

BORAGINACEAE
OF BUTTE COUNTY, CALIFORNIA

Robert A. Schlising

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B O R A G I N A C E A E
O F B U T T E C O U N T Y, C A L I F O R N I A

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The cover diagram, depicting a mature nutlet of Plagiobothrys tenellus, is from a scanning electron micrograph provided by Robert Banchemo, Department of Biological Sciences, California State University, Chico.

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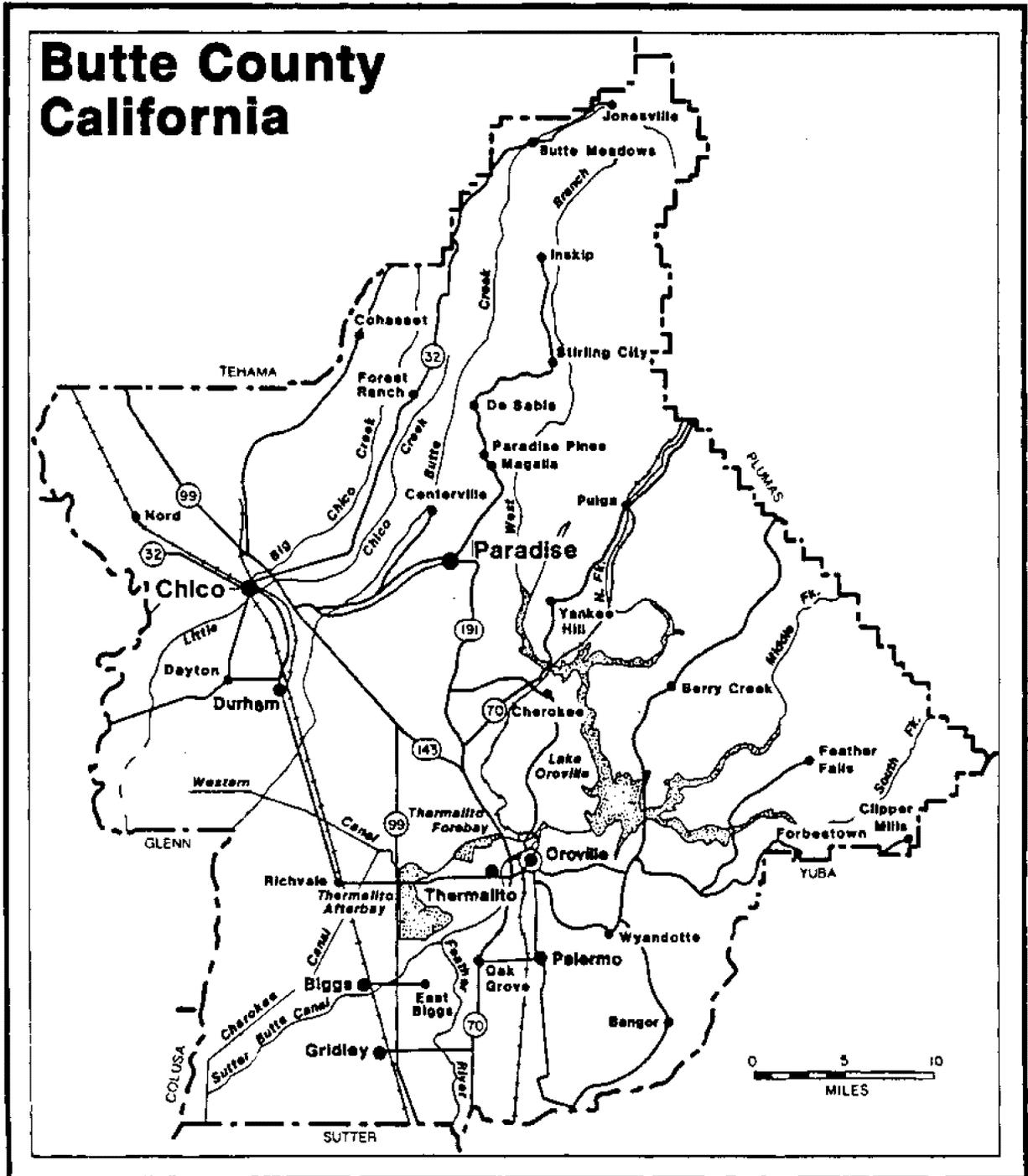
There are 10 genera and 35 species (with two varieties) of the Boraginaceae (the borage or forget-me-not family) known to occur without cultivation in Butte County, California. The vast majority of these 37 taxa are native to the region. They occur in all the major plant communities except freshwater marsh, with 18 species most common in grasslands and/or foothill woodlands, and 14 species most common in yellow pine and/or red fir forests. Several of these natives are very poorly represented by collections or contemporary sightings, and are probably quite rare in the county (e.g., Amsinckia eastwoodae, Cryptantha rostellata, C. simulans, Cynoglossum occidentale, Myosotis discolor and Plagiobothrys bracteatus var. aculeolatus). Only two of the Butte County borages are introduced weeds (Heliotropium europaeum and Myosotis verna), and both are uncommon. One native species, Amsinckia intermedia, a so-called "native weed," is extremely abundant some years and can be a nuisance in orchards or crop fields and other areas disturbed by human activities. This species is recorded as a "weed from California" in several other parts of the world.

The following treatment for all species in the Boraginaceae is based primarily on field studies in the county 1980-1983. In addition, it is based on specimens from Butte County on file in herbaria of California State University, Chico (CHSC); California Academy of Sciences, San Francisco (CAS, DS); and in the University (UC) and Jepson (JEPS) Herbaria at the University of California, Berkeley. Descriptions and keys are designed mainly for identification and separation of Butte County taxa. Characteristics listed in the keys are usually not repeated in the descriptions, and the short descriptions do not cover all aspects of each species. The two major floras used in the preparation of this study--Munz and Keck (1968) and Abrams (1951)--should be consulted for more complete descriptions, for Latin names in synonymy up to these dates, and for illustrations (in Abrams). Additional monographs and studies used are cited near the beginning of generic or specific descriptions. Specific epithets and author names follow Rice et al. (1982), except in Amsinckia, where Kartesz and Kartesz (1980) are followed; recent synonyms are given in brackets. Common names are based mainly on Abrams (1951).

A unique feature in this local floristic study is a summary of the literature on reproductive biology for each genus and species. Flowering dates in the literature have been modified so as to pertain particularly to Butte County plants, but other information is given for the taxa without special reference to this county alone.

The county range maps for each taxon show dots based on 1) herbarium specimens studied by the author, 2) sight records made in the field by the author, and in some cases, 3) specific locations cited in monographs or taxonomic treatments if the identify of the taxon seems certain. The Butte County outline maps (including the location map shown on the next page) were provided by Charles Nelson, Department of Geography, California State University, Chico. Plant community boundaries drawn on some of the dot maps are from a map prepared by James Nelson in the "Land Use Element of the Butte County, California General Plan" (Nelson, 1979). Plant community names are from Munz and Keck (1968), except that their "valley grassland" is replaced by "grasslands."

The author gratefully acknowledges James Jokerst and Mary Susan Taylor for their reviews of this paper and also for their help in field and herbarium during the years of this study. Thanks are also extended to John S. Morgan of the Professional Development Program, California State University, Chico, for funds to print this study.



The BORAGINACEAE in Butte County

Annual to perennial herbs, with simple, entire, mostly alternate leaves; flowers perfect, sometimes axillary, but usually in coiled (scorpioid) raceme- or spike-like inflorescences that tend to straighten with age; calyx of 5 sepals, fused at base, usually persistent; corolla of 5 petals, fused into a tube at base and expanded into 5 lobes usually spreading at right angles to the tube, often also with crests near top of tube; stamens 5, attached to and included within the corolla-tube; ovary superior, usually 4-lobed, with each lobe developing into a hard, single-seeded nutlet; nutlets at maturity separating independently from the receptacle (or from its extension, the gynobase); style attached to receptacle (rarely on top of ovary) and separate from ovary lobes.

Key to genera of BORAGINACEAE in Butte County

(Described in alphabetical order following the key)

- A Flowers white (although sometimes with colored veins or central areas or crests)
- B Corolla 7-12 mm broad; pubescent perennial from a thick rootstalk; nutlets with firm prickles (these armed with barbed tips) over most of surface; plants of dry forests
HACKELIA (H. CALIFORNICA only)
- BB Corolla 1-7 (occasionally to 12) mm broad; annuals (or if a perennial as in Heliotropium currasavicum, with stem semi-succulent and completely glabrous); nutlets not covered with firm prickles
- C Annuals or perennials; flowers sessile, barely separated from each other in dense, one-sided spikes; corolla white to bluish, the older flowers with yellow- or purple-veined centers; style lacking or attached to top of ovary, not deep-seated in center of ovary lobes; plants of roadsides and sandy or alkaline places below 500 feet elevation
HELIOTROPIUM
- CC Annuals; older flowers and fruits at least several mm apart on inflorescences; corolla sometimes with raised yellow center but without colored veins; style attached to receptacle area in center of deeply-lobed ovary, not connected to ovary or to maturing nutlets
- D Corolla very inconspicuous, with lobes ascending and barely as long as sepals; nutlets flattish and rhomboid, widely spreading, with hooked hairs at their tips; inconspicuous plants of grasslands and foothill woodlands
PECTOCARYA
- DD Corolla small to large, but usually conspicuous, with lobes spreading at top of tube and exceeding sepals; nutlets not very flattened, ovoid or lanceolate, erect, pointing in the same direction, without hooked hairs at their tips; species of many habitats and elevations

- E Mature nutlet, when removed from the receptacle, with a straight or forked groove or slit running the entire length of the ventral (inner) side; plants finely or coarsely stiff-pubescent
CRYPTANTHA

- EE Mature nutlet, when removed from the receptacle, with both a ridge-like keel and a rounded to linear attachment scar on the ventral (inner) side (the scar variously located from the middle to near the base); plants variously pubescent, or glabrous (for plants with nutlets completely smooth and scar completely basal, see Myosotis)
PLAGIOBOTHRYIS

- AA Flowers not white (i.e., yellow, orange, rose-brown, pinkish, pale to deep blue)
 - F Corolla yellow to orange
 - C Annuals; leaves lance-linear, reduced in size from middle to top of stem; mature nutlets roughened and brown
AMSINCKIA

 - GG Perennial; leaves mainly ovate or oblong, the upper about the same size as those on the middle of stem; mature nutlets smooth and white
LITHOSPERMUM

 - FF Corolla color other than yellow or orange
 - H Corolla 12-18 mm long, longer than broad, tubular at base and widened upward, with petal lobes not at right angles to tube; tall, glabrous perennial from high elevations
MERTENSIA

 - HH Corolla under 10 mm long, not longer than broad, usually with petals spreading at right angles to top of tube, or if petals barely spreading, flowers sessile; annuals or perennials from various elevations
 - I Corolla pale blue (sometimes yellowish or pinkish), often with deeper colored veins, 1-5 (occasionally to 9) mm broad; mature nutlets often concealed by the sepals, sometimes roughened, but without distinct prickles

 - J Annual or perennial with side branches in leaf axils; main leaves spatulate or rounded, petioled; flowers sessile; older corollas with yellow- or purple-veined centers; plants of open roadsides, sandy or waste places below 1000 feet elevation
HELIOTROPIUM

JJ Annuals, usually without side branches in leaf axils; main leaves linear, without distinct petioles; flowers pedicelled; corolla without colored veins; plants of mid elevation meadows or forest openings

MYOSOTIS

II Corolla rich blue or rose-brown, sometimes with a whitish central area of crests, 5-15 mm broad; mature nutlets not concealed by sepals, with prickles; perennials

K Corolla blue; inflorescence highly branched with age, its branches glabrous, or if pubescent with bract-like leaves within it

L Blades of lower and basal leaves ovate, abruptly narrowed to a long petiole; plants in flower February to May, from below 3000 feet elevation

CYNOGLOSSUM (C. GRANDE only)

LL Blades of lower stem and basal leaves oblanceolate or linear, gradually narrowed to base; plants in flower June to August, from above 5000 feet elevation

HACKELIA

KK Corolla rose-brown or reddish; inflorescence pubescent, little branched and without bract-like leaves within it; rare plants of forests
CYNOGLOSSUM (C. OCCIDENTALE only)

AMSINCKIA Lehm.

Fiddleneck, fireweed

References: Hitchcock et al. (1959), Ray and Chisaki (1957a, b, c)

Description Simple to highly branched, bristly-pubescent annuals; leaves linear or lanceolate, entire, 3-15 cm long, usually bearing hairs with pustulate-expanded bases; flowers in scorpioid spikes, elongating with age; calyx bristly; corolla yellow or orange, sometimes with red in the throat; style filiform, with a small 2-lobed stigma; nutlets 1-4, ovoid, 2-3.5 mm long, roughened, keeled both dorsally and ventrally, the small scar at one end of the ventral keel.

In their three-part study on Amsinckia in North America, Ray and Chisaki (1957a, b, c) stressed that the species of Amsinckia section Muricatae (which includes the three species found in Butte County), are the plants responsible for giving Amsinckia the "notorious reputation" of being a taxonomically difficult group. The following points made by Ray and Chisaki (1957c) apply to the Butte County taxa: 1) Individuals within any single population often tend to be strikingly uniform in morphology; 2) Different species are potentially capable of hybridization (hybrids have been found in Butte County); 3) It is nevertheless common to encounter two or more species or morphological variants of the same species growing intermixed in the field without any evidence of integration; 4) "Yet from population to population, flower... and vegetative characters seem to vary and recombine to such an extent that the Amsinckia which occurs at one locality may be morphologically intermediate between two forms which grow together, without intergradation, at a second locality."

Reproductive biology Species of Amsinckia occurring in Butte County are known to be self-compatible and also capable of hybridizing (Ray and Chisaki, 1957a, c). Moldenke (1976) indicates that there regularly is outcrossing to some degree, and lists bombyliid flies, butterflies, and bees of several genera as flower visitors and pollinators for the genus.

Ray and Chisaki (1957b) provided comments on seed germination for Amsinckia in general, which probably pertain to the Butte taxa. Seeds taken from herbarium specimens not more than three years old or from the field the previous season, when planted in moist sand, germinated in 5 to 15 days. Seeds planted immediately or a few months after field collection needed stratification on moist filter paper in closed dishes at 4° C for 1 to 4 weeks, and then gave 75-100% germination. Seedlings raised in the spring invariably gave larger and more vigorous plants than those raised in summer; the vegetative rosette stage lasted longer and flowering was correspondingly more vigorous and more prolonged.

Stebbins (1965) stressed several features of reproductive biology that promote the abundance and widespread and weedy nature of some Amsinckias. These include seedling vigor (especially the size of the bilobed cotyledons and the first leaves), early and persistent flowering, and very high seed productivity. Weediness in Amsinckia is most striking in A. intermedia, and is discussed under that species.

Key to species of AMSINCKIA in Butte County

Corolla to 3 mm broad, 4-7 mm long, barely longer than calyx; corolla yellow, the tube cylindrical; stems bristly-hirsute and also with

very fine, appressed hairs

1. AMSINCKIA MENZIESII

Corolla 5-14 mm broad, 7-20 mm long, the tube longer than the calyx, yellow to deep orange; corolla tube nearly cylindrical or expanding widely at the throat; stems coarse-bristly

Corolla (5-)8-10 mm broad, 1-2 times the length of the calyx, orange to orange-yellow; corolla tube nearly cylindrical, the stamens usually appressed to the stigma; abundant

2. AMSINCKIA INTERMEDIA

Corolla 8-14 mm broad, 2-3 times the length of the calyx, orange; corolla tube definitely expanding at the throat, with the stamens spread apart in the open throat and usually shorter than the style and stigma; rare

3. AMSINCKIA EASTWOODAE

1. AMSINCKIA MENZIESII (Lehm.) A. Nels. & MAP 1
J. F. Macbr.

[A. retrorsa Suksd.]

Small flowered fiddleneck, harvest fireweed

Description Stems to 6 dm high, simple or with few ascending branches near top, bristly-hirsute and also finely hairy; spikes 5-15 cm long, mainly pale grayish; calyx 5-11 mm long, white- or light tawny-hispid; corolla to 3 mm broad.

The treatment for Amsinckia in the Flora of the Pacific Northwest (Hitchcock et al., 1959) has a narrower conception of A. menziesii, and those authors segregate plants with the fine, appressed hairs as A. retrorsa.

Reproductive biology Flowers April to June. Flowers are odorless, an unusual condition for the genus (Ray and Chisaki, 1957b). Ray and Chisaki (1957c) noted that regular physical contact of anthers and stigmas produces automatic self pollination and sets nearly 100% of the seed without pollinators. Moldenke (1976) lists this species as an obligate cleistogamous selfer.

Distribution and habitat This species is frequent throughout the grasslands and foothill woodlands of Butte County.

2. AMSINCKIA INTERMEDIA Fisch & C. A. Meyer MAP 2
Common fiddleneck, rancher's fireweed, fireweed fiddleneck, yellow forget-me-not

Description Stems simple to widely branched, to 9 dm high, bristly-hairy, especially above; spikes 5-20 cm long in age, leafy at base only; calyx 5-10 mm long, lobes rusty-hispid on back, white-hirsute on edges; corolla to 8 or 10 mm broad, usually reddish in the throat.

Variation in height, branching, pubescence and flower size and coloration make Amsinckia intermedia one of the most variable species in Butte County. Most floras note this widespread species (ranging north to Washington and Idaho and south to Baja California and Arizona) as the most diverse in the genus. Jepson's A Flora of California (1943) lists numerous other specific epithets applied to variants of A. intermedia. The German botanist Wilhelm Suksdorf, after one extensive collecting trip through western North America, published over

200 names that are now mostly considered synonyms of A. intermedia. Even A. eastwoodae, treated as a separate species for Butte County (as is done in Kartesz and Kartesz (1980)), is difficult to clearly separate from the larger-flowered populations of A. intermedia.

Reproductive biology Flowers February to June. Ray and Chisaki (1957c) reported a peculiar sourish flower odor for this species, and also noted that often physical contact of anthers and stigma produce self pollination, and that at least the smaller-flowered forms set nearly 100% seed in this fashion. This implies that larger-flowered forms of A. intermedia may have cross pollination occur due to insect pollen vectors. Krombein et al. (1979) list one species of bee, Synhalonia amsinckiae, that collects pollen for its nests only from species of Amsinckia, including A. intermedia. These authors list 28 additional species of bees that visit A. intermedia flowers for pollen and/or nectar, but all are known to visit other species also: Andrena (2 species visit A. intermedia), Perdita (1), Anthidium (1), Hoplitis (1), Osmia (3), Megachile (1), Synhalonia (6), Anthophora (9), and Emphoropsis (4).

The potential of 4 seeds (nutlets) per flower was not achieved in the field population of A. intermedia studied by Ornduff (1976): he reported a mean of only 2.0 seeds per flower (n=37).

A very noteworthy reproductive feature in A. intermedia is its ability to colonize unstable or pioneer habitats. Stebbins (1965) discussed A. intermedia as one of the most successful weeds that has arisen from the native Californian flora. The weedy tendencies are noted in Butte County, where this species occupies orchards or recently abandoned pastures or cultivated ground, sometimes producing sheets of color when in flower. Ray and Chisaki (1957c) discussed the importance of this species' reproductive method--self pollination--in permitting its weedy tendencies. Selfing is an asset to colonizing plants because it can increase population uniformity, rate of population increase, and chances for successful migration to a new site. Amsinckia intermedia now occurs on several continents as a weed. Salisbury (1961) noted its introduction in England on sand dunes, in grain fields, and in "old fowl runs." Distribution and habitat This species is abundant and widespread in grasslands, some cultivated lands, and foothill woodlands. It is less common in openings within chaparral and is rare in yellow pine forests at lower elevations in Butte County.

3. AMSINCKIA EASTWOODAE J. F. Macbr. MAP 3
[A. intermedia Fisch & C. A. Meyer var. eastwoodae
(J. F. Macbr.) Jeps. & Hoov.]

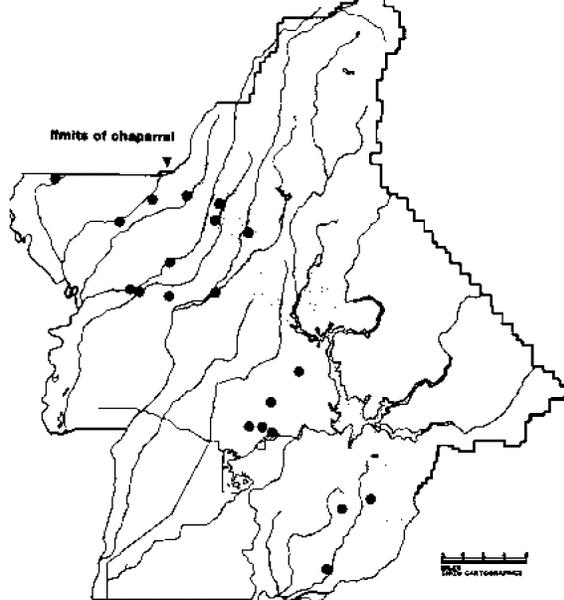
Description Similar to A. intermedia, but flowers larger and with style and stigma exserted; corolla deep orange, 14-20 mm long.

Reproductive biology Flowers March to June. Ray and Chisaki (1957c) noted a peculiar sourish flower odor as in A. intermedia. These authors found plants grown in a greenhouse set seeds only irregularly unless they were pollinated by hand. The flowers are self-compatible, but since stamens do not automatically contact the stigma the flowers tend to be cross pollinated by insects. Potential pollinators include the three species of bees listed as visitors to flowers of A. eastwoodae by Krombein et al. (1979). All three (Andrena misella, Anthophora crotchii, and Synhalonia amsinckiae) are known to visit other species of flowers, but the Synhalonia bee is thought to collect pollen only from species of Amsinckia.

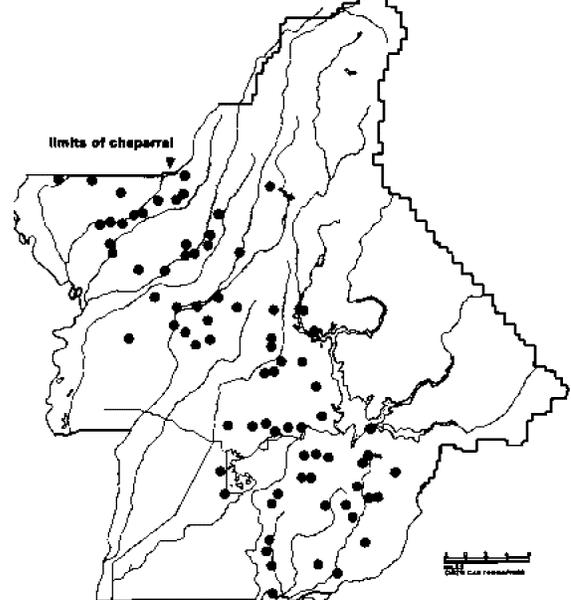
Distribution and habitat This species is probably quite rare in grassy

Amsinckia menziesii

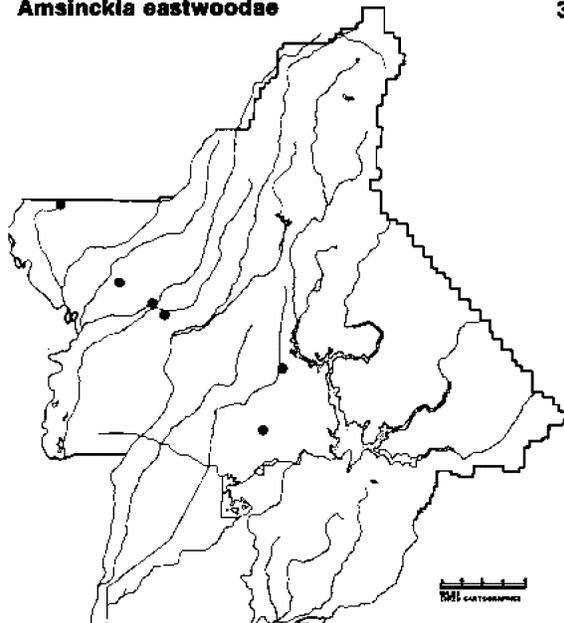
1

**Amsinckia intermedia**

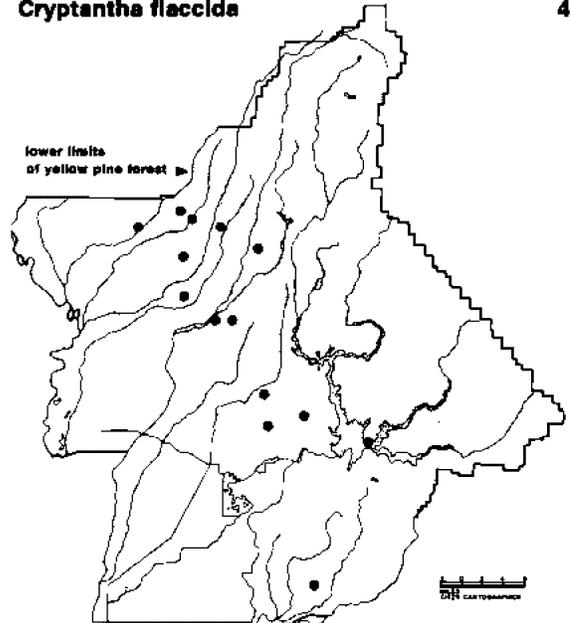
2

**Amsinckia eastwoodae**

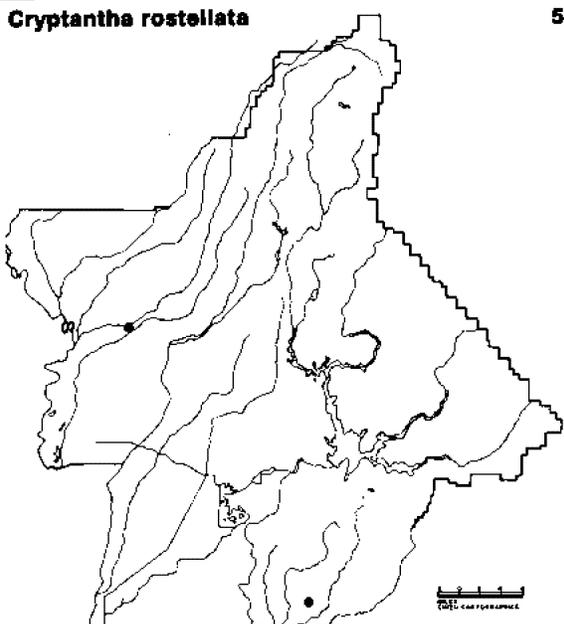
3

**Cryptantha flaccida**

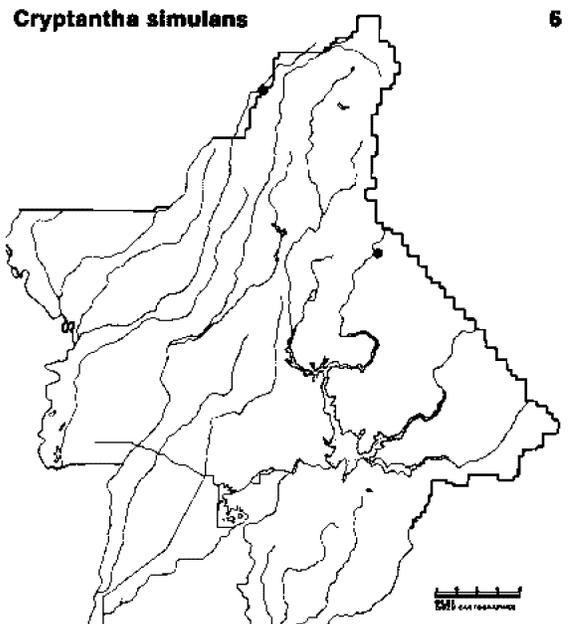
4

**Cryptantha rostellata**

5

**Cryptantha simulans**

6



habitats at low elevations in Butte County. Few collections are on hand, especially from recent years [e.g., along highway at Sycamore Ranch north of Chico, 1967, S. Gualtieri, s. n. (CHSC)], and the present author has not seen the plant growing in the county.

CRYPTANTHA Lehm. ex G. Don
Cryptantha, popcorn flower
Reference: Johnston (1925)

Description Stiffly erect, branched annuals, often with both fine, appressed and also spreading pubescence; leaves linear, oblong or oblanceolate; flowers in scorpioid spikes or racemes; calyx deeply lobed, pubescent; corolla white; nutlets 1-4, lanceolate to triangular-ovoid, (1.5-)2-2.5(-3) mm long, attached on their sides to the elongated receptacle, and when detached displaying an elongated, often basally-forked groove or slit on the ventral side.

It is essential to have mature fruits to determine Cryptantha species. Although the seven Butte County taxa can be fairly well identified according to features of habit, pubescence and habitat, there are still pairs of species that do need nutlet features for their ultimate separation (i.e., C. flaccida/rostellata, affinis/milobakeri, simulans/torreyana). Johnston (1925) allowed for considerable variation within some of the species, and acknowledged that this group is in an active state of evolution.

Reproductive biology Moldenke (1976) considers Cryptantha a genus of self-compatible and predominantly selfing plants, but nevertheless a group in which notable speciation has occurred due to occasional visits by pollinating insects. He notes that two species of specialist-feeding bees associate with Cryptantha in the northern Sierra Nevada and northern Central Valley. The bee genera Andrena and Proteriades are emphasized as important pollinators (see discussion under C. intermedia). Bombyliid flies (especially Bombylius, Phthiria and Oligodranes) and acrocerid flies are also considered frequent pollinators. Moldenke also lists sphecid and vespid wasps and tachinid flies as possibly important pollinators in some places.

Johnston (1925, p. 18) appeared to stress dispersal features when noting "By taking on the annual habit, and developing detachable somewhat bur-like fruiting calyces, Cryptantha has been able to reproduce, spread and evolve very rapidly, adapting itself to the variety of conditions in western America."

Key to species of CRYPTANTHA in Butte County

- A Calyx (in flower or in fruit) with recurved or hooked hairs, sometimes with straight hairs as well)
 - B Mature nutlets 1 per flower, smooth and shiny; hooked hairs present on sepal midribs and margins (hairs scruffy at 20X); plants mainly of grasslands
 - C Style less than 1/2 height of mature nutlet; nutlet with ventral groove closed all the way to base
 - 1. CRYPTANTHA FLACCIDA
 - CC Style 1/2 to 2/3 height of mature nutlet; nutlet with a

small open space (areola) at base of ventral groove

2. CRYPTANTHA ROSTELLATA

BB Mature nutlets 4 per flower, tuberculate-roughened; recurved or hooked hairs present on midribs or tips of sepals (hairs not scruffy at 20X), but sepal margins with soft, ascending hairs; plants mainly of foothill and montane areas

3. CRYPTANTHA SIMULANS

AA Calyx (in flower or in fruit) lacking recurved or hooked hairs

D Groove on ventral surface of nutlet clearly to one side of center, making whole nutlet appear flattened and asymmetrical (especially in cross section)

4. CRYPTANTHA AFFINIS

DD Groove down the center of ventral surface of nutlet; nutlet symmetrical (not flattened in cross section)

E Mature nutlets tuberculate (at 10X); nutlets usually 4 per flower; mature calyx well constricted above nutlets, with calyx lobes spreading widely at their tips

F Pubescence of main internodes of fine, appressed hairs only; corolla 2 mm or less broad; inflorescence variously branched, sometimes branched in 2's

3. CRYPTANTHA SIMULANS

FF Pubescence of main internodes of both fine, appressed hairs and of longer, widely-spreading hairs; corolla usually at least 4 mm broad; inflorescence usually branched in 2's or 3's

5. CRYPTANTHA INTERMEDIA

EE Mature nutlets smooth and shiny; nutlets 1, 2, or 4 per flower; calyx sometimes constricted above nutlets

G Nutlets usually 1 per flower; corolla 2 mm or more broad; calyx densely covered with soft, whitish or tawny, ascending hairs

6. CRYPTANTHA MILOBAKERI

GG Nutlets usually 4 per flower; corolla 1-2 mm broad; calyx with at least some stiff, spreading bristles on midribs of lobes

7. CRYPTANTHA TORREYANA

1. CRYPTANTHA FLACCIDA (Dougl. ex Lehm.) Greene MAP 4
Flaccid cryptantha

Description Stem stiffly erect, branched, 15-45 cm high, whitish; spikes stiff, 4-8(-10) cm long; calyx 2-5 mm long in fruit, asymmetrical; sepal midribs with downward-curving bristles that appear scruffy-encrusted at 20X; corolla 1-4 mm broad; nutlets 1, smooth; style 1/3 to 1/2 height of nutlet.

Reproductive biology Flowers April to June. Krombein et al. (1979) list 9 species of bees (4 species Andrena, 2 Proteriades, 2 Ceratina, 1 Chelostoma) that have been collected from C. flaccida. Most of these bees are known to visit other plant species also for pollen and/or nectar. However, Proteriades nanula sparsa appears to take pollen only from species of Cryptantha, including C. flaccida; P. evansi is thought to collect pollen only from C. flaccida.

Distribution and habitat Cryptantha flaccida is found throughout Butte County grasslands, foothill woodlands and openings in chaparral. It is often in shallow or poor soils, and its known range is from about 400 feet elevation near Rock Creek to about 2200 feet south of Nimshew.

2. CRYPTANTHA ROSTELLATA (Greene) Greene MAP 5
Beaked cryptantha

This species is very similar to C. flaccida, with the only recent collections from Butte County made near Honcut. These plants [L. Ahart, s. n., L. Ahart, 101, and L. Ahart, 4606 (all CHSC)] differ from C. flaccida in having few branches that are only near the top of the stem. They weakly show two characteristics that distinguish C. rostellata from C. flaccida: there is a more-open region (areola) at the base of the ventral groove on the nutlet, and the style reaches up to 2/3 or more the height of the nutlet. The Ahart collections are from grasslands and a gravel bar in a wash, all at about 150 feet elevation. Johnston (1925) listed the only other collection known for the county: "near Chico, 1887, Parry (UC)."

3. CRYPTANTHA SIMULANS Greene MAP 6
Pine cryptantha

Description Stem whitish, with few ascending branches 15-45 cm high; spikes elongate, sparsely flowered; calyx 3-8 mm long in fruit, with lobes connivent but their green tips spreading and their midribs bearing short, recurved bristles; corolla 0.5-1.5(-2) mm broad; nutlets 4, tuberculate; style about 3/4 to 4/5 height of nutlets.

Reproductive biology Flowers June and July.

Distribution and habitat Only two collections (both CHSC) are on hand for Butte County, from yellow pine forest at 3680 feet elevation just S of the Tehama County line along Hwy 32, and at about 1500 feet N of Cresta Powerhouse in the Feather River Canyon along Hwy 70:

4. CRYPTANTHA AFFINIS (Gray) Greene MAP 7
Common cryptantha

Description Stem 10-40 cm high, usually branched at middle or above; flowers in loose spikes 2-8(-15) cm long, sometimes in clusters and with a few leaflike bracts below; calyx 2.5-4 mm long in fruit, hirsute; corolla to about 1.5 mm broad; nutlets 4, smooth and shiny, sometimes dark and mottled, obliquely compressed and with the groove distinctly off-center; styles shorter than to about equalling height of nutlet.

Reproductive biology Flowers June to September.

Distribution and habitat Cryptantha affinis, the most common cryptantha in Butte County, is abundant in forests and montane chaparral, mainly above 3500 feet elevation.

5. CRYPTANTHA INTERMEDIA (Gray) Greene MAP 8
[C. hendersonii (A. Nels.) Piper, C. intermedia var.]

hendersonii Jeps. & Hoov.]
Common cryptantha

Description Stem stiff, branched mainly above, from 15 to nearly 40 cm high; spikes 3-15 cm long, commonly in 2's or 3's; calyx 2-7 mm long in fruit, the lobes often connivent and with spreading tips, the midribs always sharp-hirsute; corolla 2-8 (usually about 5) mm broad; nutlets 4, coarsely and densely tuberculate; style about equalling the nutlets.

Collections of Cryptantha intermedia have often been labelled Cryptantha hendersonii, and even the monographer of Cryptantha (Johnston, 1925) noted that C. hendersonii completely "passes into" C. intermedia in northern California. Butte County plants appear quite similar throughout. Although the two taxa are maintained as separate entities in Munz and Keck (1968) and in Abrams (1951), C. hendersonii is here treated as a synonym of C. intermedia, as it is in the most recent lists [e.g., Kartesz and Kartesz (1980) and Rice et al. (1982)].

Reproductive biology Flowers April to June. Krombein et al. (1979) list one species of wasp (Pseudomasaris edwardsii) and 139 species of bees (plus 2 additional subspecies of these bees) that are known to visit flowers of Cryptantha intermedia. The wasp and the vast majority of the bees visit many species of flowers for pollen and/or nectar. However, females of 7 species of Proteriades are listed as collecting pollen only from C. intermedia; 4 more species of Proteriades and 3 of Andrena restrict their collecting to Cryptantha, including C. intermedia. The additional 125 species of bees collected from flowers of C. intermedia are: Colletes (2 species), Hylaeus (2), Andrena (30), Ancylandrena (1), Panurginus (4), Nomadopsis (3), Perdita (5), Dufourea (7), Conanthalictus (1), Anthidium (7), Callanthidium (1), Dianthidium (1), Anthidiellum (1), Heriades (1), Chelostoma (4), Chelostomopsis (1), Proteriades (1), Hoplitis (3), Anthocopa (1), Ashmeadiella (9), Osmia (15), Megachile (5), Calicodoma (1), Exomalopsis (2), Melissoides (5), Synhalonia (2), Anthophora (3), and Ceratina (7).

Distribution and habitat Cryptantha intermedia is known from north-central parts of the county, where it is found in open areas, often on shallow soils of serpentine or of Tuscan Formation volcanic mudflow outcrops. Several collections [e.g., "3 miles N of Chico" (CAS, JEPS) and "Chico, 190 feet" (CHSC)] suggest its occurrence at grassland elevations; these populations have not been seen by the author. Known sites range from a low of about 600 feet in Bidwell Park, Chico to as high as 3200 feet (e.g., Millsap Bar Road) in foothill woodlands, woodland/chaparral ecotones, or yellow pine forests.

6. CRYPTANTHA MILOBAKERI I. Johnst. MAP 9
Milo Baker's cryptantha

Description Stem 10-40 cm high, with mostly strictly ascending branches; spikes often in 2's or 3's, 3-10 cm long; calyx 2-3 mm long in fruit, the lobes straight and densely pubescent; corolla 2-4 mm broad; nutlets usually 1, sometimes 2 or 4, smooth or inconspicuously roughened; style to about 3/4 height of nutlets.

Reproductive biology Flowers May to July.

Distribution and habitat This species has been collected in three locations: along Hwy 32 and along Humboldt Road between 3850 and 4450 feet elevation near Lomo in N Butte County, 3 miles S of Pulga in the Feather River Canyon at about 2000 feet (CAS), and on the granite of Bald Rock

Dome, Middle Fork of the Feather River, from 1600 to 3000 feet. All regions are in yellow pine forests.

7. CRYPTANTHA TORREYANA (Gray) Greene MAP 10
Torrey's cryptantha

Description Stem 10-40 cm high, sometimes with spreading branches; spikes congested and sometimes paired, elongate and loosely flowered or with flowers densely congested; calyx 3-7 mm long in fruit, the lobes connivent and their tips spreading, with midribs bearing at least some bristles and margins usually soft hairy; corolla 1(-2) mm broad; nutlets usually 4, smooth and shiny, sometimes mottled; style to 2/3 or whole length of nutlets.

Reproductive biology Flowers June to August.

Distribution and habitat This species occurs mainly on bedrock outcrops and in openings within yellow pine and red fir forests (and occasionally in montane chaparral) in N Butte County. It is also collected from lower elevations near the ecotone of yellow pine forest and chaparral [e.g., NE of Forest Ranch at 3950 feet (CHSC) and S of Cohasset on red clay in Adenostoma chaparral at about 1800 feet (CAS)].

CYNOGLOSSUM L.
Hound's tongue

Description Perennials with 1 or several stems from thick rootstalks; basal leaves long-petioled, the upper sessile; flowers in panicles or scorpioid racemes; corolla tube closed at top by crests; mature nutlets diverging horizontally, covered with barbed prickles.

Reproductive biology Moldenke (1976) lists Californian plants in this genus as self-incompatible; he considers the degree of outcrossing occurring as about one half of that possible. He considers both flower visitation by insects and seed set as quite heavy, and lists as pollinators bombyliid flies (particularly Bombylius major) and polylectic bees in Anthophora. Krombein et al. (1979), also without specifying species of Cynoglossum, list the polylectic bees Megachile brevis brevis and Synhalonia angustifrons as visitors to Cynoglossum flowers.

Key to species of CYNOGLOSSUM in Butte County

Stems nearly glabrous; basal leaves ovate, very abruptly narrowed to long petioles; flowers blue; plants of foothill and montane regions

1. CYNOGLOSSUM GRANDE

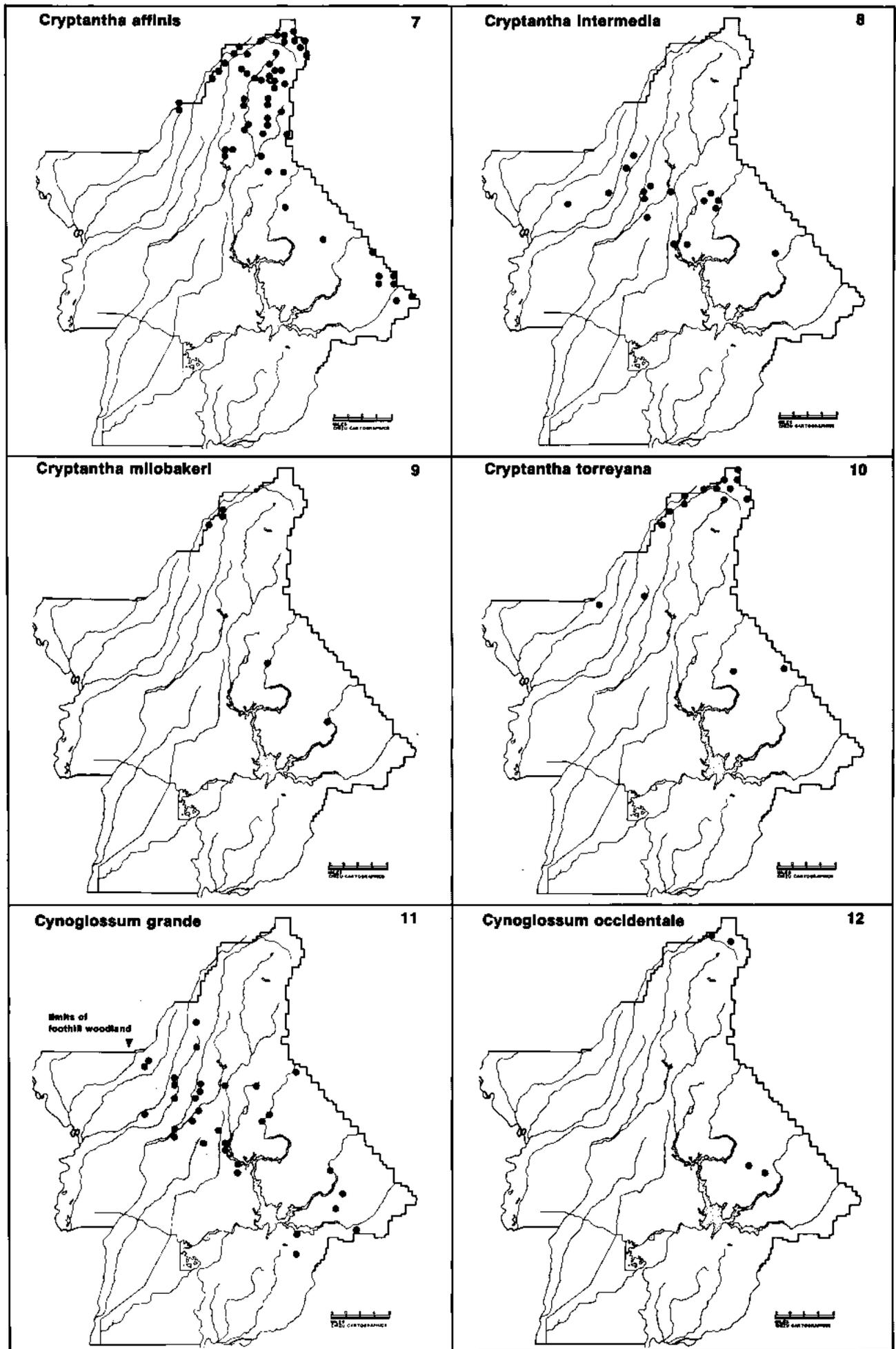
Stems densely pubescent; basal leaves oblanceolate or spatulate, gradually narrowed to winged petioles; flowers rose-brown or reddish; plants of montane regions

2. CYNOGLOSSUM OCCIDENTALE

1. CYNOGLOSSUM GRANDE Dougl. ex Lehm. MAP 11
Hound's tongue

Description Stem 3-8 dm high; blade of basal leaves ovate, 7-15 cm long and 5-10 cm wide; panicle long-peduncled and sometimes highly branched; corolla with tube 8-12 mm long, over 10 mm broad, nutlets 5-6 mm long.

Reproductive biology Flowers February to May. Data from Moldenke (1976)



listed above for this genus probably pertain particularly to this showy, common species. Krombein et al. (1979) list the polylectic bee Anthophora pacifica pacifica as a flower visitor to C. grande.
Distribution and habitat Cynoglossum grande occurs the length of Butte County. It is occasionally found as low as 300 feet elevation, in brushy foothill woodlands (e.g., on N-facing slopes near Bidwell Park Golf Course, Chico); it occurs mainly in foothill woodlands and yellow pine forest to 2800 feet.

2. CYNOGLOSSUM OCCIDENTALE Gray MAP 12
Western hound's tongue

Description Stem 3-5 dm high; basal leaves 20-25 cm long, to 4 cm wide; panicle on long peduncle, with a few stiff branches; corolla 4-6 mm long and about as broad; nutlets 7-9 mm long.

Reproductive biology Flowers May to July.

Distribution and habitat This species is known from only three localities in the county: Jonesville (UC), from near Humbug Summit at 6000 feet elevation (CHSC), and SW of Brush Creek at about 3000 feet (CHSC). All sites are in yellow pine forests.

HACKELIA Opiz
Stickseed

References: Gentry (1972), Gentry and Carr (1976)

Description Pubescent perennials from stout taproots, with 1 to several stems 3-10 dm high; lower leaves oblanceolate, elliptic or oblong, often with long, winged petioles; leaves reduced above and mostly ovate; inflorescence a panicle of racemes, with fruiting pedicels recurved and to 12 or 15 mm long; calyx deeply lobed; corolla with a crested throat; style shorter than the mature nutlets; nutlets ovoid, 3-5 mm long, covered with barbed bristles, the four forming a broad pyramidal fruit.

Reproductive biology Moldenke (1976) lists Californian species of Hackelia as genetically self-compatible, but with about 50% outcrossing of the flowers. He also lists pollinators of flowers in California Hackelia as bombyliid flies (especially Bombylius major), syrphid flies, butterflies, and generalist-feeding bees (with many genera in all families, including males of species where the females are specialists in pollen collecting on other plants).

Key to species of HACKELIA in Butte County

Corolla white; fruit with numerous prickles on dorsal surface that are as long as the marginal prickles

1. HACKELIA CALIFORNICA

Corolla blue; fruit with few to numerous prickles on dorsal surface, these from as long as, to much shorter than, the marginal prickles

Corolla tube longer than the calyx; prickles on dorsal surface of nutlet as long as those on the margins

2. HACKELIA NERVOSA

Corolla tube not or barely exceeding calyx; prickles on dorsal surface of nutlet shorter than those on the margins

3. HACKELIA MICRANTHA

1. HACKELIA CALIFORNICA (Gray) I. Johnst. MAP 13
California stickseed

Description Leaves ascending, 4-15 cm long, 10-20 mm wide, villous to hirsute, the upper often clasping; corolla white, 7-12 mm broad, the tube shorter than to about equalling the calyx lobes; mature nutlets broadly ovoid, the surface prickles 10-16; marginal prickles 10-18 per side, mainly distinct to their bases.

Reproductive biology Flowers June to August.

Distribution and habitat This species is common in dry soils of open or brushy areas, mainly above 5000 feet elevation in Butte County. This region is mainly red fir forests, but includes "islands" of yellow pine forests and of montane chaparral.

2. HACKELIA NERVOSA (Kellogg) I. Johnst. MAP 14
Sierra Stickseed

Description Leaves 3.5-8.5 cm long, 8-15 mm wide, strigose to harshly pubescent with age; corolla blue, 6-10 mm broad, the tube longer than the calyx lobes; mature nutlets ovoid, the surface prickles 7-17; marginal prickles 7-11 per side, mostly separate to their bases.

Reproductive biology Flowers June to early August.

Distribution and habitat This species is fairly common in NE Butte County in yellow pine forests (e.g., down to about 5200 feet elevation SE of Bald Mt., T25N, R4E), in red fir forests (up to 7000 feet near Humboldt Peak), and in montane chaparral within this region.

3. HACKELIA MICRANTHA (Eastw.) J. L. Gentry MAP 15
[H. jessicae (McGregor) Brand]
Jessica's stickseed
Reference: Gentry (1972)

Description Basal leaves 8-23 cm long, 12-30 mm wide, hirsute or strigose; corolla blue, 4-7(-9) mm broad, the tube shorter than to about equal to the calyx lobes; mature nutlets ovoid, the dorsal surface with 4-8 prickles; marginal prickles 4-9 per side, distinct from each other or slightly fused at their bases.

Reproductive biology Flowers June to August. Krombein et al. (1979) list one species of bee (Osmia sculleni) that has been collected only from flowers of this species (listed as H. jessicae). Other bees listed by them (collected from H. jessicae and from other plants as well) include Osmia thysanica, O. densa densa, Andrena medionitens, Anthidium emarginatum and Megachile melanophaea calogaster.

Distribution and habitat Only four localities within the red fir forest region are known for Butte County: NE of Snag Lake at 6000 feet elevation, N slope of Snow Mt. at 6700 feet, N of Philbrook Reservoir at 5600 feet (all CHSC), and at "Scotch John Meadow" (DS).

HELIOTROPIUM L.
Heliotrope
Reference: Ewan (1942)

Description Annual or perennial, with simple leaves usually bearing short branches in the axils; flowers crowded in dense terminal, very coiled spikes; corolla funnelform, bluish or whitish, the older ones with colored veins; style apical or lacking on the unlobed or slightly

lobed ovary; nutlets 1.5-2.5 mm long.

Reproductive biology Moldenke (1976) lists Heliotropium in California as genetically self-compatible, but with flowers about one third out-crossed. Bombyliid flies as well as bees of several genera (Andrena, Ashmeadiella, Nomadopsis and Perdita) are listed as major pollinators.

Key to species of HELIOTROPIUM in Butte County

Plants glabrous, glaucous and somewhat succulent

1. HELIOTROPIUM CURASSAVICUM var. OCULATUM

Plants pubescent throughout

2. HELIOTROPIUM EUROPAEUM

1. HELIOTROPIUM CURASSAVICUM L.

var. OCULATUM (A. Heller) I. Johnst. MAP 16

Wild heliotrope

Description Glabrous, glaucous and fleshy perennial with stem 1-5 dm high; leaves spatulate, tapered to base, to 4 cm long; spikes to 8 cm long; calyx 2-3 mm long; corolla 3-6 mm broad, white to pale blue, with center and veins yellow or purplish with age; nutlets smooth.

Reproductive biology Flowers June to October. Krombein et al. (1979) list fifteen bee species in seven genera as foragers on H. curassavicum var. oculatum; most are polylectic, visiting several to many other species of plants for pollen, but two (Nomadopsis hesperia hesperia and Perdita panochaena) are known as visitors restricted to this variety of heliotrope. The same authors list 41 additional species of bees as recorded from Heliotropium curassavicum, with no variety of the plant listed; many of these may be associated with the var. oculatum. Perdita heliotropii heliotropii and P. heliotropii perducta collect pollen only from Heliotropium curassavicum (no variety listed), but visit a few other plants for nectar.

Distribution and habitat This species is known only from low elevations in westernmost Butte County from riverbanks, levees and open fields. It is probably most common in the Gray Lodge Wildlife Area.

2. HELIOTROPIUM EUROPAEUM L. MAP 17

Hairy heliotrope

Description Pubescent annual with stem prostrate and to 3 dm long, or upright and to 6 dm high; leaves rounded or oval, petioled, 1-2(-4) cm long; corolla to about 4 mm broad; nutlets tuberculate-roughened.

Reproductive biology Flowers late July to early November.

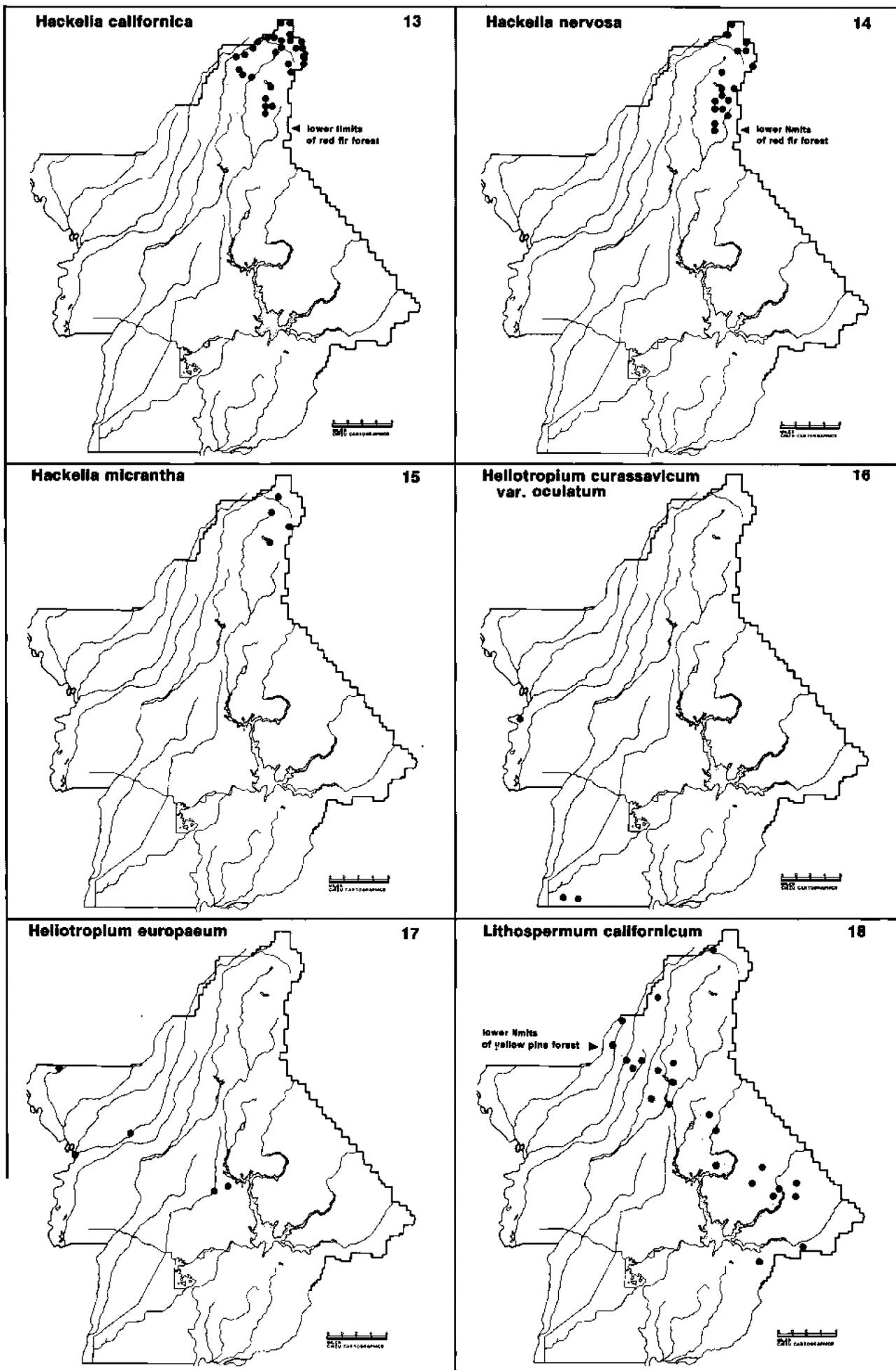
Distribution and habitat This species, introduced from Europe, may be spreading as a weed in Butte County. All collections seen were made since 1959. It occurs along gravelly banks of the Sacramento River but also has been found at roadsides (e.g., in the NW part of the county near Singer Creek and in Bidwell Park, and in the central part of the county near Mesilla Valley growing with Eremocarpus setigerus).

LITHOSPERMUM L.

Gromwell, puccoon

1. LITHOSPERMUM CALIFORNICUM Gray

MAP 18



[L. ruderale Dougl. var. californicum Jeps.]
California gromwell, Shasta puccion
Reference: Johnston (1952)

Description Perennial from a thick rootstalk, with several hirsute, spreading or upright stems to 40 cm high; leaves linear at the base to lanceolate or ovate above, hirsute, 3-6(-8) cm long; corolla trumpet-shaped, bright yellow, 12-18 mm long and 6-10 mm broad at the top; mature nutlets thick-ovoid, 5-6 mm long, white and shiny, with flat attachment scar at the very base.

Reproductive biology Flowers late March to May. This species is heterostylous: some plants have long styles and short stamens, the other plants have short styles and longer stamens. According to Johnston (1952) pollen grains of the short-style flowers are larger than those of long-style flowers. Ganders (1979) reports that the long-style (or "pin") flowers produce three times as many pollen grains as the short-style ("thrum") flowers--a ratio of 3.12 pin/thrum. His observations on one population also indicate that most pollinator movements were among flowers on one plant, and that there is potentially much within-plant pollination in this species.

Distribution and habitat This species occurs mostly in yellow pine forests from 1800 to 4000 feet elevation throughout Butte County. Unusual collection sites include a serpentine outcrop N of Jarbo Gap [M. S. Taylor 3511 (CHSC)] and rocky openings in montane chaparral at 5500 feet near Jonesville [H. F. Copeland, 1531 (UC)].

MERTENSIA Roth
Bluebells, lungwort
Reference: Williams (1937)

1. MERTENSIA CILIATA (E. James ex Torr.) G. Don
var. STOMATECHOIDES (Kellogg) Jeps. MAP 19
Sierra mountain bluebells, lungwort

Description Woody-rooted perennial, with several glabrous stems to 12 dm high; leaf blades lanceolate, oblong or ovate, to 12(-18) cm long, the lower on long petioles, the upper smaller and clasping; inflorescence paniculate; corolla blue or pinkish, the tube 6-8 mm long, the segments about the same length and not spreading widely; style longer than corolla; nutlets 4, roughened with toothlike processes.

Reproductive biology Flowers June and July. Moldenke (1976) categorizes Mertensia in California as possibly genetically self-compatible, and lists full seed set as the observed condition. He notes that Colletes is a bee genus with at least one species emphasizing pollen collection from Mertensia in the northern Sierra Nevada. Krombein et al. (1979) list Colletes paniscus mertensiae as a visitor to Mertensia ciliata var. stomatechoides, and also note that the bee genera Bombus and Osmia are known to contain important pollinators of Mertensia species.

Distribution and habitat This species is known only in extreme N Butte County [e.g., from about 4400 feet elevation near Butte Meadows to 6000 feet at Upper Scotts John Creek (both CHSC), and to 6500 feet at Kirby Meadow (DS)]. It grows within yellow pine and red fir forests, at creeksides and in seeps that remain moist well into the summer.

MYOSOTIS L.

Forget-me-not, scorpion grass

Reference: Hitchcock et al. (1959)

Description Pubescent, little-branched annuals or biennials, with linear, lanceolate or oblong leaves; racemes elongate and loosely flowered; calyx with hooked hairs; corolla inconspicuous, about 2 mm broad, with crests at top of tube; nutlets 4, 1-1.5 mm long, smooth and shiny, with a raised margin all the way around, attached at their bases.

Key to species of MYOSOTIS in Butte County

Calyx symmetrical, not 2-lipped, the lobes similar; corolla whitish, yellowish or pale blue when fresh

1. MYOSOTIS DISCOLOR

Calyx asymmetrical, somewhat 2-lipped, with 3 lobes shorter than the other 2; corolla white

2. MYOSOTIS VERNA

1. MYOSOTIS DISCOLOR Pers. MAP 20

[M. versicolor (Pers.) J. E. Smith]

Yellow and blue scorpion grass

Description Stem hirsute, 10-50 cm high; leaves few, the lowermost oblanceolate, 1-2.5 cm long; pedicels in fruit 1-3 mm long; calyx 3-5 mm long; corolla yellowish or whitish, becoming pale blue (dark blue in pressed specimens); nutlets dark, shorter than or equal to the style.

Reproductive biology Flowers April to July.

Distribution and habitat Two collections (both CHSC) are known from eastern Butte County, both from meadows within yellow pine forests. This species is introduced from Europe.

2. MYOSOTIS VERNA Nutt. MAP 21

[M. virginica (L.) B. S. P.]

Spring or early scorpion grass

Description Stem hirsute, to 30 cm high; leaves 1-4 cm long; pedicels shorter than fruiting calyx; calyx 4-7 mm long, more or less 2-lipped. corolla white; nutlets longer than style.

Reproductive biology Flowers April to June.

Distribution and habitat This apparently native species has been collected only once in Butte County: R. A. Schlising, 4285, Concow Meadows, at head of Concow Creek, T23N, R4E, section 26, elevation about 3600 feet; in meadow with Ranunculus (CHSC).

PECTOCARYA DC. ex Meisn.

1. PECTOCARYA PUSILLA (A. DC.) Gray MAP 22

Little pectocarya

Description Annual with forked or simple stems 5-20 cm long; leaves linear or oblanceolate, to 15 mm long; sepals with hooked hairs at tips; corolla whitish, barely longer than calyx, about 1 mm broad; nutlets 1-4, to 2.5 mm long, divergent, rhomboid and flattened, with

bristles on the raised margins.

Reproductive biology Flowers late March to May. Moldenke (1976) lists species of this genus as consistently selfed but outcrossed "under unusual situations."

Distribution and habitat This species is presently known from grasslands at 400 feet elevation to foothill woodlands at 2000 feet, mainly in N-central and SE portions of the county. It is easily overlooked and may occur more widely in Butte County.

PLAGIOBOTHRYS Fisch. & Meyer
Popcorn flower, allocarya
References: Johnston (1923, 1932)

Description Annual, mostly pubescent herbs; leaves linear or lanceolate, reduced and alternate above; inflorescence a spike or slender raceme, often coiled and forked; corolla white, some species with yellow central crests at top of tube; nutlets 1-4, lanceolate to broadly ovoid, (1.2-)1.5-3 mm long, keeled on back and usually also on sides and ventral (inner) surface; place of attachment showing as a rounded to linear scar on ventral side when nutlet is free of receptacle.

Current floristic and environmental studies often separate Plagiobothrys into two genera: Plagiobothrys and Allocarya. This has been followed in major floras, e.g., Jepson (1943) and Abrams (1951). Yet, in his two works on Plagiobothrys, Johnston (1923, 1932) convincingly described the lack of distinguishing characters that can consistently separate all species of Plagiobothrys from Allocarya as well as the other genera are separated in the Boraginaceae. Johnston's detailed arguments (1932) for including Allocarya in the "very natural" genus Plagiobothrys are still appropriate today. It seems to serve no useful purpose to separate out Allocarya in the Butte County taxa, so the present treatment recognizes only Plagiobothrys, as is done in Munz and Keck (1968), and in the most recent lists by Rice et al. (1982) and Kartesz and Kartesz (1980).

Reproductive biology Moldenke considers species of Plagiobothrys genetically self-compatible and consistently self-pollinated. He further notes that they may be efficiently outcrossed and lists the following as pollinators: bombyliid flies (especially in Bombylius, Oligodranes and Phthiria); syrphid flies; bees in Andrena and others that are usually generalist feeders in genera of the Halictidae. Several species of bees in the genera Andrena, Dufourea, Synhalonia and Anthophora are listed by Krombein et al. (1979) as visitors to unspecified species of Plagiobothrys in general.

Key to species of PLAGIOBOTHRYS in Butte County

- A Upper stem and leaves with at least some spreading pubescence as well as fine, appressed hairs; basal rosette prominent and persisting (often brown and dried) into fruiting stage; plants of well-drained and early-drying "upland" habitats, rarely in depressions that held standing water; nutlet attachment scar more or less centrally located on ventral (inner) side of nutlet; nutlet without spines or bristles (section PLAGIOBOTHRYS)
- B Sepals with reddish hairs on backs, margins and tips, but yellowish or whitish at their fused bases, bending together

and capping the fruit, and then circumscissile with age (all coming off the fruit together as a cap); plants often with lines of purple dye on stems, leaves or roots

1. PLAGIOBOTHRYIS NOTHOFULVUS

BB Sepals not with contrasting reddish tips and pale bases and not circumscissile with age; plants rarely with purple dye

C Sepals covered with reddish hairs throughout (this not always persisting in fruit); scar on nutlet round and ring-like, with a depression in the center

2. PLAGIOBOTHRYIS FULVUS var. CAMPESTRIS

CC Sepals not covered with reddish hairs throughout, but sometimes with lines of reddish hairs; scar on nutlet round but solid, sometimes raised

D Nutlets ovoid, constricted into an abrupt beak at apex; stem often forked near base, mostly over 20 cm high

3. PLAGIOBOTHRYIS CANESCENS

DD Nutlets cross-shaped due to constrictions at top and bottom; stem usually forked in the inflorescence, sometimes from base, or unforked

E Sepals 5-7 mm long; nutlets 2-2.7 mm long; spikes with bracts throughout; plants of grasslands and foothill woodlands

4. PLAGIOBOTHRYIS SHASTENSIS

EE Sepals 3-4 mm long; nutlets 1.5-2 mm long; spikes with bracts only at base; plants of foothill woodlands and openings in chaparral and yellow pine forests

5. PLAGIOBOTHRYIS TENELLUS

AA Upper stem and leaves with fine appressed whitish hairs, or glabrous; basal rosette not well developed and not prominent at fruiting; plants of moist or wet places, especially depressions that held standing water in winter and spring; nutlet attachment scar variously shaped, but if rounded and centrally located, then nutlet with spines or bristles (section ALLOCARYA)

F Outer surfaces of nutlets with coarse, spine-like processes, these covered with hairs; plants mostly erect at flowering and fruiting, occasionally with some lax side branches

G Back and sometimes sides of nutlets with sharp ridge-like keels bearing spines, each spine with hooked hairs; nutlets narrow, about half as broad as long

6. PLAGIOBOTHRYIS AUSTINAE

GG Entire back of nutlet covered with spines, the spines hairy; nutlets broad (2/3 or more as broad as long)

7. PLAGIOBOTHRYIS GREENEI

- FF Outer surfaces of nutlets not bearing coarse spines, but covered with horizontal ridges and wrinkles, these in turn sometimes with whitish teeth, knobs or fine bristles; plants erect or prostrate
- H Plants from above 4000 feet elevation and flowering late May to September; attachment scar of nutlet elongate, parallel with, and on the ventral keel
8. PLAGIOBOTHRYIS SCOULERI
- HH Plants mainly from below 3000 feet and flowering late February through June; attachment scar of nutlet triangular, oval or roundish, at very base of nutlet, or if on the ventral keel, 1/5 to 1/3 length of the whole nutlet
- I Plants prostrate in fruit, usually so while in flower; sepals usually all turned to one side in fruit; at least some nutlets with solitary or tufts of bristles
- J Nutlets narrow, lanceolate, sharply keeled on back; scar small, not surrounded by a distinct, raised ridge; lower pedicels not stout and recurved
9. PLAGIOBOTHRYIS LEPTOCLADUS
- JJ Nutlets ovoid, with fine ridges on the back; scar large (1/5 or more length of nutlet) and surrounded by a raised collar-like ridge (sometimes obscure); lower pedicels usually stout and recurved in fruit
10. PLAGIOBOTHRYIS SCRIPTUS
- II Plants usually erect in fruit, some with a few lax lateral branches; sepals spreading in all directions in late flower and fruit; nutlets without bristles but sometimes with whitish teeth on the ridges
- K Nutlets ovoid, with ridges and keels bearing whitish, rounded teeth; scar large, triangular, on ventral side of nutlet; sepals appressed to nutlets
11. PLAGIOBOTHRYIS GLYPTOCARPUS
- KK Nutlets lanceolate, with ridges and wrinkles but not with distinct rounded teeth on back; scar small, oval or triangular, at very base or oblique to the base; sepals not appressed to nutlets
- L Nutlets with basal scar perpendicular to the main axis of the nutlet (i.e., on the bottom); plants with sparse to dense appressed hairs; common in vernal pools in grasslands
12. PLAGIOBOTHRYIS STIPITATUS
- LL Nutlets with scar just above and at oblique angle with very base; plants with fine, spreading hairs
13. PLAGIOBOTHRYIS BRACTEATUS

1. PLAGIOBOTHRYIS NOTHOFULVUS (Gray) Gray MAP 23
Rusty popcorn flower

Description Plants to 3.5 dm high, often with purple dye on roots, stems and margins of leaves; inflorescence usually forked, well elongated with age; calyx with reddish hairs on the lobes but whitish or yellowish on basal portion, the lobes bending over the developing nutlets and coming off as a cap with age; corolla 3-9 mm broad; nutlets 1-4, round-ovoid, with an abrupt acute apex and with rectangular areas between keels and ridges on the back; attachment scar with a raised ring around it.

This "upland" species of popcorn flower is the only one with clearly reddish-tipped sepals with white bases. A greenish zone near the bottom of the calyx indicates (even in flower) where the sepals will later drop off together as a cap. Plants are fairly consistent in morphology throughout the county except for individuals at Richvale Vernal Pools, where both vegetative and reproductive parts are larger.

Reproductive biology Flowers March to May. Krombein et al. (1979) list 14 species of bees, all known to visit flowers in addition to Plagiobothrys, that have been collected on P. nothofulvus. These potential pollinators are mainly in the genus Andrena (9 species), but some are also in Dufourea, Chelostoma, Chelostomopsis and Ceratina.

Distribution and habitat This species is abundant in grasslands and foothill woodlands throughout Butte County except, unexpectedly, in the extreme southern portion.

2. PLAGIOBOTHRYIS FULVUS (Hook. & Arn.) I. Johnst.
var. CAMPESTRIS (Greene) I. Johnst. MAP 24
Fulvous popcorn flower

Description Much like P. nothofulvus in habit and size; calyx cleft nearly to its base, the lobes with reddish or tawny hairs throughout, especially when young; calyx lobes spreading and less reddish in fruit; corolla 3-4 mm broad; nutlets usually 4, ovoid and as in P. nothofulvus, but scar circular and with distinct depression in the middle.

Reproductive biology Flowers March to May.

Distribution and habitat This species is abundant throughout grasslands and foothill woodlands the length of the county. It and P. nothofulvus are the most common and widespread popcorn flowers in Butte County.

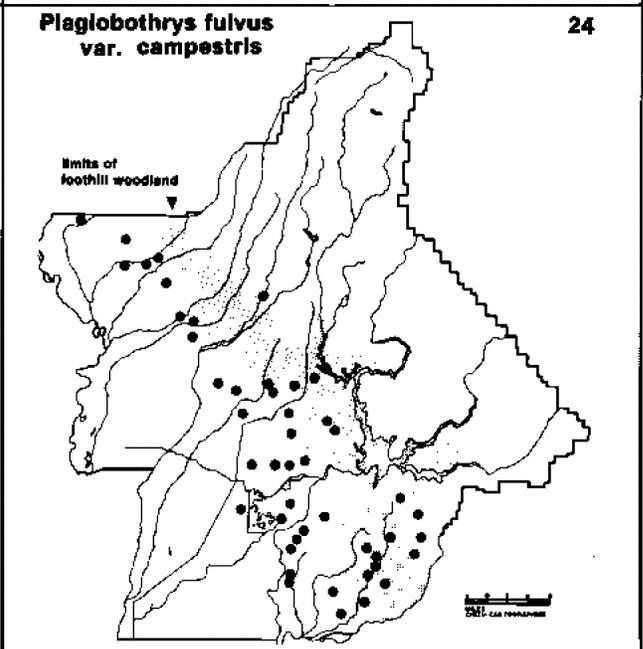
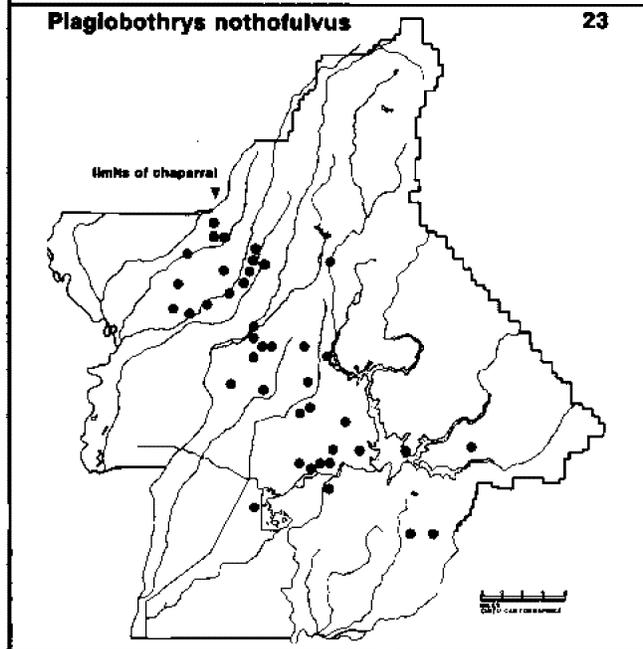
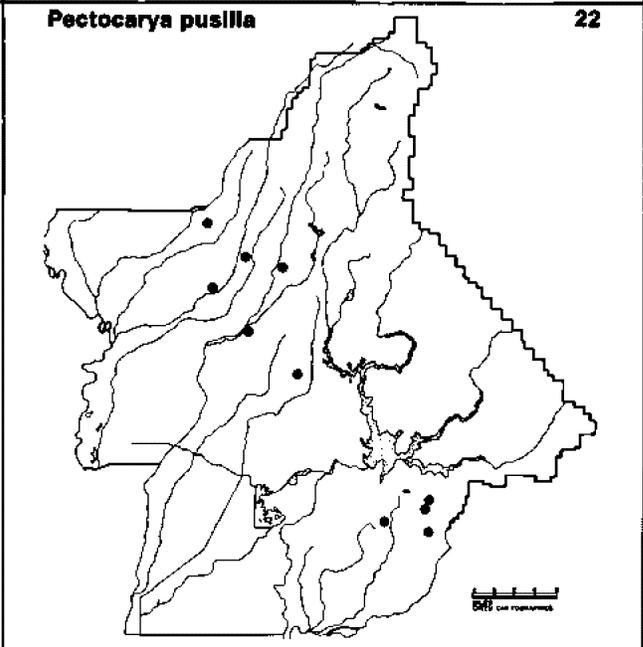
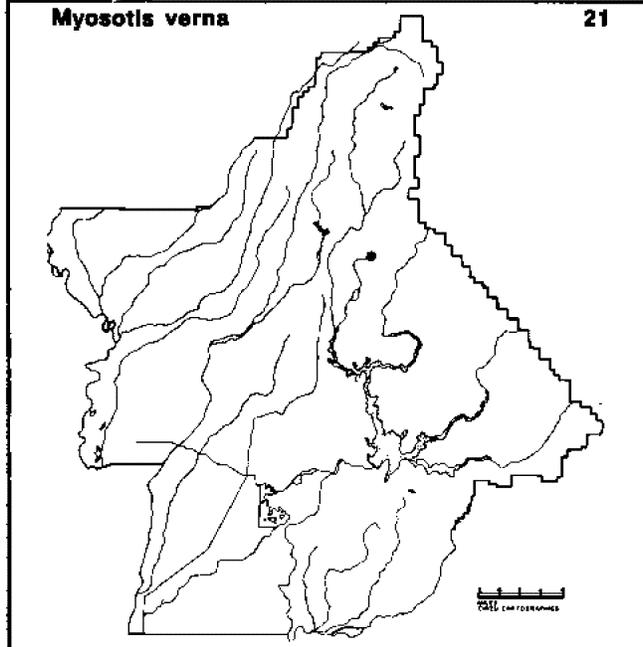
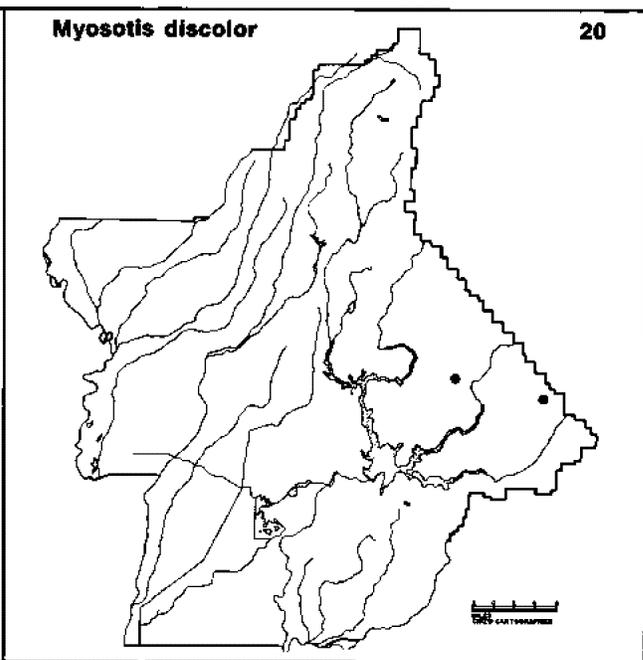
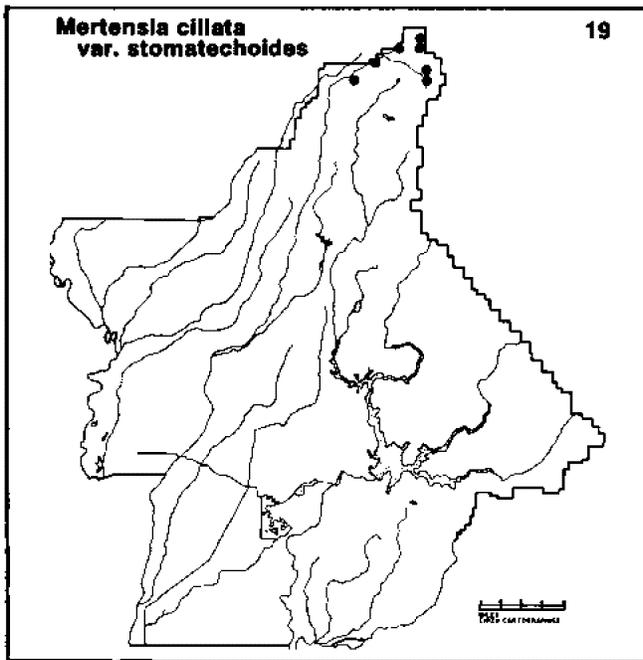
3. PLAGIOBOTHRYIS CANESCENS Benth. MAP 25
Valley popcorn flower

Description Habit and size similar to P. nothofulvus, but more often forked at base and sometimes decumbent; calyx 4-6 mm long; corolla 3-4 mm broad; nutlets usually 4, roundish-ovoid, constricted at apex into a beak, strongly convex, with prominent transverse ridges bearing rounded teeth.

Reproductive biology Flowers March to May. The bee Andrena chapmanae is the only species listed as a flower visitor to P. canescens (Krombein et al., 1979).

Distribution and habitat This species is less common than P. nothofulvus and P. fulvus var. campestris, both of which it resembles in habit and in "upland" habitat. It is found the length of Butte County in open areas of grasslands and foothill woodlands.

4. PLAGIOBOTHRYIS SHASTENSIS Greene ex Gray MAP 26
Shasta popcorn flower



Description Stem erect, 1-2(-3) dm high, forked in the inflorescence; spikes often in 2's; calyx often reddish when young, 4-7 mm long, with lobes about as long as tube; corolla 2.5 mm broad; nutlets more or less cross-shaped due to constrictions at both ends, shiny, with keels on back and sides, and the area between the keels with flat transverse ridges separated by fine grooves.

Reproductive biology Flowers April and May.

Distribution and habitat This taxon is the least common of the five "upland" popcorn flowers, and collections are from the center of the county (e.g., Pentz Road) southward, mainly in grasslands.

5. PLAGIOBOTHRYS TENELLUS (Nutt. ex Hook.) Gray MAP 27
Slender popcorn flower

Description Similar in habit to P. shastensis; stem slender, 5-30 cm high; calyx with whitish or reddish hairs, to 4 or 5 mm long in fruit; corolla 2-3 mm broad; nutlets cross-shaped, light colored, three-keeled on back, and with rounded teeth on and between the keels.

Reproductive biology Flowers March to early June. Two species of bees (Andrena auricoma and A. candida), both known to collect pollen from many species of plants, are known to visit P. tenellus flowers (Krombein et al., 1979).

Distribution and habitat This popcorn flower is common in the county in foothill woodlands, openings in chaparral, and in the lower elevations of yellow pine forests.

6. PLAGIOBOTHRYS AUSTINAE (Greene) I. Johnst. MAP 28
[Allocarya austinae Greene]
Austin's popcorn flower, Austin's allocarya

Description Stem branched from the base or middle, to 1.5(-2) dm high, the inflorescence usually not further branched; calyx lobes with reddish hairs, 4-5 mm long in fruit; corolla 1.5-2 mm broad, with yellow center; nutlets 4, pyramidal-ovoid, with knife-like keel on the back, and with spines covered with hooked hairs on the keel and sometimes on the sides; scar triangular, 1/3 or more the length of nutlet.

Reproductive biology Flowers late February to late April.

Distribution and habitat This species is most common in shallow depressions that held standing water ("hog wallows"), but not in the deeper vernal pools in grasslands and open foothill woodlands in the northern half of Butte County. Plagiobothrys austinae occurs mainly within the region of Tuscan Formation volcanic mudflows.

7. PLAGIOBOTHRYS GREENEI (Gray) I. Johnst. MAP 29
[Allocarya greenei (Gray) Greene]
Greene's popcorn flower, Greene's allocarya

Description Similar to P. austinae in habit and size; calyx 5-8 mm long in fruit; corolla 2-5 mm broad; back of nutlet with several keels; keels and areas between covered with spines bearing fine hairs; scar ovate or triangular, surrounded by a collar-like flange.

Reproductive biology Flowers March to May.

Distribution and habitat This popcorn flower is common throughout Butte County in the vernal pools and "hog wallows" of grasslands and foothill woodlands.

8. PLAGIOBOTHRYYS SCOULERI (Hook. & Arn.) MAP 30
I. Johnst.

[P. hispidulus (Greene) I. Johnst., Allocarya hispidula Greene, P. cognatus (Greene) I. Johnst., A. cognata Greene]

Scouler's or harsh popcorn flower, harsh allocarya

Reference: Hitchcock et al. (1959)

Description Plants rather delicate, with stems branched at base and prostrate or loosely ascending, usually under 2 dm long; racemes slender and loosely flowered in age; calyx lobes 2-3 mm long; corolla 1-2 mm broad; nutlets ovoid or lance-ovoid, covered with ridges sometimes bearing fine papillae or bristles; scar linear-oblong, on ventral side of nutlet, parallel with, or even on the ventral keel, and encircled by a ridge or wrinkle.

Johnston (1932) admitted that P. hispidulus (the name then used for P. scouleri) "is closely related and habitually very similar to P. cognatus and cannot be sharply separated from that species." He cited a Butte County collection of P. cognatus from "open places in yellow pine forest, Butte Meadows...4200 feet, Heller 12841." The present author has seen a few plants that fit P. cognatus in Chico Meadows, about 1 mile N of Butte Meadows. However, Hitchcock et al. (1959) have simplified identification of the high elevation popcorn flowers by "lumping" these two taxa as P. scouleri, and that name is used here for all Butte County collections.

Reproductive biology Flowers late May to September.

Distribution and habitat Plagiobothrys scouleri is common in high elevation Butte County, northeastward from Butte Meadows (from above 4000 feet elevation) and from Inskip. Here, within yellow pine, red fir and lodgepole pine forests, it occurs in portions of meadows that dry in the summer. One collection not shown on the range map [Stern 5768, (CHSC)] is from the serpentine rock outcrop N of Magalia, which is at about 2400 feet. It has not been relocated there, and the locality is probably in error.

9. PLAGIOBOTHRYYS LEPTOCLADUS (Greene) I. Johnst. MAP 31
[Allocarya leptoclada Greene]

Smooth-stemmed popcorn flower, smooth-stemmed allocarya

Description Stem with fairly straight, prostrate branches to 2(-3) dm long, somewhat wiry and with flowers from near the base and more or less on one side of stem; calyx in fruit 3-8 mm long, curved to one side of nutlets, and with bases of lobes strongly ribbed; corolla 1-2 mm broad; nutlets lanceolate and acute, the back keeled above the middle, smooth, roughened or finely hairy; ventral side of nutlet keeled to the basal scar, this horizontal or oblique and sometimes with a collar-like flange directed away from the scar.

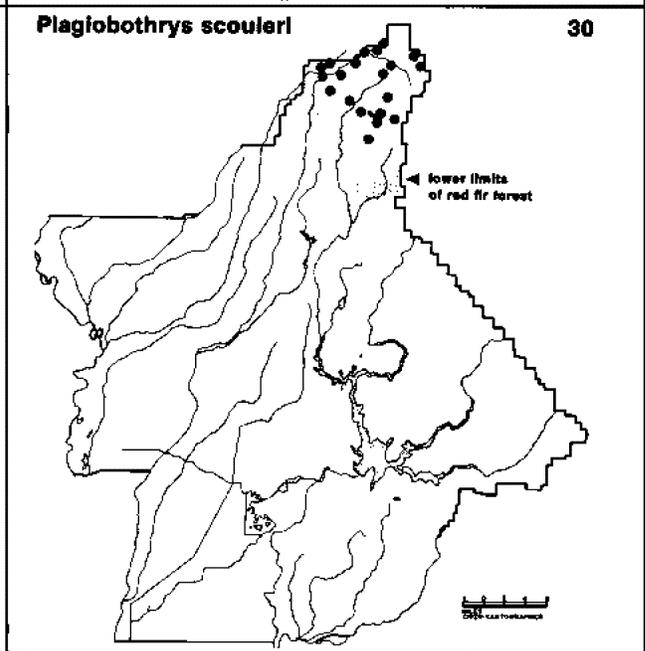
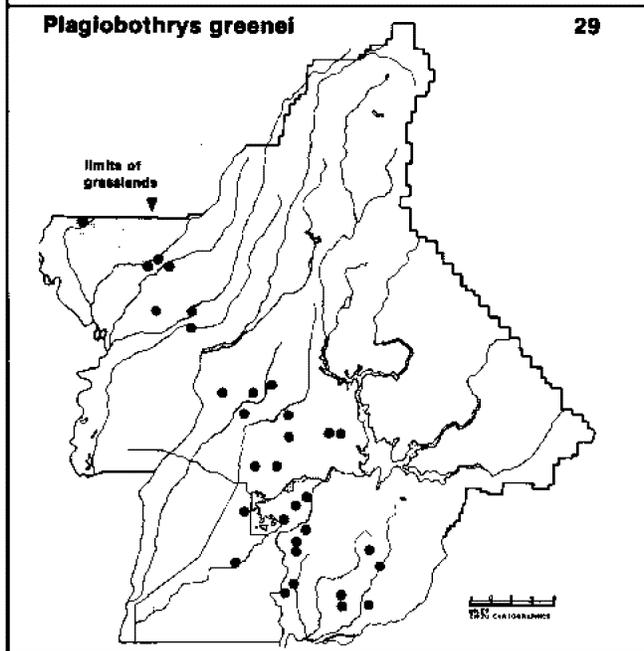
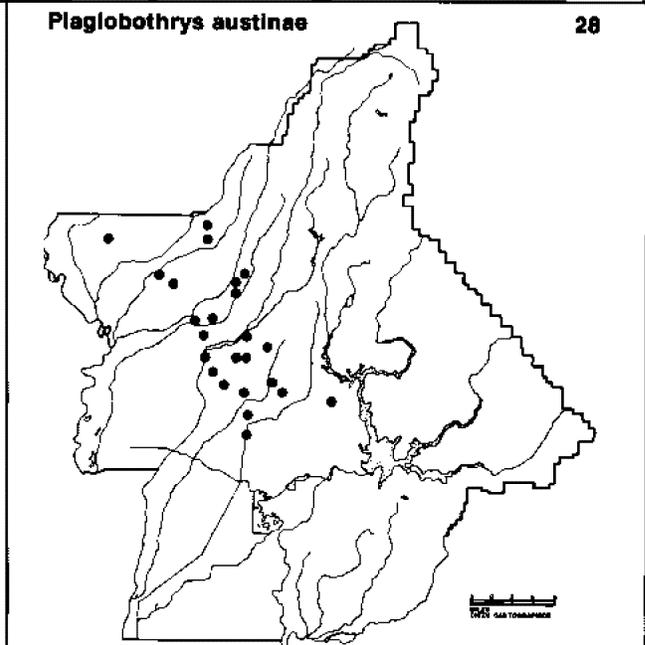
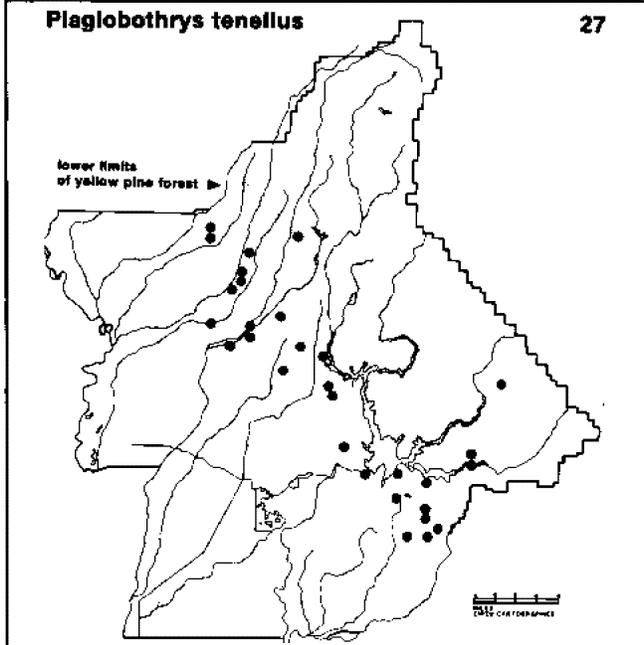
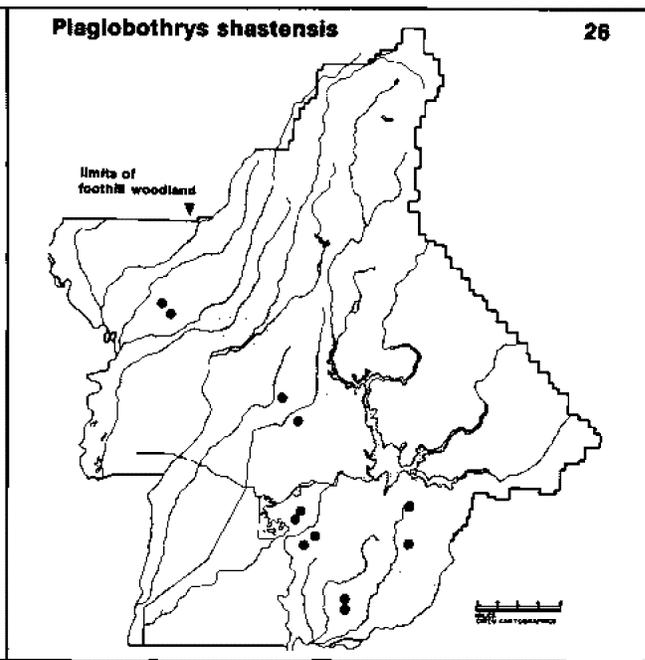
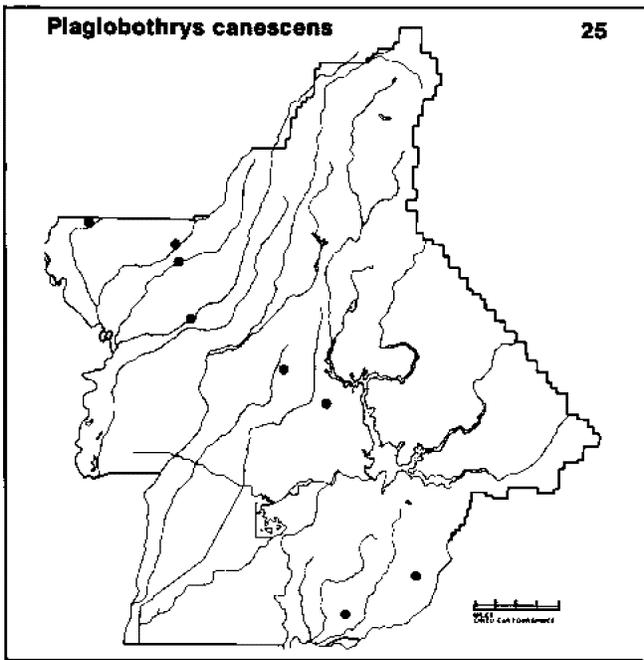
Johnston (1932) indicated that nutlet variation in a single colony can range from glabrous to hairy.

Reproductive biology Flowers March to June.

Distribution and habitat This popcorn flower is presently known from only four localities in vernal pools of grasslands and in low, alkaline areas (i.e., at Gray Lodge Wildlife Area) in the SW part of the county.

10. PLAGIOBOTHRYYS SCRIPTUS (Greene) I. Johnst. MAP 32
[Allocarya scripta Greene]

Scribe's popcorn flower, scribe's allocarya



Description Stem prostrate, 2 to about 20 cm long, wiry and with lowest internodes short and congested; first flowers near very base, these and later flowers as well with pedicels stout and recurved with age; calyx from 2 or 3 to 8 mm long, appressed to the developing nutlets, and with firm ribs on bases of lobes; corolla 2 mm broad; nutlets ovoid or deltoid, glossy and dark, with whitish ridges and keels that bear delicate hairs; scar basal, triangular, about 1/4 to 1/3 length of the nutlet, surrounded by a high flange or collar formed by the upturned nutlet margin.

Butte County collections of P. scriptus may possibly include some plants of the closely similar P. humistratus (Greene) I. Johnst. [Allocarya humistrata Greene]. Flora and manual keys (most probably based on examination of very little plant material) indicate strongly overlapping characteristics of these two taxa. Johnston (1932), who produced the most complete and most recent study of these two taxa, separated them as follows:

"Nutlets broadly ovate, glossy, very sparsely if at all tuberculate; scar 1/3 to 1/5 length of nutlet, surrounded by a high collar.....P. scriptus

Nutlets lance-ovate, dull, granulate and tuberculate; scar 1/5 length of nutlet, not surrounded by a high collar.....
.....P. humistratus."

Floras stress the "high collar," but this is vague as a diagnostic feature. The diagram of P. scriptus (as Allocarya scripta) on p. 560 of Abrams (1951) does not show a collar or an attachment scar on the nutlet. The lack of discrete scar and collar features on collections in CHSC, CAS, DS, UC and JEPS for Butte and for other counties suggests that further study may find these two taxa conspecific. It is possible that the collar was described from slightly immature (and not dry) nutlets, and represents tissue torn from the receptacle.

Reproductive biology Flowers February to April.

Distribution and habitat This taxon occurs in grasslands and foothill woodlands and occasionally in chaparral. Most collections and sightings have been from the thin soils overlying Tuscan Formation volcanic mudflows to the E and SE of Chico. Due to this plant's very small size in early flower, its prostrate nature, and its early flowering season, it has probably been somewhat overlooked. It is also very difficult to see in dense grassland vegetation when in fruit.

11. PLAGIOBOTHRYIS GLYPTOCARPUS (Piper) I. Johnst. MAP 33
[Allocarya glyptocarpa Piper]
Sculptured popcorn flower, sculptured allocarya

Description Stem branching near base, ascending or lax, 1-4 dm long; racemes loosely flowered; calyx lobes appressed to developing nutlets; corolla 5-9 mm broad; nutlets ovoid, acute and beaked; dorsal side of nutlet keeled, with irregular transverse ridges bearing whitish teeth and knobs; scar triangular, nearly 1/3 to 1/2 length of nutlet.

Reproductive biology Flowers March to early June.

Distribution and habitat This species occurs throughout Butte County within foothill woodlands and grasslands, in ditches, vernal pools, and especially in seeps.

12. PLAGIOBOTHRYYS STIPITATUS (Greene) I. Johnst.

12a. PLAGIOBOTHRYYS STIPITATUS (Greene) I. Johnst.

var. STIPITATUS

MAP 34

[Allocarya stipitata Greene]

Stipitate popcorn flower, stipitate allocarya

Description Stem slightly succulent, erect, (0.5-)1-2.5 dm high, branched at or above the base; racemes in age elongate and wiry, with flowers somewhat on one side; calyx with strong ribs below, 5-8 mm long, the lobes erect or spreading; corolla 5-12 mm broad, sometimes with yellow center; nutlets lanceolate or narrow-ovoid, constricted into a beak, roughened with horizontal ridges on back; ventral side of nutlet keeled to the base; scar entirely basal, at right angle to main axis of nutlet.

Reproductive biology Flowers March to early June.

Distribution and habitat Plagiobothrys stipitatus var. stipitatus occurs in vernal pools. It is sporadic but fairly well distributed within grasslands and the lower parts of foothill woodlands in the county. It is less common in southern and southeastern portions of the county.

12b. PLAGIOBOTHRYYS STIPITATUS (Greene) I. Johnst.

var. MICRANTHUS (Piper) I. Johnst.

MAP 35

[Allocarya stipitata Greene subsp. micrantha Piper]

Stipitate popcorn flower, stipitate allocarya

Description Like var. stipitatus except corolla only about 2-3(-4) mm broad.

Distribution and habitat This smaller-flowered variety often grows intermixed in the same vernal pool with plants of var. stipitatus. It is more common in Butte County and is more thoroughly distributed throughout the lowlands of the county in vernal pools or ditches where standing water simulates the vernal pool habitat.

13. PLAGIOBOTHRYYS BRACTEATUS (T. Howell) I. Johnst.

13a. PLAGIOBOTHRYYS BRACTEATUS (T. Howell) I. Johnst.

var. BRACTEATUS

MAP 36

[Allocarya bracteata T. Howell]

Bracted popcorn flower, bracted allocarya

Description Very similar to P. stipitatus var. micranthus; stem branched from the base, decumbent or erect, 1-2(-3) dm high; raceme slender and elongate; corolla 1-3 mm broad; nutlets oblong-ovoid, the dorsal side with transverse ridges and wrinkles, the ventral side keeled to below the middle; scar small, ovate or elliptical, oblique to the base of nutlet and surrounded by a ridge.

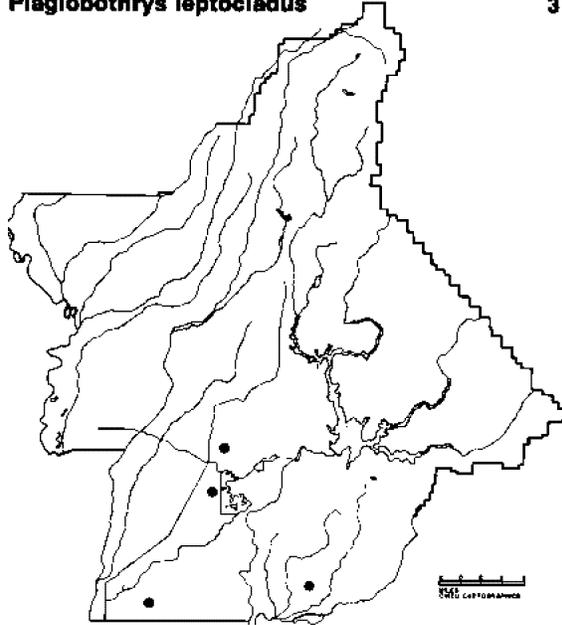
This species is exceedingly difficult to separate from P. stipitatus and can easily be confused with older plants of P. scouleri; mature nutlets are essential for identification.

Reproductive biology Flowers April to early June.

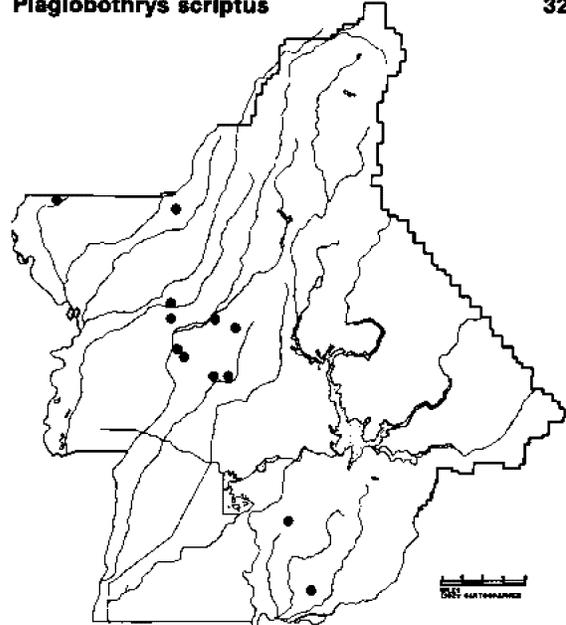
Distribution and habitat This popcorn flower has a poorly-defined range pattern in Butte County. It inhabits places where there has been water standing or seeping, and apparently, in meadows that get considerable snowfall. Plagiobothrys bracteatus bracteatus is known from grasslands (e.g., near Honcut and Chico), foothill woodlands (e.g., Kunkle Reservoir),

Plagiobothrys leptocladus

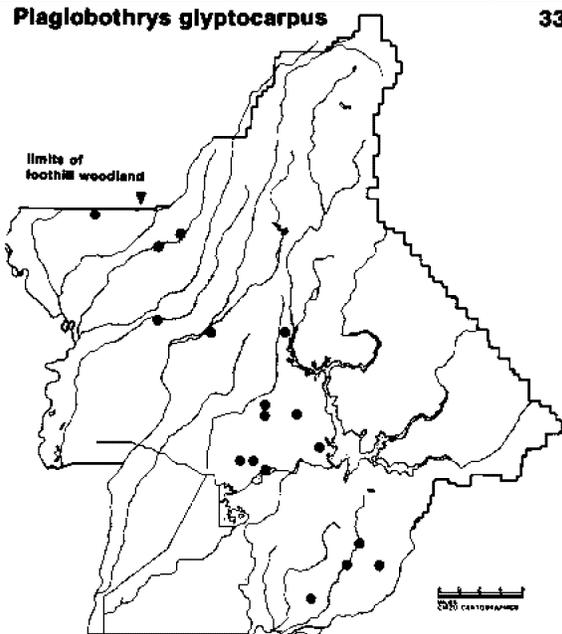
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**Plagiobothrys scriptus**

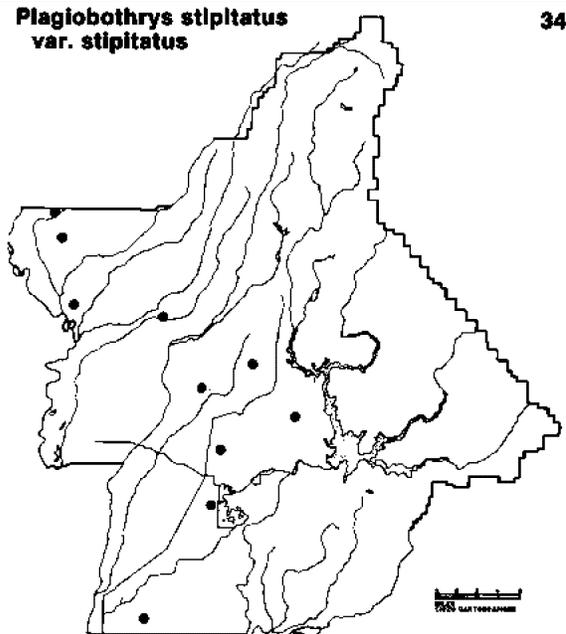
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**Plagiobothrys glyptocarpus**

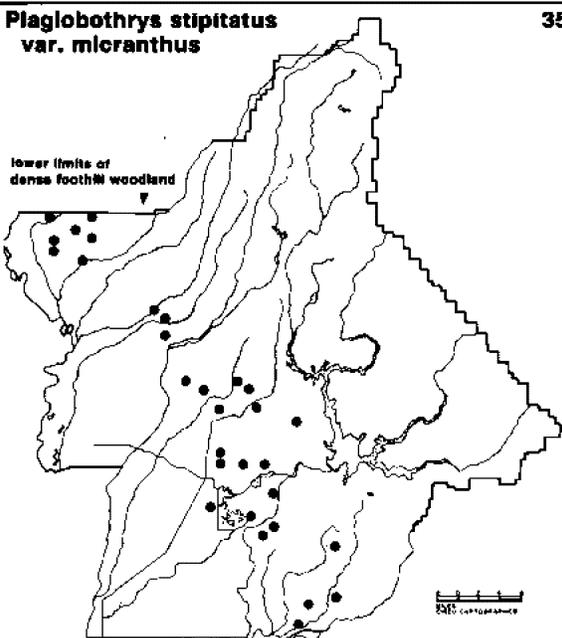
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**Plagiobothrys stipitatus**
var. *stipitatus*

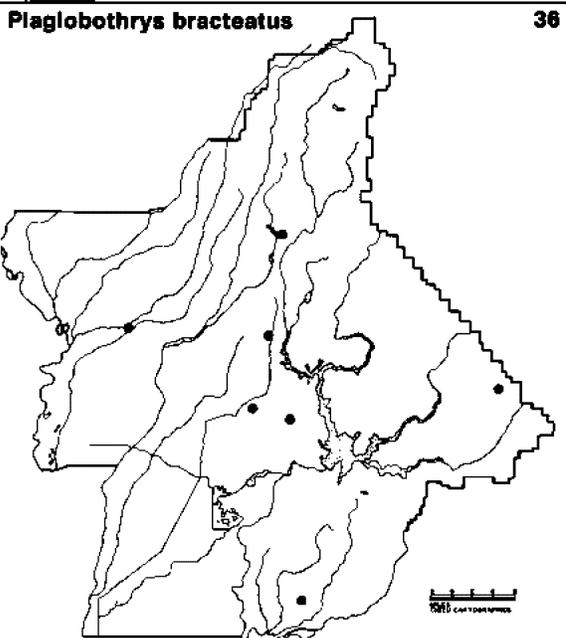
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**Plagiobothrys stipitatus**
var. *micanthus*

35

**Plagiobothrys bracteatus**

36



and meadows in yellow pine forest (e.g., near Feather Falls).

- 13b. PLAGIOBOTHRYIS BRACTEATUS (T. Howell) I. Johnst.
var. ACULEOLATUS (Piper) I. Johnst.
[Allocarya bracteata T. Howell var. aculeolata Piper]

Description As in var. bracteatus except nutlets with the dorsal keel and ridges bearing minute apically-barbed hairs; nutlet hairs scattered, solitary or clustered.

Johnston (1932) noted that "the variety aculeolatus is prostrate and more evidently strigose than is common in P. bracteatus."
Distribution and habitat This variety, which has not been seen in the field by the present author, is known only from its original collection: "dried mudhole on a ridge 10 miles east of Chico...Piper 5020" (Johnston, 1932).

REFERENCES CITED

- Abrams, L. 1951. Illustrated flora of the Pacific States, vol. 3. Stanford University Press, Stanford, Calif.
- Ewan, J. 1942. A review of the North American weedy heliotropes. Bulletin of the Southern California Academy of Sciences 41: 51-57.
- Ganders, F. R. 1979. The biology of heterostyly. New Zealand Journal of Botany 17: 607-635.
- Gentry, J. L. 1972. A new combination and a new name in Hackelia (Boraginaceae). Madrono 21: 490.
- Gentry, J. L., and R. L. Carr. 1976. A revision of the genus Hackelia in North America, north of Mexico. Memoires of the New York Botanical Garden 26: 121-227.
- Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1959. Vascular plants of the Pacific Northwest, part 4. University of Washington Press, Seattle, Wash.
- Jepson, W. L. 1943. A flora of California, vol. 3. Associated Students Store, University of California, Berkeley, Calif.
- Johnston, I. M. 1923. A synopsis and redefinition of the genus Plagiobothrys. Contributions of the Gray Herbarium 68: 57-80.
- Johnston, I. M. 1925. The North American species of Cryptantha. Contributions of the Gray Herbarium 74: 1-114.
- Johnston, I. M. 1932. The Allocarya section of the genus Plagiobothrys in the western United States. Contributions from the Arnold Arboretum 3: 1-82.
- Johnston, I. M. 1952. Studies in the Boraginaceae. 23. A survey of the genus Lithospermum. Journal of the Arnold Arboretum 33: 299-366.

- Kartesz, J. T., and R. Kartesz. 1980. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Volume 2, The biota of North America. University of North Carolina Press, Chapel Hill, North Carolina.
- Krombein, K. V., P. D. Hurd, Jr., D. R. Smith, and B. D. Binks. 1979. Catalog of Hymenoptera in America north of Mexico, vol. 2. Smithsonian Institution Press, Washington, D. C.
- Moldenke, A. R. 1976. California pollination ecology and vegetation types. *Phytologia* 34: 305-361.
- Munz, P. A., and D. D. Keck. 1968. A California flora and supplement. University of California Press, Berkeley, Calif.
- Nelson, J. R. 1979. The assessment and protection of rare and endangered plants of Butte County, California. M. A. thesis, California State University, Chico, Calif.
- Ornduff, R. 1976. The reproductive system of Amsinckia grandiflora, a distylous species. *Systematic Botany* 1: 57-66.
- Ray, P. M., and H. F. Chisaki. 1957a. Studies on Amsinckia. I. A synopsis of the genus, with a study of heterostyly in it. *American Journal of Botany* 44: 529-536.
- Ray, P. M., and H. F. Chisaki. 1957b. Studies on Amsinckia. II. Relationships among the primitive species. *American Journal of Botany* 44: 537-544.
- Ray, P. M., and H. F. Chisaki. 1957c. Studies on Amsinckia. III. Aneuploid diversification in the Muricatae. *American Journal of Botany* 44: 545-554.
- Rice, W. E., S. F. Smith, and D. E. Wasshausen. 1982. National list of scientific plant names. Volume 1, List of plant names. Volume 2, Synonymy. United States Department of Agriculture, Soil Conservation Service, Washington, D. C.
- Salisbury, E. 1961. Weeds and aliens. Collins Press, London.
- Stebbins, G. L. 1965. Colonizing species of the native California flora. In The genetics of colonizing species, H. G. Baker and G. L. Stebbins, eds. Academic Press, New York, N. Y.
- Williams, L. O. 1937. Monograph of the genus Mertensia in North America. *Annals of the Missouri Botanical Garden* 24: 17-159.

