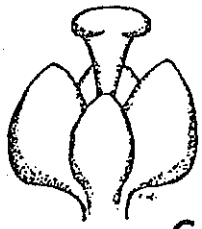

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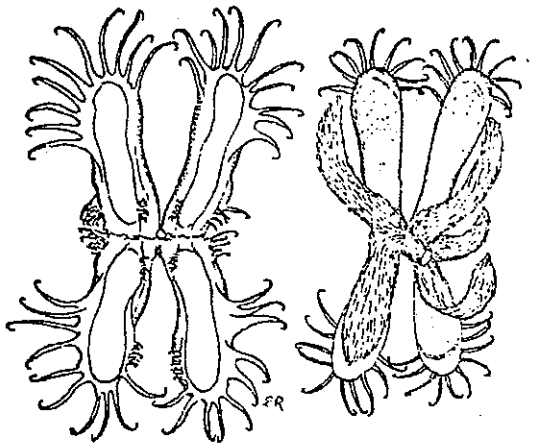


D E

mm) long; corollas 0.7 - 1.5 mm ($\bar{X}$ = 1.3 $\pm$ 0.1 mm) long. Fruiting pedicels free, ascending, 1.25 - 2.5 mm ($\bar{X}$ = 1.9 $\pm$ 0.3 mm) long. Fruiting calyces divaricate, bilaterally symmetrical, $\pm$ regular, shorter than the nutlets, 2.5 - 4.0 mm ($\bar{X}$ =3.2 $\pm$ 0.4 mm) long. Fruits monomorphic, margins of basalmost fruits well developed, planar, 2.2 - 6.3 mm ($\bar{X}$ = 4.1 $\pm$ 0.3 mm) long; nutlets geminate; nutlet outline oblong; nutlet body oblanceolate, 1.1 - 3.25 mm ($\bar{X}$ = 2.0 $\pm$ 0.3 mm) long, 0.4 - 0.75 mm ($\bar{X}$ = 0.6 $\pm$ 0.1 mm) broad; nutlets homomorphic, or one or more nutlets with margins only slightly reduced; minimum margin width, that of the lower adaxial nutlet, 0.05 - 0.6 mm ($\bar{X}$ = 0.4 $\pm$ 0.1 mm); maximum margin width, that of the upper abaxial nutlet, 0.25 - 0.75 mm ($\bar{X}$ = 0.5 $\pm$ 0.1 mm); maximum margin reduction 0.15 - 0.2 mm ($\bar{X}$ = 0.1 $\pm$ 0.01 mm); nutlet margins erect to involute (- ascending), commonly broadly bilobed or bidentate to obscurely bilobed (- subentire); each nutlet distally armed with a tuft of pectinately arranged uncinate bristles, distal margin lobes commonly lacking bristles or occasionally bristled for 1/2 to 3/4 of lateral margin length, proximal margin lobe naked or apex commonly armed with one or two short uncinate bristles. Gynobase broad-pyramidal. Chromosome number, n = 12.

Flowering Period. The growth period for P. penicillata is from January through mid August with maximal flowering from March through May.

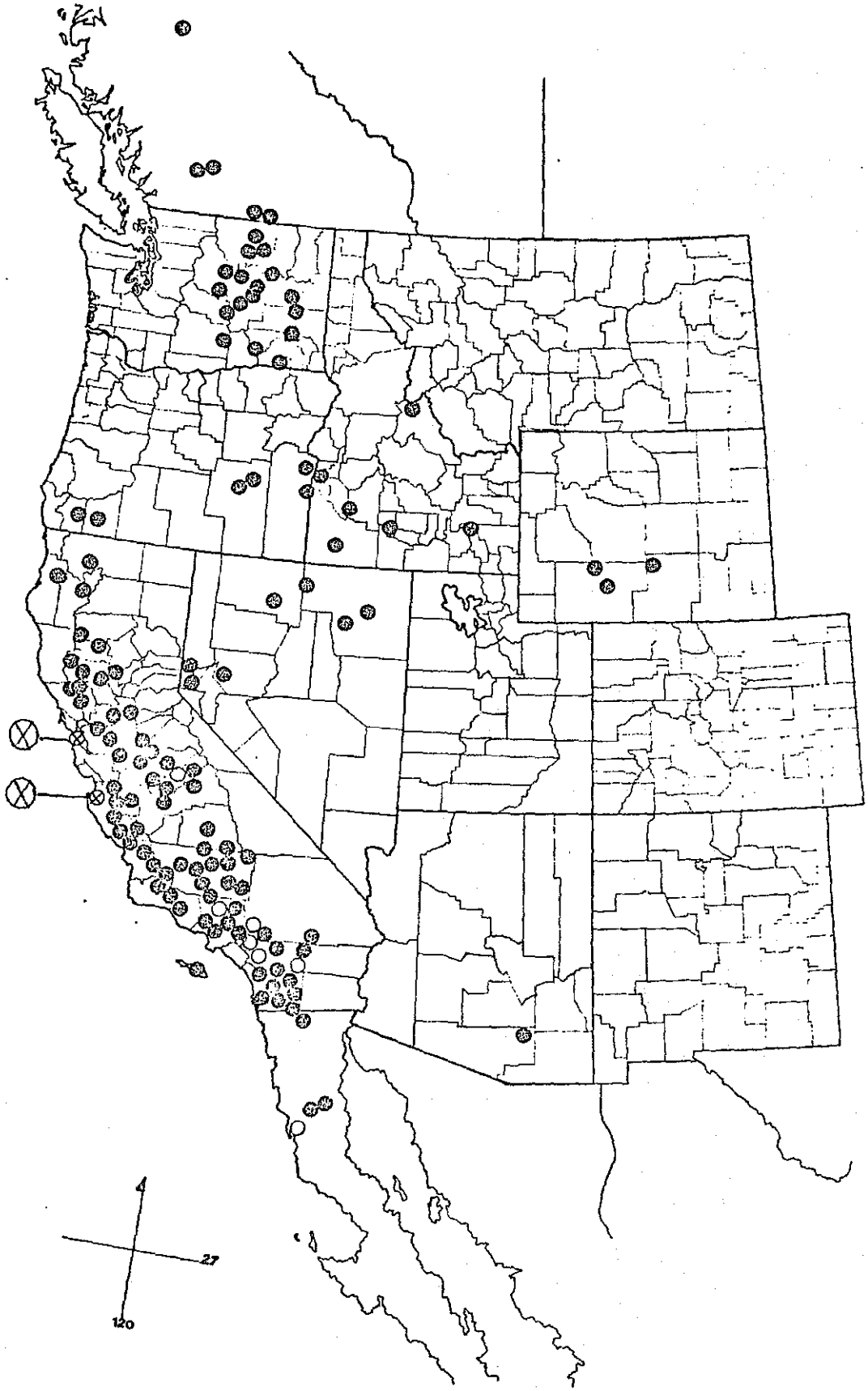
Distribution (Figure 13) and Ecology. The most widespread of the species of Pectocarya, P. penicillata extends, somewhat disjunctly, from British Columbia through Baja California Norte, Mexico. It is a weedy species, a common occupant of desturbed areas such as roadsides and clearings in chaparral. Pectocarya penicillata occurs from mesic coastal regions to semi-arid desert foothills at elevations of 300 ft (90 m) through 7000 ft (2100 m).

Specimens Examined. CANADA. British Columbia. Richter Pass Road, Calder & Spicer 33178 (CAS-DS, OSU, UC, WS); Osoyoos, 12 May 1940, Eastham s.n. (WS); Mt. Anarchist, 11 May 1940, Eastham s.n. (GH, WS); Lytton, Fletcher 1548 (BM); Fraser River Valley, Macoun 1132 (K); Lytton, Macoun 1367 (GH); Fraser River Valley, Macoun 1369 (F); Lake Osoyoos, Macoun 76742 (F, NY); Spencer's Bridge, 28 May 1889, Macoun s.n. (BM, NY, US); junction of Thompson and Fraser Rivers, May 1875, Macoun s.n. (GH); Anarchist Mt., J.W. Thompson 14389 (GH). UNITED STATES. ARIZONA. Pima County. Santa Catalina Mts., Apr 1881, Lemmon s.n. (F, NY). CALIFORNIA. Colusa County. Sand Creek, Hoover 3220 (CAS, UC). Contra Costa County. Antioch, C.F. Baker 2804 (ARIZ, G, GH, MO, NY, W); Antioch, Apr 1889, T.S. Brandegee s.n. (UC); Byron Springs, Eastwood 3833 (CAS); Antioch, Eastwood 10274 (CAS); March Creek Road, Mason 5133 (GH, UC); Antioch, Mason 6845 (UC); Antioch, 9 Apr 1910, McMur-

Figure 13. Distribution of Pectocarya penicillata  .

⊗ region of type collection.

○ chromosome voucher populations.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phy s.n. (CAS-DS); Antioch, Rose 33097 (CAS, W). Fresno County. Fresno, Apr 1889, Congdon s.n. (CAS-DS); Pinehurst to Badger, Newlon 182 (UC); Kings River, Rose 34092 (NY, W). Glenn County. 8 mi W of Orland, Wheeler 3514 (G, GH). Humbolt County. Valley of Trinity River, Tracy 3484 (UC); Trinity River Valley, Tracy 7418 (CAS-DS, GH, UC); Trinity River Valley, Tracy 12182 (GH, UC). Kern County. Famosa, Abrams 10856 (CAS-DS); between Rosamond and Mojave, Abrams 11778 (CAS-DS); Kern River Canyon, 7 Apr 1900, Abrams s.n. (CAS); Walker Pass Road, Alexander & Kellogg 1034 (GH, UC); 1/4 mi N of Rosedale Highway, Bacigalupi & Gillett 4369 (UC); Mojave, M.S. Baker 8814 (GH); White Wolf Grade, Benson 3004 (CAS-DS); Havilah, Coville & Funston 1089 (US); Edison Oil Field, Dabney 11.9 (ARIZ); Greenhouse Range, Hall & Babcock 5038 (CAS-DS, UC); Oil City, Heller 7586 (EDH); between Kernville and Isabelle, J.T. Howell 24230 (CAS, G); 2 mi N of Mojave, J.T. 24257 (CAS); Rowen Station, Jepson 6731 (UC, WS); Linns Valley, Purpus 5701 (EDH, NY, US); 5 mi W of Freeman, Rose 40034 (GH); 2 mi N of Mojave, Rose 48063 (ARIZ, UC); 2 mi N of Mojave, Rose 48078 (MO, US, W); 2 mi SE of Walker Pass, Rose 62043 (CAS-DS, WS); Poso Creek, C.N. Smith 44 (UC); 1 mi NW of Poso Mine, C.N. Smith 48 (UC); Coffee Creek, C.N. Smith 501 (UC); Fay Creek, C.N. Smith 947 (UC); W of Schwab Spring, C.N. Smith 1161 (UC); Adobe Canyon, C.N. Smith 1172-A (UC); 6 mi E of Mojave, Twisselmann 4367

(CAS); Rosamond region, Twisselmann 6846 (CAS); Tejon Ranch, Twisselmann 6951 (CAS); Boron Hills, Twisselmann 8166 (CAS); Piute Mts., Twisselmann 12117 (CAS); Kern River, 1 mi E of Weldon, Voegelin 94 (UC); N from Voice of America Radio Station, Zaninovich 88-68 (CAS). Lake County. 2 mi E of Houghs Springs, Abrams 12543 (CAS-DS, NY); Soda Creek Cabins, M.S. Baker 9704 (GH); Burn's Valley to Borax Lake, M.S. Baker 11344 (GH, UC); Burn's Valley to Borax Lake, M.S. Baker 11678 (UC); Clear Lake Park, Eastwood & Howell 5563 (CAS); 2 1/2 mi E of Lower Lake, J.T. Howell 2451 (CAS); Callayomi Valley, Jepson 17418 (UC); Soda Creek Auto Camp Grounds, Doch 959 (UC); 1 mi NW of Paradise Valley, McCaskill & Stebbins 695 (ARIZ). Lassen County. Beckworth Pass, Jepson 7770 (UC). Los Angeles County. Inglewood, Abrams 322 (CAS-DS); Big Tujunga Wash, Abrams 1377 (CAS-DS); N of Claremont, Balls 8192 (BM); N of Claremont, Balls 8192A (BM); 9.7 mi NW and W of Desert Springs, Balls 8517 (EDH, BM); N of Pomona, Braunton 213 (US); Temescal Mts., Brewer 145 (US); Santa Susana Mts., Brewer 211 (US); Raymond, 5 May 1886, Cummings s.n. (GH); Saugus, 1 Mar 1901, Davey s.n. (UC); Acton, Elmer 3706 (US); Acton, Elmer 4170 (CAS-DS, MO, NY, US); Lancaster, 17 Apr 1930, Epling, Ellison, & Anderson s.n. (CAS, G, K, MO, UC, US, W); Pasadena, Grant 914 (NMC); Santa Catalina, Grant 913 (ARIZ, F, GH, UC, US); mesas and washes, Mar 1889, Hasse s.n. (MO); mesas, Apr 1888,

Hasse s.n. (EDH); 4 mi E of Pearblossum, Higgins 8445 in part (ASU, NY); San Gabriel Mts., Holmgren 7632 (NY); Vermont Canyon, J.T. Howell 3460 (CAS, UC); 6 1/2 mi W of Lancaster, Jepson 17042 (UC); Fairmont, Jepson 19233 (UC); Lovejoy Buttes, Kamb 801b (UC); San Gabriel Mts., Kamb 936 (UC); Antioch, Kellogg & Harford 772 (CAS); Antioch, Kellogg & Harford 773 (CAS, MO, NY, US); 1 mi N of Elizabeth Lake, Munz 9983 (GH); Big Rock Creek, Raven 11966 (CAS); Acton, Rose 68015 (CAS); San Fernando Valley, H.H. Smith 4586 (F); Altadena, H.H. Smith 4957 (F); Goode Hill Road, Tavares & Brinson 265 (UC, WS); San Gabriel Mts., Thorne & Tilforth 43110 (NY); Avalon, Mar 1896, Trask s.n. (K, US); Highway N2, 1.5 mi W of Palmdale, Veno 153 (CAS); Sierra Highway, Veno 354 (CAS); 1 mi W of Kings Canyon, Wheeler 593 (G); Cobal Canyon, Wheeler 1731 (G); Claremont, 12 June 1912, White s.n. (MO). Madera County. Intersection of Merced and Madera Roads, Abrams 10771 (CAS-DS); Raymond, Eastwood 12501 (CAS); North Fork, Griffiths 4440 (US); 8 mi W of Chowchilla, Hoover 1680 (GH, UC); 4 mi S of Madera, Hoover 4005 (CAS, UC, US); 1 3/4 mi NE of Bellview, Hormay H-127 (UC); Fresno Flats, Jepson 12847 (UC); 1.6 mi S of Coarsegold, Raven 18335 (CAS-DS); 1.6 mi S of Coarsegold, Raven 18751 (CAS-DS); Fraint-Bellview Road, Weiler 6312 (UC). Mariposa County. Blockman's Ranch, Eastwood 4365 (CAS). Merced County. 10 mi E of Turlock, Hoover 284 (UC); Hopeton Bridge, Howell 1057 (CAS); Lake Merced,

Tracy 1813 (UC). Monterey County. Lockwood-Bradley Road, Bacigalupi, Chisaki, & Dempster 7396 (UC); Salinas Valley, 2 Jan 1900, Dudley s.n. (CAS-DS); Hesperia Mt., Ferris 8447 (CAS, CAS-DS, GH, UC); Del Venturi Caves, Hardham 5408 (CAS); Salinas River, King City, J.T. Howell 32075 (CAS); Jolon, J.T. Howell 39192 (CAS); Hesperia Mt., Keck 2095 (CAS-DS); Pine Canyon Road, Keck & Clausen 3026 (CAS-DS, GH); Hastings Reservation, Linsdale 295 (UC); 1.5 mi E of Bradley, Raven 18260 (CAS-DS); Big Sandy Valley, Raven 18284 (CAS-DS); greenhouse Berkeley, from Linsdale 115, Hastings Reservation, Ray & Chisaki K-53 (UC); 15.4 mi SE of Jamesburg turn-off on road to Greenfield, J.H. Thomas 2568A (CAS-DS). Napa County. W of Calistoga, Jepson 21224 (UC); W of Calistoga, 30 Apr 1893, Jepson s.n. (UC). Riverside County. St. John's Grade, Fosberg 10639 (CAS, GH, LA, UC); Swarthout Canyon, Hall 1491 (CAS-DS, EDH, UC); Thomas Valley, Hall 2181 (NY, UC, US); Riverside, Hall 3725 (CAS); Temescal Canyon, Hitchcock & Muhlick 22142 (F, NY, UC, WS); Thomas Valley, Jepson 1323 (UC); 1 1/2 mi N of Elsinor, Jepson 19149 (UC); Menifee Valley, 1893, King s.n. (UC); San Jacinto, Leiberg 3111 (GH, US); between Banning and Cabazon, J.H. Thomas 6414 (CAS-DS); Highway 71, 11 mi SE of Corona, Veno 143 (CAS); Highway 71, 11.5 mi SE of Corona, Veno 196 (CAS); Indian Avenue, Veno 222 (CAS). Sacramento County. Mormon Island, 15 Apr 1933, Copeland s.n. (GH). San Benito County. Tres Pinos River, Abrams &

Borthwick 7843 (CAS-DS); 5.4 mi S of Willow Creek School, Ferris 8349 (CAS, CAS-DS, GH, UC); Panoche Pass Road, Hesse 2432 (UC); Old Tully School, Jepson 16140 (UC); Emmet, Jepson 18111 (UC); 5.4 mi S of Willow Creek School, Keck 2020 (CAS-DS); Panoche Valley Road, Quick 1181 (UC); 8.8 mi from junction N of Bitterwater, Raven et al. 10811 CAS, UC). San Bernardino County. San Gorgonio Pass, M.S. Baker 2865b (GH); Santa Ana Wash, Mar 1923, Billings s.n. (CAS); Colton, 18 Apr, Grant s.n.(CAS-DS); Mojave Desert, Howe 5 (US); Upland, Johnston 51 (UC); Upland, 24 Feb 1917, Johnston s.n. (CAS-DS); Keen Camp, Munz & Johnston 5422 (UC); San Bernardino, Parish 41 (MO); San Bernardino, Parish 4647 (US); Adelanto, Parish 11802 (UC); San Bernardino, Apr 1887, Parish s.n. (CAS-DS, MO); Deadman Point, Rossbach 466 (UC); Hesperia, Apr 1892, Trelease s.n. (MO); San Bernardino, Vasey 696 (NY, US); 5-6 mi S of Yucca Valley, Veno 131 (CAS); Etiwanda Boulevard, Veno 160 (CAS); Etiwanda, Day Canyon Road, Veno 165 (CAS); Cajon Pass, Veno 178 (CAS); Etiwanda, Day Canyon Road, Veno 225 (CAS); Etiwanda Boulevard, Veno 388 (CAS). San Diego County. Campo, Abrams 3595 (CAS-DS); Campo, Abrams 3617 (BM, CAS-DS, EDH, G, GH, MO, NY, US); Warner's Hot Springs, Eastwood 2602 (CAS, GH, UC, US); Jacumba Springs, Egglestrom 19750 (US); Pauma, Gander 5096 (GH, UC); road to Warner, Gander 3423 (GH); Balboa Park, Gander 5100 (GH); 3 mi W of Jacumba, Gander 5125 (GH); Cuca Indian Reservation, Gander 5155

(GH); San Pasqual, Gander 5389 (GH); San Felipe and Warner Roads, Gander 9037 (GH); Montezuma View Point, Gander 9059 (GH); between Campo and Canyon City, Gander 9323 (GH); Santa Ysabel, Henshaw 195 (GH); J.R. Hoover Ranch, 4 Feb 1967, D.H. Hoover s.n. (CAS); Mason Valley, Jepson 8720 (UC); 2 mi N of Oak Grove, Jepson 19203 (UC); Alpine, F.W. Johnson 1678 (US); San Diego, M.E. Jones 3052 (GH, NMC, NY, UC, US); Fallbrook, M.E. Jones 3123 (CAS in part, GH, MO, UC, US in part); Anza Desert State Park, Keck et al. 6143 (NY); between Jacumba and Pine Valley, Meyer 429 (UC); Jacumba, Munz 8042 (GH); San Diego County, 18 Apr 1882, Pringle s.n. (F, G, GH, NY, US); 1 mi E of Banner, Purer 6330 (CAS); San Diego, Spencer 116 (GH, NY, UC, US); 7 mi SE of Pauma Valley, Veno 123 (CAS); Highway 79, 3 mi NW of Warner Springs, Veno 269 (CAS); 4.5 mi W of Jacumba, Wiggins 2254A (CAS-DS). San Francisco County. Lake Merced, 11 May 1901, Dudley s.n. (CAS, CAS-DS); Lake Merced, Raven 6903 (CAS); E of Lake Merced, Rubtzoff 2221 (CAS). San Joaquin County. Castle Rock, Gould 570 (ARIZ, NY, US); Castle Rock, Hoover 2798 (UC); 1 mi N of Corral Hollow, Hoover 3029 (G, UC, US); Corral Hollow, Jepson 9592 (UC); 2 mi E of Midway, Mason 6835 (GH, UC); Corral Hollow, Olney 48 (GH, UC); Live Oaks, Mar 1877, Rattan s.n. (CAS, CAS-DS); Hospital Canyon, Stanford 1240 (CAS, MO). San Luis Obispo County. Paso Robles, 9 Apr 1899, Barber s.n. (MO, UC); 5.5 mi S of Shandon, Breedlove 1993 (CAS-DS);

27 mi W of Simmler, Breedlove 2049 (CAS-DS); San Luis Obispo County, Clokey 5829 in part (WS); 5 mi N of Paso Robles, Ferris 7505 (CAS, GH, UC); 7 mi E of Pozo, Ferris 9094 (CAS-DS); Luguero Crossing, Hardham 916 (CAS); 2.1 mi NNW of Highland School, Hendrix 77 (UC); Yaro Creek, Hoover 6987 (CAS, CAS-DS, UC); between San Juan River and Carrizo Plain, Hoover 10354 (CAS); 5 mi N of Paso Robles, Wiggins 3414 (CAS-DS, GH). Santa Barbara County. N of Montgomery Potrero, Blakely 3442 (CAS, UC); 4 mi E of junction of Old Miranda Pine Road and Smith Canyon Road, Blakely 5969 (CAS); Nordhoff, Hobby 78 (CAS-DS). Santa Clara County. Stanford University, Elmer 4677 (CAS, CAS-DS, NY, US). Santa Cruz County. Ben Lomond Sand Hills, Hesse 1492 (CAS, CAS-DS, UC); Ben Lomond Sand Hills, Hesse 1459 (CAS); Ben Lomond Sand Hills, J.H. Thomas 1656 (CAS, CAS-DS). Shasta County. Stillwater Creek, 29 Apr 1900, M.S. Baker s.n. (UC). Siskiyou County. Etna, Ferris & Lorraine 11785 (CAS, CAS-DS, UC). Sonoma County. Sulphur Creek, M.S. Baker 4078 (GH); Russian River Bed, Bolander 3858 (F, K, MO, NY, UC, US). Stanislaus County. 3 mi from Oakdale Road, Abrams 9987 (CAS-DS); Tuolomne River, 21 Mar 1961, Allen s.n. (UC); N of Del Puerto Canyon, Hoover 4344 (CAS, GH, UC, US); Grayson Road, Hoover 4359 (CAS, GH, UC); Corral Hollow, Sharsmith 1479 (GH, UC); Arroyo del Puerto, Sharsmith 1525 (GH, UC, WS). Tehama County. 6 mi W of Paskenta, 16 Apr 1938, Bailey s.n. (UC); Stivers Ranch,

Jepson 21090 (UC). Trinity County. Weaverville, Kildale 10744 (CAS-DS); Junction City, Tracy 6428 (GH, UC). Tulare County. Milo, 6 Apr 1900, Dudley s.n. (CAS-DS); Middle Tule River, Mason 5081 (GH, UC); N of Tulare-Kern County line, J.H. Thomas 12459 (CAS-DS); Tule River, Wolf 4642 (UC, US). Ventura County. Camp Ozena, Breedlove 2406 (CAS-DS); Ojai Valley, 23 Apr 1896, Pettibone & Hubby s.n. (CAS); Signal Street, Ojai, 5 Apr 1945, Pollard s.n. (CAS); Ojai, spring 1944, Pollard s.n. (CAS); Murietta Canyon, 8 May 1948, Pollard s.n. (CAS); Matilija Canyon, 28 Apr 1967, Pollard s.n. (CAS); Ventura River flood plain, 27 Feb 1961, Pollard s.n. (CAS); Apache Canyon, Sowder 354 (GH, UC); Ballinger Canyon, Twisselmann 2758 (CAS). Unpecified county. Southern California, Grant 1919 (US); California, Coulter 516 (K); California, Coulter s.n. (GH); Southern California, Parry & Lemmon 843 in part (US). IDAHO. Ada County. Boise City, 1881, Milcox s.n. (NY). Canyon County. Parma, Davis 111 (GH). Elmore County. 6 mi N of Parma, Christ 9411 (NY); 10 mi S of Mt. Home, Christ 11095 (NY); N of Mt. Home, Christ & Ward 7020 (GH, NY); 15 mi W of Mt. Home, Davis 1939 (GH, UC); Pocatello, Palmer 18 (ARIZ, CAS, CAS-DS, UC, US). Gooding County. 8 mi S of Gooding, Christ & Ward 7203 (GH, NY). Lemhi County. Salmon, Payson & Payson 1777 (CAS, GH, MO, NY). Owyhee County. Devil Creek, Nelson & MacBride 1748 (EDH, GH). Unspecified county. Idaho, Shosone 4868 (MO);

Idaho, 1883, Wilcox s.n. (US). NEVADA. Elko County. 5 mi E of Elko, Eastwood & Howell 253 (GH); Bridges, South Fork, Holmgren 882 (NY, UC); N fork of Humboldt, Holmgren 958 (NY). Humboldt County. 15 mi N of Winnemucca, Breene 205 (GH). Ormsby County. Eagle Valley, Baker 1028 (G, GH, MO, NY, UC, US, W). Washoe County. Steamboat Springs, 15 May 1887, Sonne s.n. (UC); S of Reno, 18 June 1903, Stokes s.n. (US). OREGON. Harney County. Narrows, Peck 5863 in part (GH); 15 mi SE of Burns, Peck 18947 (UC); 15 mi NW of Crane, Peck 19177 (MO, UC); 3 mi N of Narrows, Peck 25288A (UC). Jackson County. Medford, 1 June 1921, Piper s.n. (WS). Josephine County. Grants Pass, Jos. Howell 99 (WS); Grants Pass, T. Howell 153 (US); Grants Pass, 25 June 1884, T. Howell s.n. (F, G, NY). Malheur County. Vale, Henderson 8324 (CAS); Vale, Henderson 8325 (CAS); 6 mi S of Adrian, Peck 20663 (UC). Multomah County. Woodville, May 1898, Jos. Howell s.n. (WS). Umatilla County. Pendelton, May 1889, Drake & Dickson s.n. (F). Washington County. First Street, Portland, Dickson & Drake s.n. (US). Unspecified county. Oregon, May 1886, Drake & Dickson s.n. (F); Oregon, Wilkes s.n. (NY). WASHINGTON. Adams County. Railroad, 25 June 1925, Eastwood & St. John s.n. (WS). Chelan County. Chelan Butte, J.W. Thompson 17348 (NY, WS); Columbia River, Ward 330 (ARIZ, NY, WS); Wenatchee, Whited 86 (WS). Douglas County. 6 mi N of Withrow, Daubenmire 5253 (WS). Franklin County.

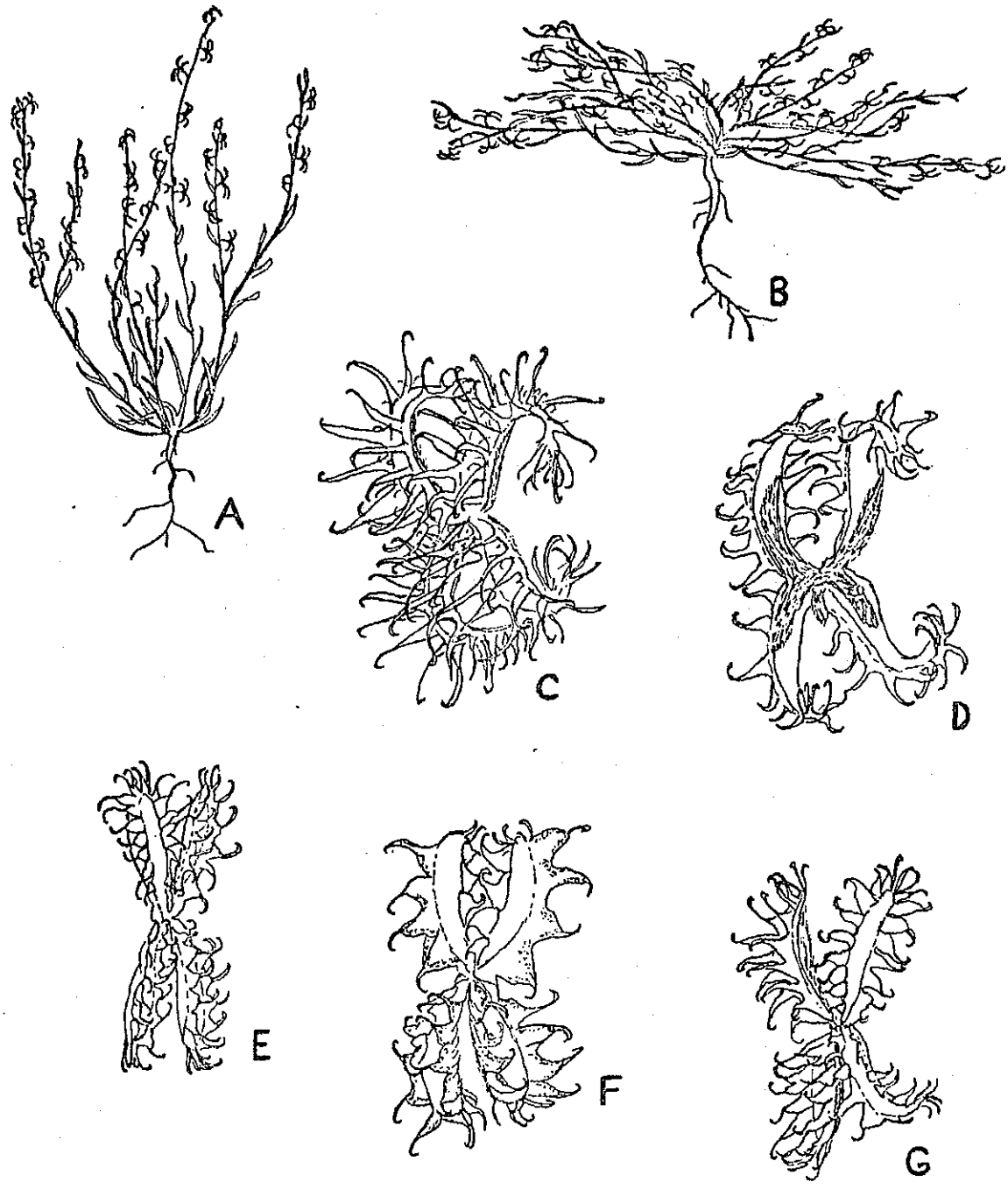
Palouse Falls, Daubenmire 38107 (WS); Palouse Falls, Daubenmire 3845 (WS); Franklin County, Elmer 8 (NY); Pasco, Piper 2967 (NY, WS). Grant County. Burke Junction, Daubenmire 5379 (WS); Grand Coulee, Eyerdam 631 (US); Wagon Gap Road, Gaines & Scheffer 341 (GH, NY); Burke, 29 Apr 1933, G.N. Jones s.n. (GH, NY); NW of Ephrata, 10 May 1956, Moomaw s.n. (WS); Ephrata, Pickett 451 (WS); Coulee City, Piper 3869 (WS); Grand Coulee, Rogers 285 (GH, MO, NY, UC, US, WS); Quincy, J.W. Thompson 6145 (CAS-DS, GH, MO). Klickitat County. Vantage, J.W. Thompson 8233 (CAS-DS, GH, MO, NY). Lincoln County. Harrington, Sanberg & Leiberg 223 (BM, CAS, F, GH, MO, NY, UC, US); Harrington, June 1893, Sanberg & Leiberg s.n. (EDH, MO, WS). Okanogan County. W of Omak, Fiker 643 (GH, WS); road to Conconully, Fiker 769 (CAS-DS, GH, MO); Fort Okanogan, Wilkes 1015 (NY). Walla Walla County. Walla Walla, T.S. Brandegee 984 (GH, NY); Walla Walla, 1883, Canby s.n. (UC). Yakima County. McLaughlins Draw, Gaines & Scheffer 562 (NY, WS); Rattlesnake Hills, Griffiths & Cotton 22 (NY, US); Highway 97, 5 mi S of Toppenish Creek, Hitchcock 3402 (CAS); 10 mi N of Sunnyside, Hitchcock & Muhlick 8216 (CAS-DS, NY, UC, WS). WYOMING. Carbon County. 17 mi E of Lamont, Porter & Porter 9519 (CAS-DS, UC). Sweetwater County. 26 mi E of Farson, Ripley & Barneby 7940 (NY). MEXICO. Baja California Norte. Bahia San Quintin, Bacigalupi 3027A (UC); 1 mi NE of Santa Catarina, Broder 694 (CAS-DS, US);

3 mi E of El Encino, Moran 18332 (ARIZ); 1.5 mi S of Colonia Guerrero, Veno 213 (CAS); road from Rancho San Jose to Socorro, Wiggins 9773 (CAS-DS, US); 16 mi SE of Tecate, Wiggins 11812 (CAS-DS, UC, US).

9. Pectocarya recurvata I.M. Johnston, Contr. Arnold Arbor. 3: 97-98, 1932. Figure 14.——TYPE: Arizona. Maricopa County. Near Chandler near Phoenix, 26 March 1930, Harrison & Kearney 6507 (holotype: GH!).

Plant branched from the base. Stems erect or ascending, cinereous-strigose, 3.5 - 21.0 cm ($\bar{X}$ = 8.9 $\pm$ 3.4 cm) long. Leaves linear, strigose to setulose, 0.5 - 3.0 cm ($\bar{X}$ = 1.25 $\pm$ 0.5 cm) long, 0.5 - 2.0 mm ($\bar{X}$ = 0.1 $\pm$ 0.05 mm) wide. Flowers chasmogamous; pedicels 0.3 - 0.5 mm ($\bar{X}$ = 0.4 $\pm$ 0.05 mm) long; calyces 0.5 - 1.25 mm ($\bar{X}$ = 1.0 $\pm$ 0.1 mm) long; corollas 0.75 - 2.0 mm ($\bar{X}$ = 1.25 $\pm$ 0.05 mm) long. Fruiting pedicels free, strongly recurved, 2.0 - 3.0 mm ($\bar{X}$ = 2.6 $\pm$ 0.3 mm) long. Fruiting calyces divaricate, bilaterally symmetrical, $\pm$ regular, shorter than the nutlets, 3.75 - 5.0 mm ($\bar{X}$ = 4.1 $\pm$ 0.3 mm) long. Fruits monomorphic, 5.0 - 8.0 mm ($\bar{X}$ = 6.5 $\pm$ 0.5 mm) long; nutlets geminate, homomorphic, (moderately -) strongly recurved to scorpiod (- coiled), narrow, linear (- linear-oblanceolate), 2.5 - 4.0 mm ($\bar{X}$ = 3.3 $\pm$ 0.4 mm) long, 0.5 - 0.65 mm ($\bar{X}$ = 0.5 $\pm$ 0.05 mm) broad; nutlet margins erect, distally pectinately cleft and uncinate bristled, laterally divided dentate;

Figure 14. Morphological characters of the Pectocarya recurvata complex. A-B. habit X 1/2. P. recurvata, C-D. C. fruit X 6. D. ventral view of fruit showing calyx X 6. P. ferocula. E. fruit X 5. P. platycarpa. F. fruit X 4. P. linearis. G. fruit X 5.


A
B
C
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E
F
G

Margin teeth terminally uncinate bristled, 0.2 - 1.0 mm ($\bar{X}$ = 0.6 $\pm$ 0.3 mm) long, 0.05 - 0.4 mm ($\bar{X}$ = 0.2 $\pm$ 0.1 mm) wide. Gynobase broad-pyramidal. Chromosome number, n = 12.

Flowering Period. Maximal flowering of P. recurvata occurs from March through mid April; however, the growth period of the species may extend from February through mid May.

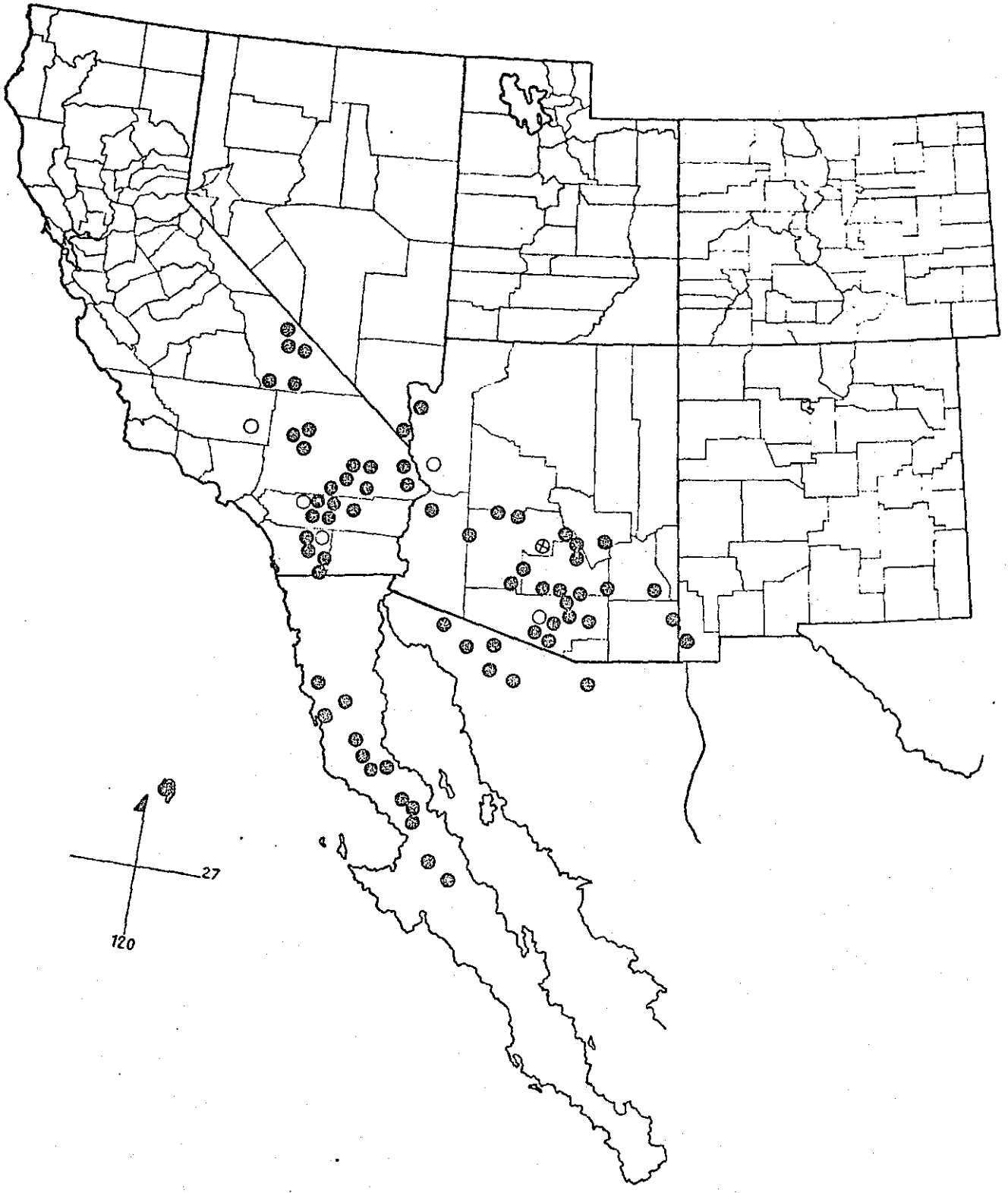
Distribution (Figure 15) and Ecology. Pectocarya recurvata occurs from southern California and Arizona through Baja California Norte and Sonora, Mexico. It is primarily a desert species often occurring in Larrea scrub and Joshual Tree Woodland at elevations of 30 ft (10 m) to 5000 ft (1600 m). Pectocarya recurvata is commonly found in areas sheltered by rocks or at the bases of shrubs, and occasionally occurs along roadsides.

Specimens Examined. ARIZONA. Cochise County. Sandy clay bottoms, P.O. Benson 42053 (ARIZ); Paradise Valley, Peebles, Harrison, & Kearney 5101 (US). Gila County. 8 mi NNW of Roosevelt, Dickerman 186 (ARIZ); Fort Apache Indian Reservation, Granfelt 69-15 (ARIZ); 10 mi W of Coolidge Dam, Maguire, Richards, & Moeller 10470 (GH); San Carlos Reservation, Wiggins 8916 (GH, NY). Graham County. 5 mi NW of Safford, Maguire, Richards, & Moeller 10110

Figure 15. Distribution of Pectocarya recurvata ⬤.

⊗ type locality.

◯ chromosome voucher populations.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120

(ARIZ, GH, UC); 10 mi S of Safford, Maguire, Richards, & Moeller 10141 (GH, MO, US); 20 mi E of Safford, Maguire, Richards, & Moeller 10647 (GH). Maricopa County. 10 mi E of Mesa, Gillespie 5366 (GH, NY, UC, US); Carefree, Gillis 6734 (ARIZ); 10 mi W of Wickenburg, Higgins 6395 (NY); Sauceda Mts., 27 Mar 1960, R.R. Johnson s.n. (ARIZ); 2 mi S of Rock Springs, Keil & Lehto 1050 (OSU); San Domingo Wash, Nash et al. 10124 (ASU, NY); Stewart Mt. Dam, Peebles & Fulton 10645 (ARIZ, US); Usery Mt., Walden 65 (ARIZ); 3.5 mi W of Hassayampa, Wiggins 8733 (ARIZ, GH, MO, OSU, US); 10 mi W of Wickenburg, Wiggins 8904 (GH); Phoenix, 12 Feb 1912, Wooton s.n. (NY); Paradise Valley, 11 Feb 1952, J.T. Wright s.n. (ARIZ). Mohave County. Virgin Narrows, Atwood & Higgins 4527 (MO); Route 95, 1.9 mi N of Chicken Springs Road, Nash et al. 10178B (NY); 20 mi SW of Kingman, Maguire 16250 (GH); road from Yucca to Alamo Crossing, Whitehead 73-34)ARIZ); Hualapai foothills, Apr-May 1969, Whitehead s.n. (ARIZ). Pima County. Tucson, 13 Apr 1948, Beal s.n. (GH, UC); 5 mi W of covered wells, Fosberg 10597 (GH, LA, UC); Colossal Cave, Fosberg 10600 (GH, LA, UC); 2 mi E of Sells, Fosberg 10660 (GH, UC); 10 mi N of Tucson, Gould 2938 (F, GH, UC); Tucson, Griffiths 2270 (NY); Tucson Mts., Griffiths 2449 (NY); Tucson Mts., Griffiths 3496 (US); Tucson, Griffiths 3635 (US); Santa Rita Forest Reserve, Griffiths 4158 (US); Highway 86, 91 mi E of Ajo, Higgins 6286 (NY); Tumamoc Hill, Keck 2999 (CAS-DS,

GH); Santa Catalina Mts., Keck 3955 (CAS-DS, GH); 5 mi NE of Oracle, Maguire, Richards, and Moeller 10025 (GH, MO); 9 mi N of Tucson, Maguire, Richards, & Moeller 10234 (GH); Tumamoc Hill, 24 Feb 1941, McGinnies & Lehto s.n. (OSU); Sierra Tucson, 1884, Pringle s.n. (W); Sierra Tucson, 15 Mar & 15 Apr 1884, Pringle s.n. (F); 15 mi S of Tucson, Shreve 5433 (GH); 15 mi S of Tucson, Shreve 10087 (GH, UC); Tucson Mts., Thornber 5488 (NY); Tucson, 30 Apr 1894, Toumey s.n. in part (NY); Baboquivari Mts., Wiegand, Maguire, Richards, & Moeller 10720 (GH, US); E of Tucson, Wiegand & Wiegand 1979 (GH, NY); Brown Mt., Wiggins 6501 (GH); 2.2 mi S of Tucson-Sells Road, Wiggins 8699 in part (GH, US); Santa Rita Range Reserve, 11 May 1912, Wooton s.n. (US). Pinal County. Picacho Peaks, Gander 8973 (GH); San Tan Mts., Harrison & Kearney 6463 (GH, US); between Casa Grande & Gila Bend, Harrison & Kearney 6536 (GH, US); Oracle, Harrison & Kearney 6658 (GH, US); Sand Tank Pass, Keck 3919 (GH); Whitlow Ranch Dam, Lehto 1649 (NY); Picacho Peak, Maguire, Richards, & Moeller 10034 (GH); Sacaton, Peebles 6513A (NY); San Tan Mts., Peebles 10690 (US); Picacho, Porter 749 (GH); 15 mi W of Oracle Junction, Shreve 10187 (UC); Fresnal, Thackery 17 (US); Picacho Peak, Wiegand, Maguire, Richards, & Moeller 10034 (GH). CALIFORNIA. Imperial County. 1/2 mi E of Mountain Springs, Ferris 7096 in part (CAS-DS). Inyo County. Surprise Canyon, Breedlove 17273 (CAS); Panamint Valley,

17 Mar 1940, Copeland s.n. (GH); Surprise Canyon, Coville & Funston 721 in part (CAS-DS, K, US); Emigrant Wash, Ferris 4007 (CAS-DS); Nevares Canyon, Gilman 2792 (GH); Boundary Canyon, Gilman 2813 (GH); Boundary Canyon, Gilman 2817 (GH); Trail Canyon, Gilman 2890 (GH); Panamint Canyon, Hall & Chandler 7045 (UC); Johnson Canyon, Jepson 19682 (UC); 3 mi N of Slate Range Crossing, Keller 121E (GH); E of Death Valley National Monument, Lehto L19818 (ASU); Slate Range, Penalosa 2420 (CAS); Death Valley, Pinkava et al. 12184 (ASU); 16 mi S of Shoshone, Pinkava et al. 12553 (ASU); Emigrant Canyon, J.H. & H.A. Thomas 440 (CAS-DS); 3 mi W of Ballarat, J.H. & H.A. Thomas 465A (CAS-DS). Riverside County. Cottonwood Springs, Clokey 6860 (F, GH, NY, UC); Thousand Palms Canyon, Fosberg 10628 (GH, LA, UC); 1/4 mi W of Aguanga, Hitchcock 24180 (UC); Whitewater Creek, Munz 14939(I) (GH). San Bernardino County. Forty-nine Palms Canyon, Cole 473 (UC); road to Twentynine Palms, Foster 47 (GH); Coyote Canyon, Hall 2845 (UC); Garlic Springs, Hoffman s.n. (GH); Paradise Springs, Jepson 17247 (UC); between Bristol and Old Dad Mts., Jepson 20381 (UC); Needles, M.E. Jones 3811 (UC); Sheephole Mts., Munz 13825 (GH); San Bernardino, Parish 5171 (EDH); Palm Springs, Parish 20001 (UC); Joshua Tree National Monument, Sipe 248 (WS). San Diego County. Box Canyon, Gander 7023 (GH); 2 mi SW of Carrizo Station, Gander 7080 in part (GH); E of Jacumba, Gander 8071 (GH); Coyote Canyon,

Harnby 12 (W); Wagon Wash, Jepson 12491 (UC); Box Canyon, Purer 6292a (GH); junction of Mason Valley and Kane Spring Roads, Purer 6314 (GH); Borrego State Park, Wolf 8485 (MO). NEVADA. Clark County. Kyle Canyon, Clokey 7683 (GH, NY, UC, WS); Guzzler N-2, Gullion 171 (UC); Nevada 77, 3.9 mi W of Arizona--Nevada state line, Pinkava et al. 12662 (ASU). NEW MEXICO. Hildago County. 500 m N of US 80, Peloncillo Mts., Spellenberg 3036 (ASU, NMC, NY). MEXICO. Baja California Norte. Guadalupe Island, Anthony 237 (GH, MO, UC, US); Cedros Island, 6 Apr 1897, T.S. Brandegee s.n. (UC); San Estaban, 17 Apr 1889, T.S. Brandegee s.n. (UC); 3 mi W of Santa Catarina, Broder 639 (US); 1 mi E of Rancho Arenoso, Chisaki 520 (ARIZ); 11 mi from San Augustine, Ferris 8558 (GH); Calmalli, 7 Feb 1935, Haines & Steward s.n. (NY, UC); Desengano, Moran 7916 (UC); Twin Canyon, Moran 6594 (GH, MO); San Juan Mine, Moran 8042 (ARIZ, UC); Rancho San Rafael, Moran 10912 (UC); El Portezuelo, Moran 20388 (ASU); San Quintin Bay, Palmer 627 (K, NY, UC, US); San Quintin Bay, Palmer 627a (K, NY, US); uadalupe Island, Palmer 69a (K, MO, NY); Cedros Island, Palmer 722 (US); Arroyo L'Agua Marga, Wiggins 9933 (US); 1 1/2 mi NW of Valle Trinidad, Wiggins & Wiggins 16066 (G). Sonora. 45 mi S of Nogales, Fosberg 10676 (GH, LA, UC); Rio Pedradas, Gentry 3585 (GH); Pinacate Peak, Hansen et al. 19467 (ARIZ); 7 mi S of Sasabe, Keck 3964 (CAS-DS, GH); 4 mi W of Caborca, Keck 4034 (GH); 7 mi NW of Tajitos,

Keck 4090 (CAS-DS, GH); E of Estacion Noria, Shreve 10050 (ARIZ).

10. Pectocarya platycarpa (Munz & Johnston) Munz & Johnston, Contr. Gray Herb. 81: 81, 1928. Figure 14.—— Pectocarya gracilis (Ruiz & Pav.) I.M. Johnston var. platycarpa Munz & Johnston, Contr. Gray Herb. 70: 36, 1924.——Pectocarya linearis (Ruiz & Pav.) DC. var. platycarpa (Munz & Johnston) Cronq., Univ. Wash. Pub. Biol. 17, part 4: 235, 1959.——TYPE: Arizona. Mesas near Camp Lowell, 16 April 1881, Pringle s.n. in part (holotype: GH!; isotype: NY!).

Plants branched from the base. Stems erect to widely ascending (- decumbent), cinereous-strigose, 4.0 - 25.0 cm ($\bar{X}$ = 10.9 $\pm$ 5.5 cm) long. Leaves linear to linear-elliptic, setulose, 1.0 - 4.0 cm ($\bar{X}$ = 1.8 $\pm$ 0.8 cm) long, 0.5 - 2.0 mm ($\bar{X}$ = 1.3 $\pm$ 0.4 mm) wide. Flowers chasmogamous; Pedicels 0.3 - 0.6 mm ($\bar{X}$ = 0.4 $\pm$ 0.05 mm) long; calyces 0.75 - 1.5 mm ($\bar{X}$ = 1.1 $\pm$ 0.1 mm) long; corollas 1.25 - 2.0 mm ($\bar{X}$ = 1.6 $\pm$ 0.1 mm) long. Fruiting pedicels free, recurved, 2.5 - 4.0 mm ($\bar{X}$ = 3.0 $\pm$ 0.5 mm) long. Fruiting calyces divaricate, bilaterally symmetrical, $\pm$ regular, shorter than the nutlets, 4.0 - 7.0 mm ($\bar{X}$ = 5.8 $\pm$ 0.5 mm) long. Fruits monomorphic, 5.0 - 9.0 mm ($\bar{X}$ = 6.4 $\pm$ 0.5 mm) long; nutlets geminate, hetermorphic, adaxial nutlet margins somewhat reduced, lower adaxial nutlet often smaller

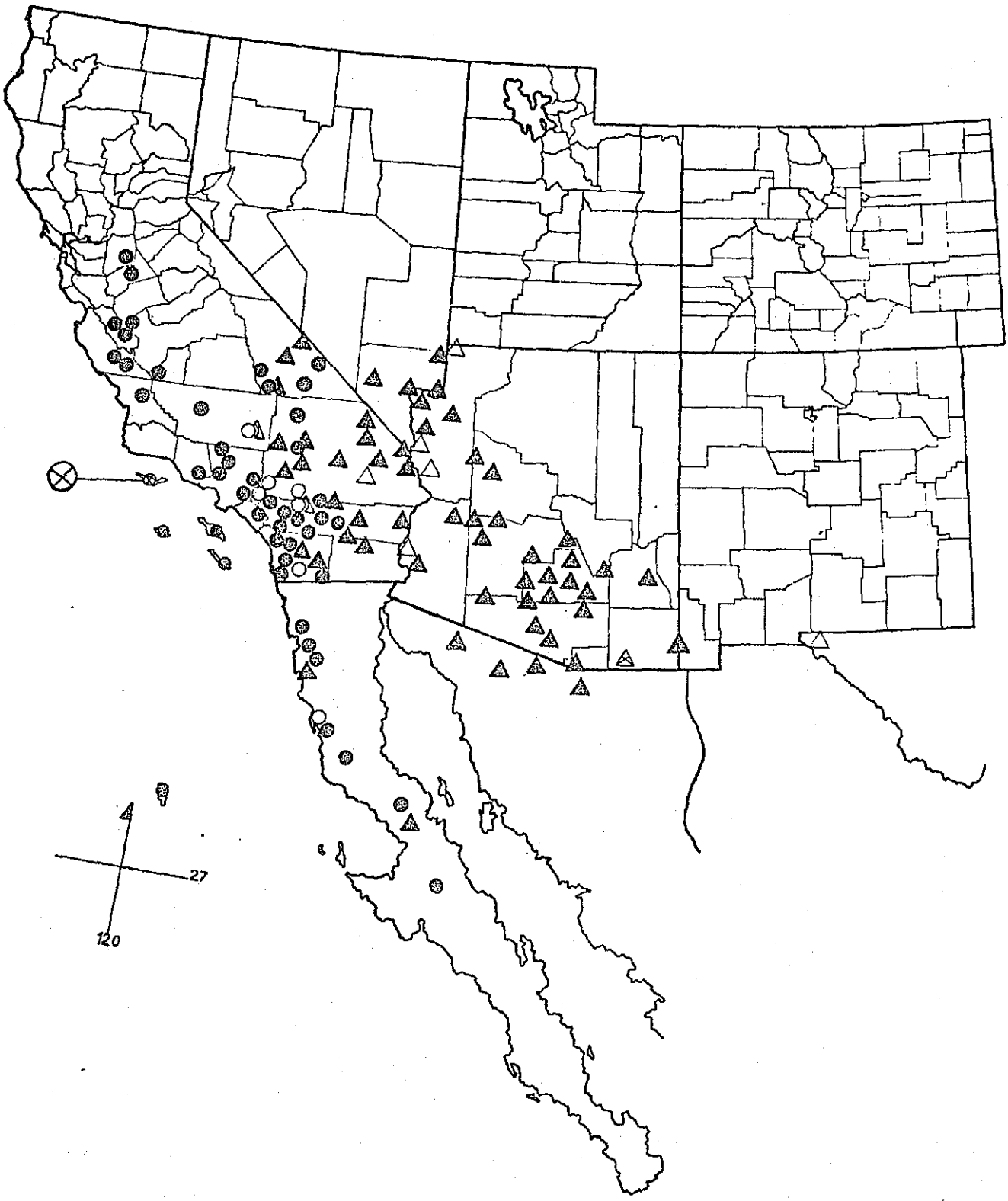
and more densely pubescent than the other three, (slightly -) moderately recurved, oblanceolate to narrowly obovate, 2.5 - 4.5 mm ($\bar{X}$ = 3.1 $\pm$ 0.5 mm) long, 0.6 - 1.0 mm ($\bar{X}$ = 0.75 $\pm$ 0.08 mm) broad; nutlet margins erect to ascending, distally pectinate and uncinate bristled, laterally coarsely cleft to parted (- divided on lower adaxial nutlet), dentate or rarely subentire; margin teeth deltoid or broadly lanceolate, terminally uncinate bristled, 0.2'-2.0 mm ($\bar{X}$ = 1.0 $\pm$ 0.5 mm) long, 0.15 - 0.75 mm ($\bar{X}$ = 0.5 $\pm$ 0.1 mm) wide. Gynobase broad-pyramidal. Chromosome number, n = 24.

Flowering Period. The growth period of P. platycarpa extends from late December, after rains, through early July; however, maximal flowering occurs from March through mid April.

Distribution (Figure 16) and Ecology. Pectocarya platycarpa occurs from southwestern California and southernmost Nevada through Baja California Norte, Mexico. It is primarily a desert species occurring at elevations of 500 ft (150 m) to 5000 ft (1500 m). Pectocarya platycarpa is common in sandy or gravelly soils, and is often scattered among shrubs and along washes and roadsides.

Specimens Examined. ARIZONA. Cochise County. Valley near Camp Lowell, 6 May 1887, Pringle s.n. (G). Graham

Figure 16. Distribution of Pectocarya platycarpa ▲
Pectocarya ferocula ● .
⊿ and ⊗ type localities.
△ and ○ chromosome voucher populations.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120

County. 5 mi NW of Safford, Maguire, Richards, & Moeller 10129 (GH); 10 mi SW of Safford, Maguire, Richards, & Moeller 11014 (GH). Maricopa County. Tempe, 19 Apr 1892, Gauong & Blaschka s.n. (GH); Scottsdale to Granite Reef, Gillespie 5652 (GH, NY, UC, US); Salt River Mts., Gillespie 8788 (GH, NY, UC, US); Wickenberg, 3 Apr 1921, W.W. Jones s.n. (GH, UC); San Tan Mts., Kearney & Harrison 6506A (NY); Shea Boulevard, Keil 1573 (ASU); Thunderbird Regional Park, Keil K11261 (ASU); Lake Pleasant Regional Park, Keil & Lehto 11802 (ASU); McDowell Mts. Regional Park, Lane 257 (ASU); McDowell Mts. Regional Park, Lane 782 (ASU); Hunt Highway, Lehto 450a (ASU); Pinnacle Peak, Lehto 1632 (ASU); San Domingo Wash, Nash et al. 10125 (ASU, NY); Buckey Hills, Pinkava 10051 (ASU); Usery Mt. Semi-regional Park, Walden 65 (NY); 32 mi N of Gila Bend, Wiggins 8414 (GH, UC, US); 13.8 mi N of Ajo, Wiggins 8394 (GH, US); 10 mi E of Wickenburg, Wiggins 8903 (GH); 15 mi E of Wickenburg, Wiggins 8913 (GH). Mohave County. US 60-70, E of Maricopa-Yuma County line, Bell 17563 (UC); Boulder Dam, Clokey 5934 (GH, UC); Boulder Dam, Clokey 5935 (GH, UC); Hualapai Valley, Cronquist 10619 (NY); 7 mi SE of Yucca, Gould & Darrow 4306 (ARIZ); Yucca, M.E. Jones s.n. (NMC); 4 mi E of Gila Bend, Keck 3910 (CAS-DS, GH, UC); 35 mi SE of Salome, Keck 4259 (UC); Signal Road, Lehto 12899a (ASU); Beaver Dam Wash, Maguire 4948 (GH, UC); 15 mi W of Kingman, Maguire 16244 (GH); Yates Ranch, Maguire 20613 (GH,

NY); Willow Beach Campground, Nash et al 10024 (ASU); Union Pass, Nash et al. 10268 (ASU); Kathrine Campground, Pinkava et al. 12581 (ASU); 10 mi SE of Searchlight Ferry, Shreve 7863 (ARIZ); Tamarix Flat , 17 Apr 1973, Van Devender, Phillips, & Phillips s.n. (ARIZ); Highway 68, 4-5 mi W of Kingman, Veno 400 (CAS); Yucca, Veno 472 (CAS); Kingman, Apr-Mar 1969, Whitehead s.n. (ARIZ); Yucca, 12 Mar 1912, Wooton s.n. (US). Pima County. Tucson, 1911, Beard s.n. (MO); 5 mi W of Ajo, Fosberg 10652 (GH, LA, UC); 2 mi E of Sells, Fosberg 10658 (GH, LA, UC); W of Big Ajo Mts., Fosberg 10665 (GH, LA, UC); 10 mi N of Tucson, Gould 2936 (F, GH, NY, UC, US); Tucson, Greene 1109 (GH); Tucson, Griffiths 2269 (NY); Santa Catalina Mts.,Apr 1881, Lemmon s.n. (F); Tucson, spring 1907, Loyd s.n. (F); 9 mi N of Tucson, Maguire, Richards, & Moeller 10233 (GH, MO, UC, US); Dripping Springs, Parker 7935 (WS); Sierra Tucson, 15 Mar and 15 Apr 1884, Pringle s.n. (F, NY); Tucson Mts., Shreve 9463 (GH, UC); Tucson, 30 May 1894, Toumey s.n. (GH, NY, UC); Tucson Estates Road, Veno 289 (CAS); Tucson, Whiting 1051/4749 (MO); 75 mi W of Tucson, Wiggins 6523 (GH); 2.2 mi S of Tucson-Sells Road, Wiggins 8700 (GH, UC, US). Pinal County. Florence, 14 Mar 1937, Darrow s.n. (GH, UC); Superstition Mt., Harrison 6609 (GH, US); San Tan, Harrison & Kearney 6506A (US); between Casa Grande and Gila Bend, Harrison & Kearney 6537 (ARIZ, GH, US); Oracle, Harrison & Kearney 6659 (GH); Casa Grande, Har-

rison & Peebles 9113 (UC); 2.3 mi S of Chuichu, Lehto et al. 10619 (NY, US); Picacho, Maguire, Richards, & Moeller 10035 (GH, UC); Gila River, Maguire, Richards, & Moeller 10426 (GH); 1/2 mi N of Mammoth, Maguire, Richards, & Moeller 10830 (GH); 20 mi W of Casa Grande, Nelson 1231a (NY); Superior, Nelson 11221a in part (GH, MO, NY, UC); Sacaton Indian Reservation, Pultz & Smith 1551 (WS); 15 mi W of Oracle Junction, Shreve 10186 (UC); 2 mi S of Sacaton, T.J. Smith 1551 (GH); 2 mi below Coolidge Dam, Wiegand et al. 10426 (GH). Santa Cruz County. Harrison's Ranch, Tidestrom 748 (US). Yavapai County. Joshua Tree Parkway, Higgins 6505 (NY); between Yava & Hillside, McKelvey 4070B (GH). Yuma County. 28 mi S of Quartzsite, Hitchcock 25803 (NY); 4.1 mi N to Alamo Crossing from Route 60, McLeod & Pinkava 10303 (NY, US); Highway 95, 26 mi S of Parker, Veno 287 (CAS). CALIFORNIA. Imperial County. Chocolate Mts., Wiggins 9643 (CAS-DS, GH, UC). Inyo County. Boundary Canyon, Gilman 2813B (GH); Boundary Canyon, Gilman 2817B (GH); Daylight Pass Road, Howell & True 49127 (CAS). Kern County. Highway 14, 21.5 mi NE of Mojave, Veno 352 (CAS). Riverside County. Big Maria Mts., Bacigalupi & Hutchison 6198 (UC); U.S. 95, 11.3 mi mi N of Blythe, Ferris & Bacigalupi 13249 (UC); Aqueduct Road, Kamb 886b (UC); Indian Avenue, Veno 439 (CAS). San Bernardino County. 10 mi NW of Needles, Alava 1757-A (UC); N of Hinkley, Clokey & Anderson 6854 (GH, NY, UC);

Calico Wash, Jepson 6705 (UC); Essex, Jepson 18162a (UC); Amboy Crater, Jepson 20310 (UC); Needles, M.E. Jones 3811 (F, G, US); Twentynine Palms, J. Keck 3800 (CAS-DS); Fort Mohave, Apr 1884, Lemmon s.n. (UC); Kelbaker Road, Veno 237 (CAS); 5 mi NE of Danby, Wiegand & Upton 4143 (F). San Diego County. 11 mi E of Banner, Gould 2264 (WS); Yaqui Well, Jepson 17114 (UC); E of Mountain Springs, Newlon 385 (UC). NEVADA. Clark County. Kyle Canyon, Clokey 7681 (F, G, LA, MO, NY, UC, US); Kyle Canyon, Clokey 7682 (GH, NY, UC, WS); Pahrump Valley, Holmgren 7971 (NY); 1 mi S of Mesquite, Maguire 4949 (GH); 1 mi W of Meade, Maguire 16284 (GH, UC, US); Las Vegas, Munz 14928(I) (GH); 4.2 mi S of Searchlight, Pinkava et al. 12378b (ASU); Nevada 77, 3.9 mi W of Arizona-Nevada state line, Pinkava et al. 12661 (ASU). Lincoln County. El Domio Canyon, 1880, Davis s.n. (MO). Nye County. 2.5 mi W of Mercury, Beatley 3877 (NY). NEW MEXICO. Hidalgo County. 500 m N of US 80, Peloncillo Mts., Spellenberg 3037 (ASU, NMC, NY). TEXAS. El Paso County. War Road, Correll & Flyr 38340 (MO, UC); Franklin Mts., Spellenberg 2204 (NMC, UC); NE of El Paso, Spellenberg 4611 (LA). UTAH. Washington County. Valley of Virgin, Parry 167 (F, GH, MO, NY). Unspecified county. Southern Utah, 1874, Parry s.n. (BM). MEXICO. Baja California Norte. Cucopa Mts., MacDougal 179 (NY); San Quintin Bay, Palmer 627 (US); 9 mi E of Pozo Aleman, Wiggins 7785A (US); 9 mi E of Pozo Aleman, Wiggins

7785B (CAS). Sonora. 45 mi S of Nogales, Fosberg 10602 (GH, UC); 45 mi S of Nogales, Fosberg 10674 (GH, UC); Sykes Crater, Hansen, de Rosa, & Felger 18948 (ARIZ); 7 mi S of Sasabe, Keck 3966 (GH); 8 mi NW of Tajitos, Keck 4095 (GH); 27 mi NNW of Hassayampa, Shreve 7616B (GH); 15.5 mi NW of Costa Rica, Wiggins 8312 (GH).

11. Pectocarya ferocula (I.M. Johnston) Veno comb. nov. Figure 14.——Pectocarya linearis (Ruiz & Pav.) var. ferocula I.M. Johnston, Contr. Arnold Arbor. 3: 95-97, 1932.——TYPE: California. Santa Barbara County. Steep grassy slope, Ladys Harbor, Santa Cruz Island, 10 April 1930, Munz & Crow 11846 (holotype: GH!; isotype: LA!).

Plants branched from the base. Stems prostrate to decumbent (- widely ascending), cinereous-strigose, 6.0 - 26.0 cm ($\bar{X}$ = 10.9 $\pm$ 6.5 cm) long. Leaves linear, cinereous-strigose to setulose, 0.7 - 4.0 cm ($\bar{X}$ = 2.1 $\pm$ 0.4 cm) long, 0.5 - 1.5 mm ($\bar{X}$ = 1.0 $\pm$ 0.1 mm) wide. Flowers chasmogamous; pedicels 0.3 - 0.5 mm ($\bar{X}$ = 0.4 $\pm$ 0.05 mm) long; calyces 1.3 - 2.0 mm ($\bar{X}$ = 1.75 $\pm$ 0.2 mm) long; corollas 1.5 - 2.0 mm ($\bar{X}$ = 1.6 $\pm$ 0.02 mm) long. Fruiting pedicels free, recurved, 1.5 - 3.0 mm ($\bar{X}$ = 2.1 $\pm$ 0.4 mm) long. Fruiting calyces divaricate, bilaterally symmetrical, $\pm$ regular, shorter than the nultets, 2.5 - 4.8 mm ($\bar{X}$ = 3.7 $\pm$ 0.4 mm) long. Fruits monomorphic, 4.0 - 7.5 mm ($\bar{X}$ = 5.6

± 0.5 mm) long; nutlets geminate, homomorphic to slightly heteromorphic, ± planar or distally somewhat recurved, linear-oblanceolate, 2.0 - 3.8 mm ($\bar{X}$ = 2.8 ± 0.4 mm) long, · 1.0 mm ($\bar{X}$ = 0.6 ± 0.1 mm) broad; nutlet margins .- rarely ascending), distally pectinately cleft and uncinate bristled, laterally (cleft -) parted to divided or rarely proximally entire or subentire; margin teeth lanceolate, terminally uncinate bristled, 0.2 - 0.75 mm ($\bar{X}$ = 0.5 ± 0.1 mm) long; 0.25 - 0.4 mm ($\bar{X}$ = 0.35 ± 0.1 mm) wide. Gynobase broad-pyramidal. Chromosome number, n = 24.

Flowering Period. In North America P. ferocula occurs from February through June, and is occasional in July and December; however, the peak flowering period of the species is from mid March through April.

In South America P. ferocula occurs from late September through mid December.

Distribution (Figures 16 and 17) and Ecology. In North America P. ferocula extends from Northern California through Baja California Norte and Sur, Mexico.

Argentina is the primary distribution center for P. ferocula in South America; however, the species is also occasional in Chile.

An inhabitant of semi-arid and arid regions, P. ferocula is a weedy species which commonly occurs along

Figure 17. Distribution of Pectocarya ferocula ▲ and Pectocarya linearis ● .

⊗ type locality

△ and ○ chromosome voucher populations.

roadsides, on grassy slopes, and in vegetational clearings at elevations of 15 ft (5 m) to 7000 ft (2000 m).

Specimens Examined. NORTH AMERICA. CALIFORNIA. Fresno County. Between Mercy Hot Springs and Panoche, Wolf 1683 (GH). Kern County. 3-5 mi N of Rosamond, Abrams 11193 (CAS); U.S. 6, 10 mi N of Mojave, 17 Mar 1940, Copeland s.n. (GH); California City, Holmgren 7696 (NY); Oildale-Woody Road, Hoover 3169 (UC); Red Rock Canyon, Howell 4964 (CAS); 2 mi N of Mojave, J.T. Howell 24262 (CAS); Silver Queen Road, Twisselman 6839 (CAS); Red Rock Canyon, Twisselman 6934 (CAS); E of Ridgecrest, Twisselman 11839 (CAS); Tarweed Creek, Twisselman 15384 (CAS); Tarweed Creek, Twisselman 16460 (CAS); Highway 14, 21.5 mi N of Mojave, Veno 455 (CAS). Kings County. Kettleman Hills, Hoover 2928 (CAS, GH, NY, UC, US); Kettleman Hills, Hoover 3318 (UC). Imperial County. 1/2 mi E of Mountain Springs, Ferris 7069 in part (CAS) Inyo County. 63 mi N of Mojave, M.S. Baker 8883 (GH); Highway 6, S of Olancha, Brenckle 51248 (NY, UC); Panamint Mts., Coville & Funston 488 (US); Johnson Canyon, Ferris 13509 (CAS-DS). Los Angeles County. Inglewood, Abrams 321 (CAS-DS); San Fernando Valley, Abrams 1320 (CAS-DS); Santa Cruz Island, Almeda, Mathias, & Sauer 2563 (LA); Garvanza, Braunton 169 (US); Catalina, 27 Mar 1911, Condit s.n. (UC); Saugus, 1 Mar 1901, Davy s.n. (UC); Claremont, Derkie s.n. (MO);

Claremont, Eastwood 4135 (UC); San Fernando Wash, Eastwood 31619 (CAS); Roscoe, Eastwood 31620 (CAS); Catalina, Fosberg S4404 (F, GH, MO, NY, UC); Coach Road, Catalina, Fosberg 10644 (CAS, GH, LA, UC); Bullrush Canyon, Fosberg 54779 (GH); Elizabeth Canyon, Gifford 473 (UC); 4 mi E of Pearblossum, Higgins 8440 (NY); Santa Cruz Island, Hoffman s.n. (CAS); 1/2 mi below San Dimas Dam, Horton 579 (GH); Santa Cruz Island, J.T. Howell 6340 (CAS); Claremont, Apr 1912, Howery s.n. (MO); Avalon, F.W. Johnson 1437 (NY); Occidental College, 29 Mar 1940, Kruckeberg s.n. (CAS-DS); Middle Ranch, Catalina, Moran 698 (CAS, GH); San Clemente Island, Munz 6690 (GH, UC); San Clemente Island, Murburger 100 (UC); Catalina Island, Nuttall 23 (BM); Schoolhouse Mt., Nuttall 28 (F); Catalina Island, Nuttall 237 (F); S of Pearblossum, Raven 11966 (CAS); Acton, Rose 68015 (GH, W); Azusa, H.H. Smith 4938 (F); San Clemente Island, Thorne 36101 (MO); San Nicholas Island, Trask 56 (K); Avalon, Apr 1896, Trask s.n. (MO); San Nicholas Island, Apr 1897, Trask s.n. (MO); 2 mi N of Palmdale, Wiegand 1975 (GH); N of Pearblossum, Wiggins 20620 CAS-DS); Santa Catalina Island, Wolf 3536 (CAS-DS, GH, US). Merced County. Laguna Seca Creek, 27 Mar 1943, Lyon s.n. (CAS). Monterey County. Shirt Tail Gulch, Ewan 9159 (GH); Jolon Road, Keck & Clausen 3046 (CAS, UC); 1 mi ENE of Los Lobos Spring, Wilson 488 (UC). Orange County. 1/2 mi above Trabuco Oaks, Trabuco Canyon, Wolf 1846 (UC). Riverside

County. 3 mi Ne of Murietta, Ewan 10786 (GH); Riverside, Hall 3725 (F); 5 mi S of Morongo Valley, Higgins 8491 (NY); Elsinore, McClatchie 91 (NY); Palms to Pines Highway, Parks 24174 (UC); Alberhill, Rose 49052 (G); Whitewater, Shreve 8156 (GH). San Benito County. Panoche Pass Road, Carter 1348 (GH, UC); Panoche Pass Road, Hesse 2463 (UC); Panoche Pass, Hoover 3004 (UC); Panoche Valley Road, Quick 1181 in part (UC). San Bernardino County. E of Claremont, C.F. Baker 4135 (UC); Highway 18, 5 mi E of Apple Valley, Chambers 3608 (NY); E of Claremont, 10 Mar 1898, Chandler s.n. (UC); San Bernardino Mts., Cumming s.n. (GH); San Bernardino Mts., 1 May 1896, Fernald s.n. (GH); Morongo Valley, 11 Apr 1937, Haines & Erickson s.n. (UC); Neenach School, Antelope Valley, Jepson 19236a (UC); 4-5 mi NE of Paradise Mts., Jepson 20329 (UC); Willow Springs, MacFadden 73e (UC); Willow Springs, MacFadden 75m (UC); Claremont, May 1903, Palmer s.n. (UC); San Bernardino, Parish 41 (F, NY); San Bernardino, Parish 4648 (NY, US); San Bernardino, Parish 5610 (CAS); San Bernardino Valley, Parish 11155 (UC); San Bernardino, Mar 1897, Parish s.n. (MO); 5-6 mi SW of Yucca Valley, Veno 130 (CAS); Cajon Pass, Veno 176 (CAS); Day Canyon Road, Veno 224 (CAS). San Diego County. Rincon Springs, Bacigalupi & Heckard 8374 (UC, US); San Diego, Baker 1636 (G, GH, K, MO, NY, UC, W); San Diego, T.S. Brandegee 1636 (NY, UC); San Diego, Mar 1906, T.S. Brandegee s.n. (UC); Lee's Valley, Gander 3554

(GH); San Ysidro, Gander 4990 (GH); 3/4 mi W of Dehesa School, Gander 5049 (GH, UC); Clamar School, Gander 5141 (GH); Whispering Oaks, Gander 5224 (GH); 3.5 mi E of Banner, Keck 6105 (NY); San Diego, M.E. Jones 3052 (MO); 2 mi E of Pala, Munz 10362 (GH); La Junta, Newlon 345 (UC); Otay Valley, 20 Mar 1883, Orcutt s.n. (F); San Diego, 18 Mar 1901, Setchell s.n. (UC); San Diego, Spencer 115 (GH, K, NY, UC, US); Maroon Valley Road, Veno 238 (CAS); E of Jacumba, Wiegand 1978 (GH); 1 mi W of Jamul, Wiegand & Upton 4144 (F); 1.5 mi from Jamul, Wiggins 1920 (UC); San Diego, Wright 46 (NMC). San Joaquin County. Between Castle Rock and Black Butte, Hoover 3043 (GH, NY, UC, US). San Luis Obispo County. Cottonwood Pass, Hoover 6878 (CAS); San Juan River, Hoover 7464 (CAS, UC); canyon, N end of Elkhorn Plain, Hoover 10304 (CAS). Santa Barbara County. Pelican Bay, Santa Cruz Island, Abrams & Wiggins 78 (CAS-DS, UC); Santa Cruz Island, June 1888, T.S. Brandegee s.n. (UC); Pelican Bay, Santa Cruz Island, Clokey 4811 (UC); Prizoner's Harbor, Clokey 5035 (NY, UC, US); Prisoner's Harbor, Jepson 12066 (UC); Santa Cruz Island, Niedenmuller 8205 (UC); 1.2 mi W of Stanton Ranch, Raven (CAS); Santa Cruz Island, 12 Apr 1927, Stason s.n. (UC). Stanislaus County. Del Puerto Canyon, Hoover 4344 (CAS). Ventura County. Simi Valley, Jepson 8455 (UC). MEXICO. Baja California Norte. Sparrmann's Canyon, Carlquist 450 (UC); 1 mi E of Rancho Arenoso, Chisaki 520 (GH,

UC); 3 mi S of Anchorage, Guadalupe Island, Moran 5960 (GH, UC); N of Twin Canyon, Moran 6633 (GH); Lower Circus, Moran 6650 (GH); ex-mission San Borja, Moran 12325 (UC, US); 10 mi S of Ensenada, Purer 7143 (GH, MO); 10 mi S of Ensenada, Purer 7150 (GH); San Quintin, Raven, Mathias, & Turner 12376 (UC); 17 mi S of Santo Tomas, Veno 404 (CAS); Barracks Cove, Guadalupe Island, Weber & McCoy 11978 (UC); 9 mi E of Punta Prieta, Wiggins 7648 (GH, UC, US); 9 mi E of Pozo Aleman, Wiggins 7785 (GH, UC, US); 20 mi N of Punta Prieta, Wiggins 15958 (GH); 1 1/2 mi NW of Valley Trinidad, Wiggins 16066 in part (ARIZ); N of Twin Canyon, Guadalupe Island, Wiggins & Ernst 81 (GH, UC). Baja California Sur. Santa Cruz Island, T.S. Brandegee s.n. (UC); 27 mi E of Pozo Aleman, Wiggins 7839 (F, UC). SOUTH AMERICA. ARGENTINA. Chubut. Camarones, Aurelius 44 (GH); Rio Chubut near Rawson, Dusen 5 (GH, MO). Mendosa. Las Heras, Paci 534 (GH); Tunuyan, Ruiz 1712 (GH) Tunuyan, Ruiz 1767 (GH); Mendoza, Ruiz 25/ 2168 (GH); Tupungato, Ruiz 2229 (GH); Lujan, Ruiz 2248 (GH); Lujan, Ruiz 2250 (GH); Tunuyan, Ruiz 2342 (GH); Lujan, Ruiz 11255 (GH); Frutilla, Oct 1913, Sanzin s.n. (GH). Nueguen. Borrancas--Buta Ranquil, Ancibov, Cano, & Crespo 90146 (CONC); Gobernacion de Neuguen, Cabrera 11044 (GH); Cerro Lotena and Zapala, Comber s.n. (EDH, K); Bosque Petrificado, Mroginski & Fernandez 22494 (MO); Capital, Ruiz 18060 (GH). Rio Negro. Rio Negro, 19 Nov 1894,

Berg s.n. (GH); San Antonio Oeste, Castellanos 28/1192 (GH); General Roca, Fischer 123 (GH, MO, NY, US). Santa Cruz. Rio Gallego, 11 Mar 1882, C.S. s.n. (GH). CHILE. Aconcagua. Limache, Garaventa 1938 (GH); Zapallar, Looser 5517 (GH). Atacama. Rio de la Laguna Grande, E of Vallenar, Johnston 6283 (GH). Coquimbo. Valley de Elqui, Looser 5780 (GH). Santiago. Santiago, Claude-Joseph 684 (US); Santiago, Claude-Joseph 1496 (US); Rinconada de lo Cerde, Schlegel 1430 (CONC). Valparaiso. Vina de Mar, 23 Sept 1922, Behn s.n. (F); progeny from Zöllner 9410, Quilpue, University of California, Los Angeles, Veno 483 (CAS); Quilpue, Zöllner 9410 (MO).

12. Pectocarya linearis (Ruiz & Pav.) DC., Prodr. 10: 120, 1846. Figure 14.——Cynoglossum lineare Ruiz & Pavon, Fl. Peruv. 2: 6, 1799.——TYPE: Sancti Jacobi, Chilensis, campis aridis, Ruiz & Pavon s.n. (holotype: MA).

Pectocarya chilensis DC., Prodr. 10: 120, 1846.——TYPE: in pascuis saxosis collium Chilensium ad Quillota, Rancagua et secus flumen Cachaqual, Bertero 211, 944 (holotype: G-DC; isotypes: BM!, G!, W!). The type specimens of P. chilensis are consistent with the characters of P. linearis; therefore, the two taxa are considered conspecific.

Plants branched from the base. Stems prostrate to decumbent, cinereous-strigose, 6.0 - 30.0 cm ($\bar{X}$ = 12.0 ± 6.1 cm) long. Leaves linear, setulose, 0.5 - 4.0 cm ($\bar{X}$ = 1.7 ± 0.9 cm) long, 0.5 - 1.5 mm ($\bar{X}$ = 1.1 ± 0.3 mm) wide. Flowers chasmogamous; pedicels 0.25 - 0.5 mm ($\bar{X}$ = 0.3 ± 0.1 mm) long; calyces 1.0 - 1.6 mm ($\bar{X}$ = 1.3 ± 0.2 mm) long; corollas 1.0 - 2.0 mm ($\bar{X}$ = 1.5 ± 0.4 mm) long. Fruiting pedicels free, recurved, 1.6 - 3.0 mm ($\bar{X}$ = 1.3 ± 0.2 mm) long. Fruiting calyces divaricate, bilaterally symmetric, ± regular, equal to or often somewhat exceeding the nutlets, 4.0 - 8.0 mm ($\bar{X}$ = 5.6 ± 0.6 mm) long. Fruits monomorphic, 4.0 - 6.8 mm ($\bar{X}$ = 5.5 ± 0.3 mm) long; nutlets geminate, heteromorphic or occasionally obscurely heteromorphic, moderately recurved, oblanceolate, 2.0 - 3.3 mm ($\bar{X}$ = 2.6 ± 0.3 mm) long, 0.5 - 1.0 mm ($\bar{X}$ = 0.7 ± 0.1) mm broad; nutlet margins erect to strictly ascending, often medial-laterally constricted, irregularly dentate, coarsely cleft to parted (- divided); margin teeth 0.4 - 1.8 mm ($\bar{X}$ = 0.9 ± 0.3 mm) long, 0.25 - 0.7 mm ($\bar{X}$ = 0.4 ± 0.1 mm) wide. Gynobase broad-pyramidal. Chromosome number, n = 36.

Flowering period. The growth period of P. linearis extends from August through November; however, maximal flowering occurs from September through October.

Distribution (Figure 17) and Ecology. Pectocarya

linearis is distributed in Chile from Coquimbo through Valdivia provinces. It is an inhabitant of arid regions, and is commonly found on roadsides and hillsides in dry, hard, rocky soils at elevations of 15 ft (5 m) to 5000 ft (1500 m).

Specimens Examined. CHILE. Aconcagua. San Felipe, Claude-Joseph 1351 (US); San Felipe, Claude-Joseph 3853 (US); Las Palmas de Pedegua, Sept 1933, Grandjot s.n. (GH, MO); Valle de Marga-Marga, Jaffuel & Pirion 3064 (GH); Valle de Marga-Marga, Jaffuel & Pirion 3102 (GH); Limache, Looser 3309 (GH); Los Andes, Mancilla 11317 (CONC); Los Andes, Mancilla 13309 (CONC); Rio Colorado, Los Andes, Salazar 11624 (CONC); Estero Pocuro, Los Andes, Salazar 11632 (CONC); Cerros de la Vargas, Torres 14148 (CONC). Antofagasta. Paquica, Rose 19189 (US). Atacama. Yerba Buena, Collao 38 in part (GH), 5 km al sur de Vallenar, Ricardi & Marticorena 4853/1238 (CONC). Coquimbo. Ovalle, Caren, Barros 6333 (GH); La Serena, Barros 6340 (GH); Paiguano, Behn 8313 (CONC); Coquimbo, Drake s.n. (F); Coquimbo, Drake & Gay s.n. (F); Choapa, Germain 59 (GH); Coquimbo, Jaffuel 2661 (GH); La Calera, Jiles 3177 (CONC); Carretera Panamericana, Pichidanqui y Los Vilos, Marticorena & Matthei 24 (CONC); Parque Nacional Fray Jorge, Marticorena, Matthei, & Rodriques 473 (CONC); Camino de Almirante Latorre y La Serena, Marticorena, Rodriques, &

Weldt 1547 (CONC); Carretera Panamericana, El Tofo, Marticorena, Rodriques, & Weldt 1636 (CONC); Coquimbo, Montero 63 (GH); Illapel, Rose 19269 (US); La Cumbre, Rose 19349 (NY, US); Coquimbo, Shottsberg 722 (F, GH, NY); progeny Marticorena, Matthei, & Rodriques 473, Parque Nacional Fray Jorge, at University of California, Los Angeles, Veno 483 (CAS); 3 mi W of Vicuna, Wagenknect 18424 in part (F, G, GH, UC); road from Vicuna to La Serena, Worth & Morrison 16352 (GH, UC). O'Higgins. Termas de Cauquenes, 1 Nov 1952, Pfister s.n. (CONC). Santiago. Santiago, Barros 6288 (GH); Ovalle, Barros 6360 (GH); Santiago, Sept 1919, Behn s.n. (CONC); Santiago, 1855, Germain s.n. (BM, F, G, K, W); Santiago, 1856 & 1857, Germain s.n. (BM, W); Santiago, Hastings 56 (US); Cerro San Cristobal, Santiago, Looser 775 (GH); Cerro San Cristobal, Montero 27 (GH); La Obra, Montero 479 (F, MO); Santiago, Phillipi 437 (W); Santiago, 1861, Phillipi s.n. (CONC, G, W); Santiago, Phillipi & Hokenaker 437 (BM); Santiago, Phillipi & Hokenaker 495 (BM). Valdivia. Valdivia, Reid s.n. (K). Valparaiso. Valparaiso-Vina del Mar, 23 Sept 1922, Behn s.n. (CONC); Valparaiso--Limache--Cuesta de la Dormida, 12 Sept 1937, Behn s.n. (CONC); Valparaiso--Limache--Cuesta de la Dormida, 3 Nov 1940, Behn s.n. (CONC); Valparaiso--Limache--Cuesta de la Dormida, 5 Oct 1947, Behn s.n. (CONC); Valparaiso, Sept 1830, Bridges 332 (K); Valparaiso, 30 Sept 1895, Buchtien

s.n. (EDH, G, GH, US); Valparaiso, Cumming 721 (BM, EDH, K, W); Valparaiso, Apr - June 1856, Harvey s.n. (EDH, K); Valparaiso, Jaffuel 3633 (GH); Quebrada de San Juan, Pfister & Ricardi 9750 (CONC); Valparaiso, Phillipi & Borchers 82 (BM, F); Concon, Poeppig 282 diar. (BM, MO, W); Llay-Llay, Ricardi & Marticorena 4182/567 (CONC); Cuesta del Melon, Ricardi & Marticorena 4225/610 (CONC). Maule. Cauquenes, Reid s.n. (K). Unspecified province. Chile, Bridges 253 (BM, K, W); Chile, late Apr 1834, Cumming 722 (W); Chile, 1871-1876, Germain s.n. (G).

13. Pectocarya lateriflora (Lam.) DC., Prodr. 10: 120, 1846. Figure 18.——Cynoglossum lateriflorum Lam., Encyc. 2: 239, 1786; Ill. Gen. tab. 92, fig. 2, 1786. ——Rindera lateriflorum (Lam.) Roem. & Schult., Syst. 4: 762, 1819.——Mattia lateriflorum (Lam.) Don, Gen. Syst. 4: 310, 1838.——TYPE: Peru. Lima, Dombey s.n. (holotype: P-JU; isotypes: F!, US!).

Cynoglossum pilosum Ruiz & Pav., Fl. Peruv. 2: 6; tab. 111, fig. b, 1799.—— Rindera pilosa (Ruiz & Pav.) Roem. & Schult., Syst. 4: 762, 1819.——Mattia pilosa (Ruiz & Pav.) Don, Gen Syst. 4: 310, 1838.——TYPE: Peru. In Cercado et Chancay Provinciis, locis aridis, versus Limae et Arnebo tractus, Ruiz & Pavon s.n. (holotype: MA; isotype: G!). The identity of this taxon is established by the plate in Flora Peruviana and confirmed by the isotype. Cynoglossum pilosum

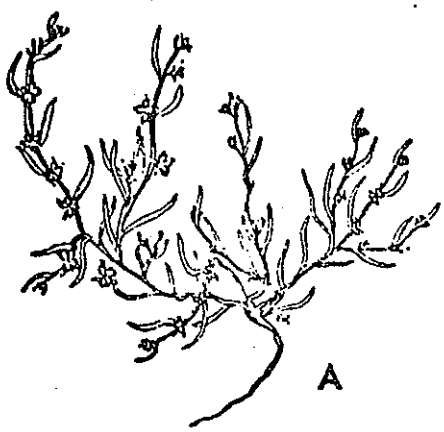
possesses all the characters of P. lateriflora, and is considered conspecific.

Ktenospermum linifolium Lehm., Del. Sem. Hort. Hamburg 17, 1837, nom. nud. I have not seen the original publication; however, subsequent authors (Brand, 1921; Johnston, 1924 and 1927) have cited this name as a nomen nudum.

Pectocarya gracilis (Ruiz & Pav.) I.M. Johnston var. boliviana I.M. Johnston, Contr. Gray Herb. 70: 37, 1924.——Pectocarya boliviana (I.M. Johnston) I.M. Johnston, Contr. Gray Herb. 78: 118, 1927.——TYPE: Bolivia. Andine region, Chignana, 3700 m, 22 March 1921, Asplund 3897 (holotype: US!; isotype: GH!). The type specimen of this taxon is P. lateriflora; therefore, P. boliviana belongs in synonymy with the earlier name.

Plants branched from the from the base. Stems ascending to erect, coarse and stiff, finely cinereous-strigose to hispidulous, 3.0 - 23.0 cm ($\bar{X}$ = 12.3 $\pm$ 5.9 cm) long. Leaves linear to linear-elliptic, coarse pilose, 0.7 - 5.6 cm ($\bar{X}$ = 1.8 $\pm$ 1.0 cm) long, 0.5 - 3.0 mm ($\bar{X}$ = 1.7 $\pm$ 0.6 mm) wide. Flowers chasmogamous; pedicels 0.4 - 1.0 mm ($\bar{X}$ = 0.5 $\pm$ 0.2 mm) long; calyces 1.0 - 2.5 mm ($\bar{X}$ = 1.7 $\pm$ 0.5 mm) long; corollas 1.5 - 3.0 mm ($\bar{X}$ = 2.0 $\pm$ 0.5 mm) long. Fruiting pedicels free, somewhat recurved and

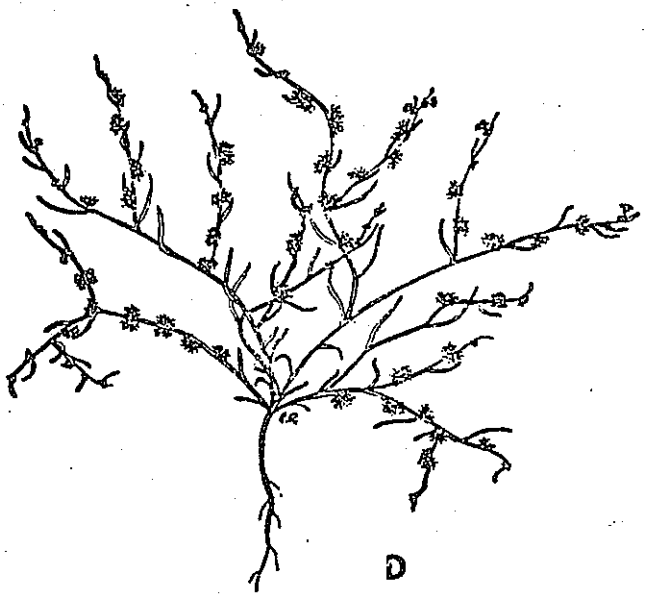
Figure 18. Morphological characters of Pectocarya lateriflora and Pectocarya anomala. P. lateriflora, A-C. A. habit X 1/2. B. fruit X 10. C. ventral view of fruit showing calyx X 10. P. anomala, D-F. D. habit X 1/2. E. fruit X 6. F. ventral view of fruit showing calyx X 6.



A

B

C



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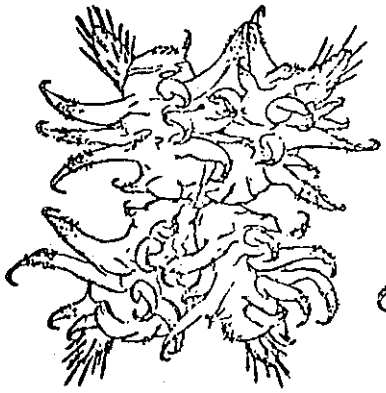

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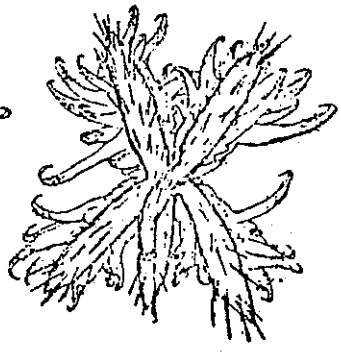


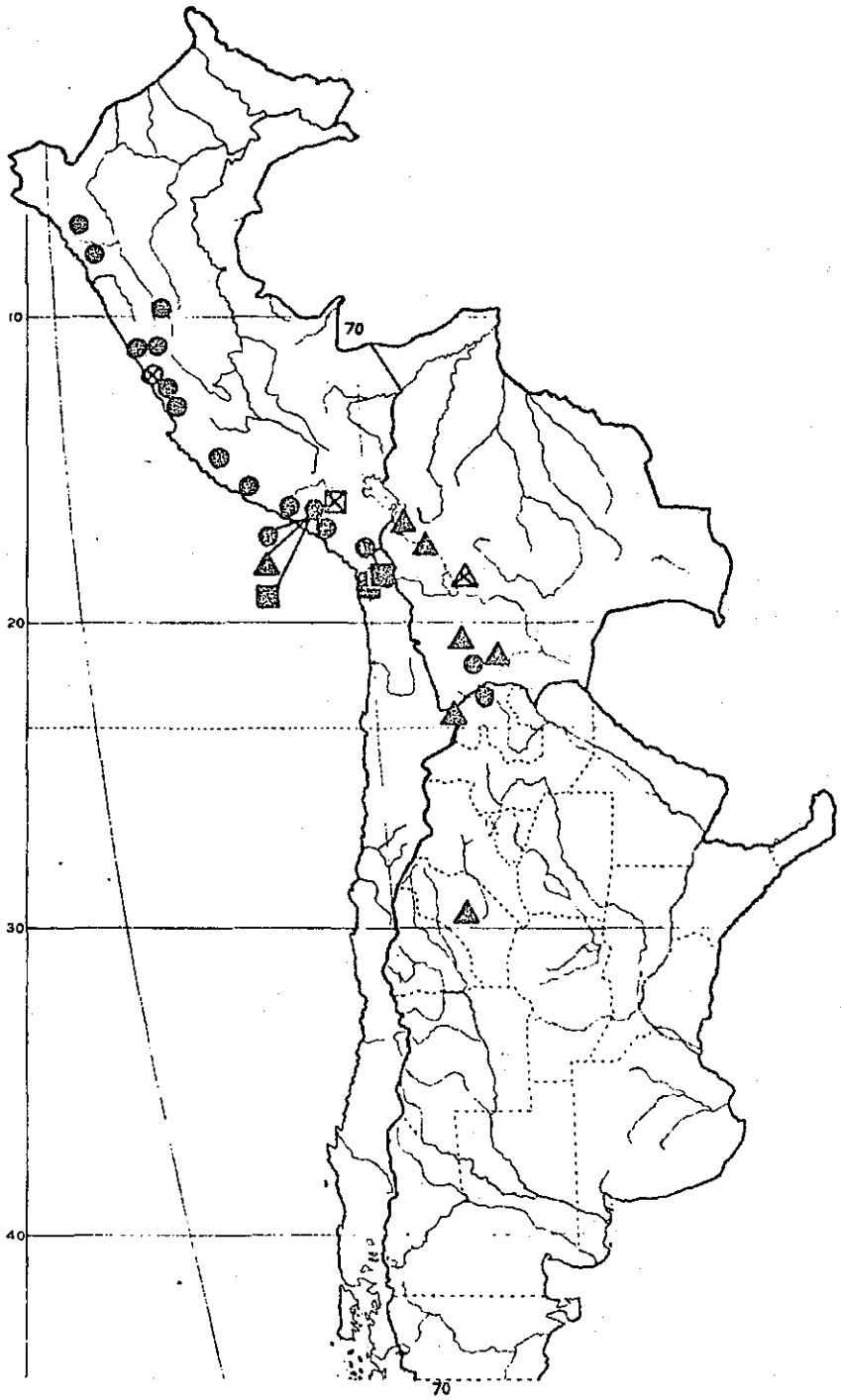
F

spreading, 1.6 - 3.5 mm ($\bar{X}$ = 2.4 $\pm$ 0.5 mm) long. Fruiting calyces divaricate, bilaterally symmetrical, $\pm$ regular, slightly exceeding the nutlets, 4.5 - 9.5 mm ($\bar{X}$ = 7.5 $\pm$ 0.8 mm) long. Fruits monomorphic, 4.0 - 7.0 mm ($\bar{X}$ = 4.9 $\pm$ 0.4 mm) long; nutlets geminate, heteromorphic; lower adaxial nutlet commonly reduced in size, more deeply rugose, and more densely pubescent than its counterparts; nutlet surface smooth to rugose, glabrous to densely uncinate pubescent, occasionally mottled, dorsal-medially ridged or occasionally medially papillate with intermittent to uniserially juxtaposed papillae; nutlet body broadly obovate to subdeltoid, 2.0 - 3.5 mm ($\bar{X}$ = 2.4 $\pm$ 0.4 mm) long, 0.8 - 2.5 mm ($\bar{X}$ = 1.5 $\pm$ 0.4 mm) broad; nutlet margin spreading, 0.5 - 1.5 mm ($\bar{X}$ = 1.0 $\pm$ 0.2 mm) wide, lacerately cleft to divided into coarse, terminally uncinate bristled teeth. Gynobase broad-pyramidal.

Flowering Period. The flowering period of P. lateriflora extends from February through mid November.

Distribution (Figure 19) and Ecology. A very distinct and easily recognizable species, P. lateriflora is a South American endemic, and is native to coastal Peru, southernmost Bolivia, and northernmost Argentina. It is an inhabitant of the lomas and desert margins where it occurs in clay, sandy, or loamy soils and on rocky slopes at elevations of 300 ft (100 m) to 15000 ft (4500 m).

Figure 19. Distribution of Pectocarya lateriflora ● , Pectocarya anomala ■ and Pectocarya brachycera ▲ . ⊗ , ⊠ and △ type localities.


10
20
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Specimens Examined. ARGENTINA. Jujuy. Jujuy, Sierra de Lenta, Budin 31/189 (GH). BOLIVIA. Potosi. Atocha, Asplund 3012 (GH). PERU. Arequipa. Mollendo, Hitchcock 22382 (US); E of "Cali" gas station, S of Lima, Hutchison 1311 (UC); Mollendo, Johnston 3534 (EDH, F, GH, US); Arequipa, Raub-Hirsh 556a (GH); Jesus--Chiguata, Vargas 8060 (GH, US); 6 km N of Atiquipa, Worth & Morrison 15654 (GH, US). Ayacucho. Entre Nazca y Puguio, Ferreyra 5479 (LA). Cajamarca. Las Achiras, Sagastegui 3864 (F). Ica. 70 km carretera central Lima-Oroya, Ferreyra 6951 (LA). Huanuco. Huanuco, 1778-1788, Ruiz & Pavon s.n. (F). Junin. Huancayo, Soukup 3131 (US). La Libertad. Canduay, Lopez 1057 (US). Lima. Atocongo, Cerrate 836 (GH, LA); Lachay, Cerrate 843 (GH); Cruz-Pama, Cerrate 1100 (LA); Lima, Cummings 1070 (BM, EDH, EDH-GL); Chancay, Eyrostaz 51 (K); Lachay, Ferreyra 843 (LA); Amancaes, Ferreyra 3957 (LA); Quilmana, Ferreyra 3988 (LA, US); Lachay, Ferreyra 8789 (LA); Lurin, Ferreyra 9570 (LA); Cerro San Bartolome, Jaffuel 2141 (GH); San Geronimo, Macbride 5907 (BM, F, GH, US); Lurin, Matthews 989 (EDH, EDH-GL, K); Canta, Pennell 14583 (F. GH, NY, US); Atocongo, Pennell 14791 (F, GH, NY); Amancaes, Pennell 14806 (F, GH, NY, US); Quilbruana, Scolnik 975 (GH); Zarate, Soukup 2143 (F); Lachay, Tovar 377 (LA); Chosica, USM 10113 (LA). Moquegua. Tarata, Weberbauer 7396 (F, US). Unspecified department. Peru, Dombey 10 (NY); Peru, McLean s.n. (K).

14. Pectocarya anomala I.M. Johnston, Contr. Gray Herb. 70: 35, 1924. Figure 18.——TYPE: Peru. Arequipa, southern slopes of Chachani Mountains, snady pampa, 2400 m, March 1920, Mr. & Mrs. F.E. Hinkley 41 (holotype: GH!; isotype: US!).

Plants branched from the base, or basally simple and dichotomously branched above. Stems erect to ascending, finely cinereous-strigose, 3.5 - 18.0 cm ($\bar{X}$ = 9.5 ± 3.4 cm) long. Leaves linear, ± setose, 0.5 - 3.0 cm ($\bar{X}$ = 1.1 ± 0.3 cm) long, 0.5 - 1.0 mm ($\bar{X}$ = 0.9 ± 0.1 mm) wide. Pedicels 0.3 - 0.4 mm ($\bar{X}$ = 0.35 ± 0.05 mm) long; calyces 1.0 - 1.3 mm ($\bar{X}$ = 1.1 ± 0.1 mm) long; corollas 1.2 - 1.5 ($\bar{X}$ = 1.3 ± 0.1 mm) long. Fruiting pedicels free, somewhat recurved, 1.25 - 2.0 mm ($\bar{X}$ = 1.5 ± 0.3 mm) long. Fruiting calyces divaricate, bilaterally symmetric, regular, equal to slightly exceeding the nutlets, 3.0 - 5.0 mm ($\bar{X}$ = 4.0 ± 0.4 mm) long. Fruits monomorphic, 3.0 - 4.5 mm ($\bar{X}$ = 3.8 ± 0.3 mm) long; nutlets geminate, homomorphic, recurved, obovate to oblong-obovate, dorsally rugose to convoluted, sparsely to densely pubescent with uncinate hairs, occasionally mottled in coloration, 1.5 - 2.3 mm ($\bar{X}$ = 1.0 ± 0.2 mm) long, 0.75 - 1.0 mm ($\bar{X}$ = 0.8 ± 0.1 mm) broad; nutlets lacking a proper margin, but appendaged laterally and dorsal-medially with subulate, subterete, uncinately bristled horns; lateral horns 0.4 - 1.75 mm ($\bar{X}$ = 0.9 ± 0.4

mm) long; medial horns 0.25 - 0.75 mm ($\bar{X}$ = 0.5 $\pm$ 0.2 mm) long. Gynobase broad-pyramidal.

Flowering Period. The flowering period of P. anomala extends from late March through early May.

Distribution (Figure 19) and Ecology. Pectocarya anomala, a South American endemic, occurs in southern Peru through extreme northern Chile. It is seemingly a rare plant, known only from six collections, and is an inhabitant of arid regions such as gravelly slopes and sandy pampas. Pectocarya anomala occurs at elevations of 100 ft (300 m) to 1000 ft (3000 m).

Specimens Examined. CHILE. Tarapaca. Camino de Arica al Portezuelo de Chapiquina, Ricardi, Marticorena, & Matthei 53 (CONC); Quebrada Cardones, Ricardi, Weldt, & Quezada 79 (CONC); Camino Zapahuira a Putre, Ricardi, Weldt, & Quezada 131 (CONC). PERU. Arequipa. Arequipa, Pennell 13165 (F, G, GH, K, LA, NY, UC, US); Yura, Arequipa, Vargas 7994 (US).

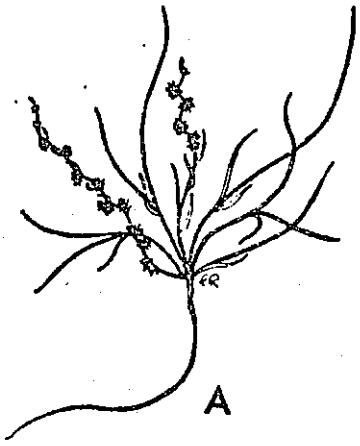
15. Pectocarya brachycera Veno sp. nov. Figure 20.

Herba annua ramosa basi. Caules erecti ad ascendentes, cinerei-strigosi ad hispidulosi, 1.5 - 12.0 cm ($\bar{X}$ = 4.4 $\pm$ 2.9 cm) longi. Folia angusta linearia, hispidulosa ad setulosa, 0.5 - 1.8 cm ($\bar{X}$ = 1.2 $\pm$ 0.3 cm) longa, 0.5 - 1.0

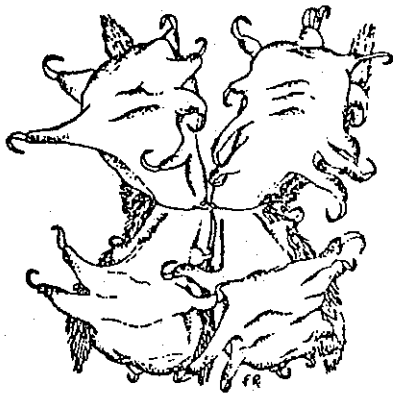
mm ($\bar{X}$ = 0.8 ± 0.1 mm) lata. Flores chasmogami; pedicelli 0.25 - 0.40 mm ($\bar{X}$ = 0.3 ± 0.1 mm) longi; calyces setosi, 1.0 - 1.5 mm ($\bar{X}$ = 1.3 ± 0.2 mm) longi; corollae infundibulares, 1.5 - 2.0 mm ($\bar{X}$ = 1.6 ± 0.2 mm) longae. Pedicelli fructiferi libri, recurvi, 1.25 - 2.25 mm ($\bar{X}$ = 1.8 ± 0.3 mm) longi. Calyces fructiferi divaricati, bilateraliter symmetrici, ± regulares, nuculae aequantes, 2.75 - 4.4 mm ($\bar{X}$ = 3.6 ± 0.3 mm) longi. Fructus monomorphi, 3.0 - 4.5 mm (X = 3.6 ± 0.2 mm) longi; nucullae geminatae, homomorphae ad leviter heteromorphae, recurvae, dorsaliter rugosae ad laeves, saepe maculosae, glabrae ad subglabrae vel varie puberulae uncinatae, obovatae ad obovatae angustae, 1.50 - 2.25 mm ($\bar{X}$ = 1.8 ± 0.2 mm) longae, 0.6 - 1.0 mm ($\bar{X}$ = 0.9 ± 0.1 mm) latae; nucullae sine marginibus distinctis, sed cornibus lateralibus, sparsis ad juxta positis, subulatibus, subteribus, setis uncinatis, 0.2 - 1.5 mm ($\bar{X}$ = 0.6 ± 0.3 mm) longis, 0.25 - 0.4 mm ($\bar{X}$ = 0.3 ± 0.1 mm) latis. Cornua dorsalia-media absentia, sed papillae mediae presentes interdum in nucularis unis vel paucis in fructu. Gynobasis latus-pyramidalis.
TYPUS: Bolivia. Potosi. Atocha, Andine region, 3700 m, 20 March, 1921, Asplund 5896 (holotypus: US).

Annual herb, branched from the base, Stems erect to ascending, cinereous-strigose to hispidulous, 1.5 - 12.0 cm ($\bar{X}$ = 4.4 ± 2.9 cm) long. Leaves narrow, linear, his-

Figure 20. Morphological characters of Pectocarya brachycera. A. habit X 1/2. B. fruit X 12. C-D. nutlet, dorsal and ventral X 12. E. ventral view of fruit showing calyx X 12.

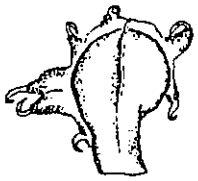


A

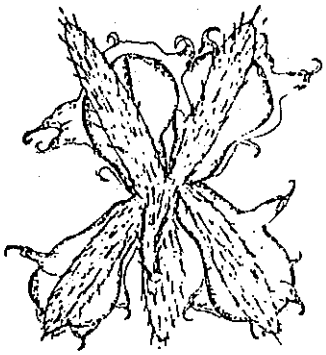


B

C



D



E

pidulous to setulose, 0.5 - 1.8 cm ($\bar{X}$ = 1.2 $\pm$ 0.3 cm) long, 0.5 - 1.0 mm ($\bar{X}$ = 0.8 $\pm$ 0.1 mm) wide. Flowers chasmogamous; pedicels 0.25 - 0.40 mm ($\bar{X}$ = 0.3 $\pm$ 0.1 mm) long; calyces setose, 1.0 - 1.5 mm ($\bar{X}$ = 1.3 $\pm$ 0.2 mm) long; corollas funnelform, 1.5 - 2.0 mm ($\bar{X}$ = 1.6 $\pm$ 0.2 mm) long. Fruiting pedicels free, recurved, 1.25 - 2.25 mm ($\bar{X}$ = 1.8 $\pm$ 0.3 mm) long. Fruiting calyces divaricate, bilaterally symmetrical, $\pm$ regular, equalling the nutlets, 2.75 - 4.4 mm ($\bar{X}$ = 3.6 $\pm$ 0.3 mm) long. Fruits monomorphic, 3.0 - 4.5 ($\bar{X}$ = 3.6 $\pm$ 0.2 mm) long; nutlets geminate, homomorphic to slightly heteromorphic, recurved, dorsally rugose to smooth, often mottled, glabrous to subglabrous or variously uncinate puberulent, obovate to narrowly obovate, 1.5 - 2.25 mm ($\bar{X}$ = 1.8 $\pm$ 0.2 mm) long, 0.6 - 1.0 mm ($\bar{X}$ = 0.9 $\pm$ 0.1 mm) wide; nutlets lacking a distinct margin, but appendaged with lateral horns, sparse to juxtaposed, subulate, subterete, uncinate bristled, 0.2 - 1.5 mm ($\bar{X}$ = 0.6 $\pm$ 0.3 mm) long, 0.25 - 0.4 mm ($\bar{X}$ = 0.3 $\pm$ 0.1 mm) wide. Dorsal-medial horns absent, but medial papillae occasionally present on one or more nutlets per fruit.

Flowering Period. The flowering period of P. brachycera extends from January through March.

Distribution (Figure 19) and Ecology. Pectocarya brachycera occurs from southern Peru through northern Argentina at elevations of 7500 ft (2300 m) through 14000

ft (4200 m). It is an inhabitant of bare, gravelly areas and the open puna.

Specimens Examined. ARGENTINA. La Rioja. La Rioja, Hieron & Niederl 466 (GH). BOLIVIA. La Paz. Between Ulloma and Callapa, Asplund 2628 (GH); General Campero, Asplund 2703 (GH); General Campero, Asplund 5894 (US). Oruro. Challapata, Asplund 5895 (US); Hacienda Huancauma prope Eucaliptus, Hammarlund 122 (NY). Potosi. Animas Mine, W of Chocaya, West 6077 (GH, UC). CHILE. Tarapaca. Camino de Cancosa, Marticorena, Matthei, & Quezada 353 (CONC). PERU. Arequipa. Arequipa, Gunther & Buchtien 1854 (GH).

Excluded Name

Pectocarya lateriflorum (Lam.) DC. var. nutallii (Spreng.) Brand, Pflanzenreich 4, 252(78): 95, 1921. Brand adopted the epithet nutallii of Sprengle (1825) as the earliest name for Pectocarya penicillata; however, the type of nutallii belongs in synonymy with the genus Lappula (Gray, 1878).

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