

**Studies from the Herbarium
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January 1987**

— Number 4 —

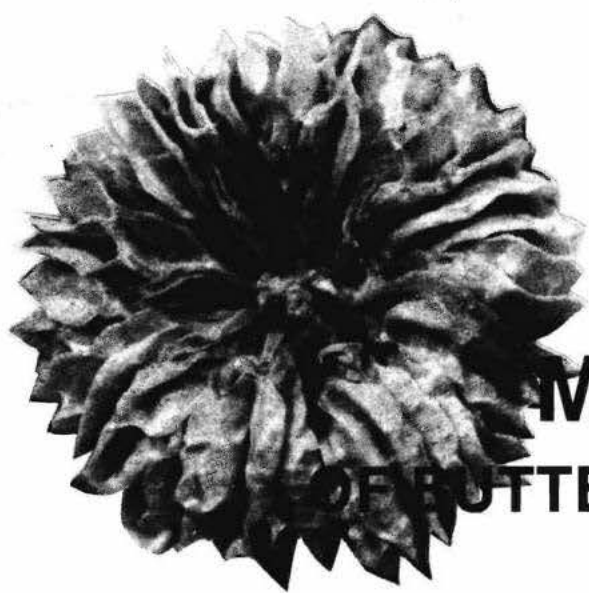
**LIMNANTHACEAE
OF BUTTE COUNTY, CALIFORNIA**

M. Jeanne Boze



and

— Number 5 —



**MALVACEAE
OF BUTTE COUNTY, CALIFORNIA**

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L I M N A N T H 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 upper photograph on the cover shows five nutlets of Limnanthes alba var. alba (the lower is of Sidalcea calycosa, a member of the Malvaceae). Bob McNulty and Chris Ottinger, Department of Biological Sciences, CSUC, aided in taking these photos.

The Limnanthaceae is represented in Butte County, California, by one genus, Limnanthes R. Br. (meadowfoam). These are low-growing, tender annuals found most often in open woodlands, moist grasslands and vernal pools. Limnanthes are long-day plants, flowering in the spring months of March through June. "Most species are relatively large flowered and form showy masses when growing in abundance" (Ornduff and Crovello, 1968).

There are three species of Limnanthes found in Butte County: L. alba, L. douglasii and L. floccosa. Limnanthes alba is represented by two varieties, alba and versicolor. Limnanthes douglasii currently has two varieties, nivea and rosea, and possibly a third variety, douglasii. The third species, L. floccosa, is represented by two subspecies in the county, subspecies californica and floccosa. Subspecies californica is a rare and endangered plant in California (Smith and York, 1984).

In Mason's (1952) monograph of this genus the species are divided into two groups, the Reflexae and the Inflexae, on the basis of petal position following pollination. In both groups the petals are persistent; in the Reflexae the petals bend sharply back away from the developing nutlets, while in the Inflexae the petals fold inward to enclose the developing nutlets. The Reflexae include L. douglasii and the Inflexae include L. alba and L. floccosa. Hybridization studies showed that viable crosses were not possible between the two groups (Mason, 1952). The later treatment of the genus by Munz (1968) ignored this grouping, and it has been little-used since, although it may still be a viable separation (Jain, 1976).

Members of this genus have flowers which are protandrous; pollen is matured and shed before the stigma of the flower is receptive. "Shortly after the bud opens, the anthers mature and the pollen is available; in some plants, dehiscence of the anther sac [is] found to have occurred before the flower opened. There is a delay of one to three days between anthesis and the maturation of the stigmas" (Mason, 1952). This strategy encourages outcrossing; however, all species of this genus are known to be self-compatible. The genus incorporates another strategy promoting outcrossing: glands at the base of each stamen secrete nectar, making the flowers "attractive to the bees, beetles and moths which serve as pollinating agents" (Mason, 1952). One species, L. floccosa, is usually described as being self-pollinating or autogamous. However, specimens from Butte County differ somewhat; members of these populations of L. floccosa are described as being only partially autogamous since they are visited by pollinators (Arroyo, 1973).

There are two oligolectic bees associated with Limnanthes: Panurginus occidentalis and Andrena (subgenus Hesperandrena) limnanthis, both of which are known to collect Limnanthes pollen. Other polylectic members of the genus Andrena have been reported as visitors to Limnanthes douglasii flowers. These are Andrena subchalybea, A. perimelas, A. opaciventris, A. pensilis, A. torulosa (known to collect nectar) and A. plana (also known to collect nectar). Another Andrena species visits Limnanthes douglasii var. douglasii to collect pollen; this is A. subtilis. Bees of other genera also visit flowers of Limnanthes douglasii: Chelostomopsis rubifloris collects pollen, as does Osmia lignaria propinqua. Other Osmia bees also have been reported as visitors: O. bruneri, O. dolerosa, O. indepressa and O. densa densa (Krombein et al., 1979).

Flowers are also visited by honey bees, Apis mellifera, other bee generalists including members of the Halictidae and Megachilidae, and by the generalist syrphid and bombyliid flies. These visitors may collect pollen, nectar or both (Thorp, 1976). Butterflies are also reported to act as pollinators for some members of Limnanthes (Moldenke, 1976).

The flowers of Limnanthes have five ovules, presenting the possibility of five nutlets once fertilized. These nutlets are one-seeded, so the words "nutlet" and "seed" may be used interchangeably in this group. Studies have been done on nutlet dispersal in this genus. Generally, nutlets are dispersed by birds, cattle and sheep (Jain, 1978) or by water through the floating ability of nutlets of some members (Hauptli et al., 1978). Patterns of surface tuberculation seem to be directly related to the use of floating as a dispersal method. Plants that occur most often in vernal pools have the most tuberculate nutlets, while the least tuberculate nutlets are associated with plants from xeric habitats (Hauptli et al., 1978).

Classification of taxa within this genus has not yet been finalized. The earliest reference to L. floccosa, in the monograph by C. T. Mason (1952), recognized three varieties of this species. Limnanthes floccosa has since been split into five subspecies. Three of the five collections cited for Butte County by Mason as examples of L. floccosa var. floccosa were later changed to subspecies californica by Arroyo (1973). However, the other two Mason (1952) citations of L. floccosa var. floccosa have remained unchanged. Whether these are valid citations of L. floccosa subsp. floccosa for Butte County, or whether this is outdated nomenclature is not known. However, there have been two findings of L. floccosa subsp. floccosa in Butte County since Mason's 1952 citations.

Such problems are not restricted to L. floccosa. In 1952 Mason discussed problems with the classification of L. alba. He had trouble distinguishing some plants in the varieties alba and versicolor. He found populations of L. alba var. alba with no var. versicolor traits, but "not one population of var. versicolor was found which did not have individuals with some hairs and varying degrees of tuberculation on the nutlets" (traits of var. alba). He also collected at the type locality of var. versicolor and found specimens with var. alba characteristics. In fact, he found that one-fifth of the flowers on the type specimen itself had short wooly hairs, although this variety is described as glabrous.

The classification and distribution of subspecific taxa for L. douglasii are also in question. There are collections of three Butte County varieties in the California State University, Chico Herbarium (CHSC); however, some researchers (e.g., R. Kesseli, personal communication) feel that var. douglasii does not occur in Butte County. Some of these specimens are hard to key out to any one of the varieties, usually because they have traits from each (Boze, personal observation). Concerning the L. douglasii populations on Table Mountain, one researcher states that ". . . the site does contain an unusual L. douglasii" (Kesseli, 1985). This unusual Table Mt. variety keys out most closely to L. douglasii var. nivea and is treated as such in this study. Since Mason (1952) did do some hybridization studies and found that members of all the varieties of L. douglasii could cross to produce viable offspring, it is very possible that these specimens which do not run true to any one variety could actually be field hybrids, probably between L. d. douglasii and L. d. nivea (Kesseli and Jain, 1984; Boze,

personal observation). Some of the specimens in the CSU, Chico Herbarium identified as L. douglasii var. douglasii were collected during the 1960's. These sites are represented on the map included in this work, although it is possible that var. douglasii no longer occurs there. Further field work is need to clarify this problem.

A good indication of the close relationship among members of the genus Limnanthes is the close similarity in the somatic chromosomes of all species. The somatic number is known to be 10 for all taxa. In fact, Mason (1952) states that "A study of the somatic chromosomes in all species . . . has revealed such similarity that the chromosome morphology and number appear to be of little taxonomic value."

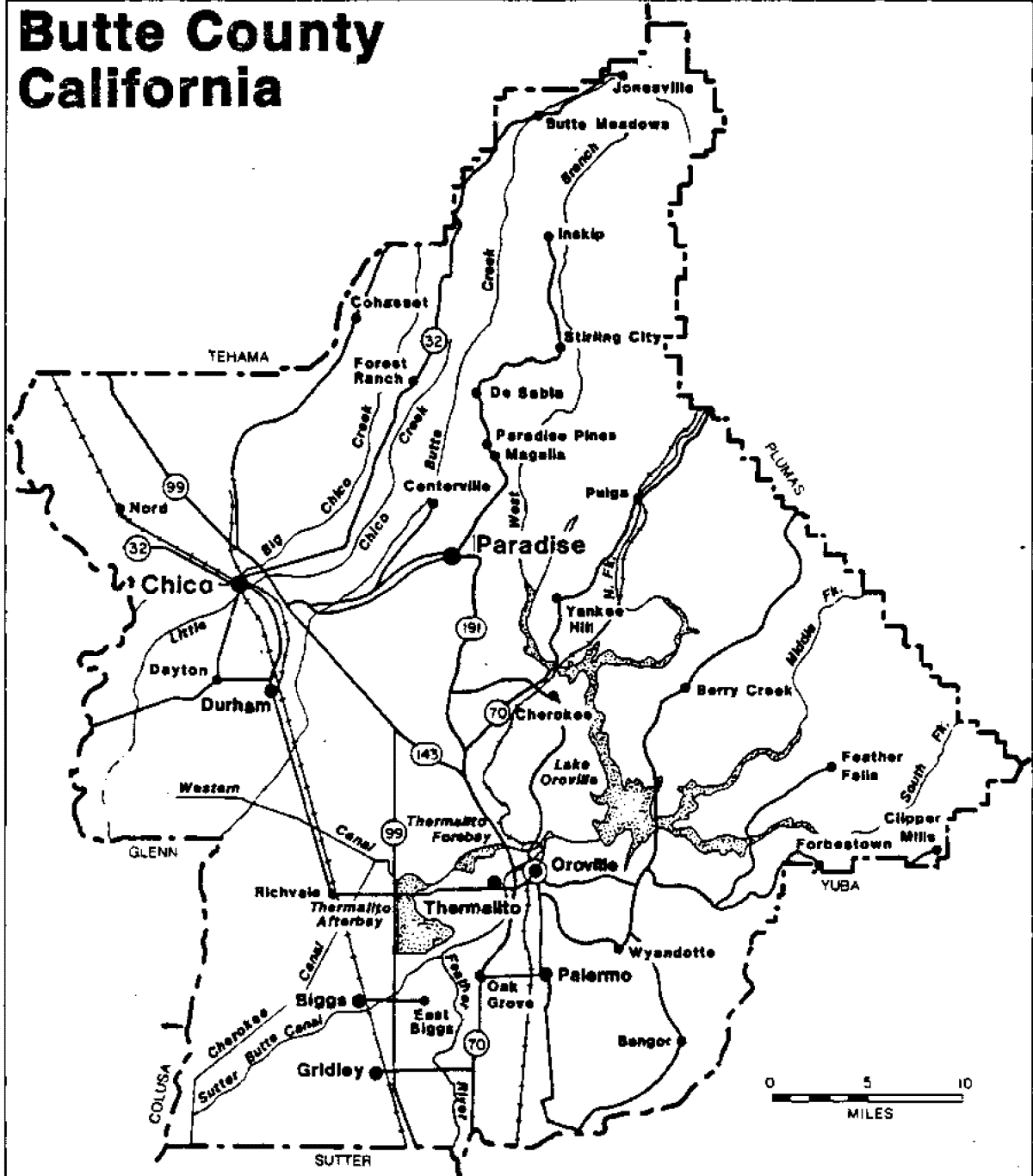
The following treatment for species of Limnanthaceae found in Butte County is based primarily on specimens in the California State University, Chico Herbarium (CHSC). In addition, literature in the references cited contains information pertinent to taxa found in the county. Descriptions and keys are designed mainly for identification and separation of Butte County plants, and are based on study of herbarium specimens and other available keys and descriptions (Munz, 1968; Arroyo, 1973).

The county range maps for each taxon show dots based on herbarium specimens studied by the author and, in some cases, specific locations cited in the literature. Flowering dates are specific for the county, coming from information on herbarium sheets studied by the author unless otherwise noted. Common names come mostly from Jepson (1943). Plant community names are from Munz (1968).

The Butte County outline maps (including the location map found on the next page) were provided by Charles Nelson, Department of Geography, California State University, Chico. The plant community boundary drawn on the Limnanthes douglasii var. rosea map is from a map prepared by James Nelson in the "Land Use Element of the Butte County, California, General Plan" (Nelson, 1979).

The author gratefully acknowledges the patient help of Robert Schlising in editing this writing. Reviews and suggestions came from Rick Kesseli of the University of California, Davis, and also from Jim Jokerst, and were much appreciated. Thanks are also extended to John S. Morgan and Byron M. Jackson of the California State University, Chico, Graduate School, for funds used in the preparation of this report.

Butte County California



Key to species of LIMNANTHES in Butte County

(Described in alphabetical order following the key)

- A Foliage densely hairy; sepals wooly within and without; petals with rounded tips and narrow bases
LIMNANTHES FLOCCOSA
- AA Foliage glabrous to sparsely villous; sepals ranging from glabrous to having many long hairs outside and/or within; petals cuneate-obovate to rounded, entire to deeply notched
- B Petals with scattered hairs along veins and with U-shaped band of hairs at base; nutlets ranging from smooth to having plate-like tubercles or a crown of tubercles
LIMNANTHES DOUGLASII
- BB Petals without hairs except for a row of hairs on each side of petal claw; nutlets ranging from smooth to having conic tubercles of varying sizes
LIMNANTHES ALBA

1. LIMNANTHES ALBA Hartw. in Benth.
Balsa foam, white meadowfoam

Description Single-stemmed to much branched from the base, 8-30 cm high; leaves 3-12 cm long (including the petioles), once or twice pinnately dissected into ovate, lanceolate or linear leaflets; herbage glabrous to sparsely villous; flowers on peduncles to 10 cm long; sepals 7-8 mm long, glabrous or with many long hairs outside and/or within; petals cuneate-obovate, 8-15 mm long, 6-10 mm wide, white, sometimes pink at apex, or aging pink, with a row of hairs on each side of the claw; stamens 5-6 mm long; nutlets dark brown, smooth or with large conic, straw-colored tubercles.

Reproductive biology Limnanthes alba flowers from April through June, later than either L. floccosa or L. douglasii var. rosea. The total allocation of resources for reproduction seems to be about equally divided between the supporting structures (calyx, corolla) and seed biomass. Seed set is concentrated in the first flowers on a plant. Later flowers are often empty, with no viable seeds developing. However, the number of seeds per plant is still higher than for L. floccosa, which almost always has at least one viable seed in each flower on the plant. This may be related to the L. alba preference for sites with higher nutrient availability, or may show a difference between a self-pollinated species (L. floccosa) and an outcrosser (L. alba). The preference for sites with higher nutrient availability often places L. alba in more exposed areas. This seems related to a higher yearly mortality rate for L. alba than for L. floccosa (Ritland and Jain, 1984a).

Viable crosses have been made between L. alba var. alba and var. versicolor (Mason, 1952). Mason found that a cross between these two varieties gave an intermediate hybrid with hairiness ranging from glabrous to very hairy. The nutlets on this hybrid were mostly with wrinkled surfaces.

In an experiment done at the University of California, Davis (Jain, 1978), artificial vernal pools were constructed. Several species and varieties of Limnanthes were compared for their ability to disperse seeds, both within pools that had been seeded, and into pools which had not been

seeded. Only L. alba showed a high level of dispersal in these tests.

There is a high degree of variability in the characteristics of L. alba which explains the adaptability of this species to varying habitats (Ornduff and Crovello, 1968). Of the species of Limnanthes in Butte County, L. alba is reported in the widest range of habitats, occurring in valley grassland, foothill woodland and yellow pine forest.

Key to varieties of LIMNANTHES ALBA in Butte County

A Herbage sparsely villous; sepals mostly with long hairs within and without

1a. LIMNANTHES ALBA var. ALBA

AA Herbage mostly glabrous; sepals nearly to completely glabrous, or hairy only within

1b. LIMNANTHES ALBA var. VERSICOLOR

1a. LIMNANTHES ALBA Hartw. in Benth.
var. ALBA

MAP 1

White meadowfoam

Description Plant 10-30 cm high; leaves sparsely villous; sepals mostly with wooly hairs within and without.

Reproductive biology Limnanthes alba var. alba collected in Butte County flowered from late March through early May [this is generally 1-2 months later than L. douglasii var. rosea (Mason, 1952)]. Pollen was shown to be about 97.6% viable when 890 pollen grains were counted (Mason, 1952). Studies have found some seed dormancy in this variety, but it seemed to be site-dependent (Ritland and Jain, 1984b).

A study of the variations in nutlet morphology for Limnanthes (Hauptli et al., 1978), which included collections made in Butte County, found that for L. alba var. alba there are three distinct classes of nutlet tuberculation patterns. At one Butte County site 89% of the nutlets had conic-shaped tubercles ranging in size from very small to very large; 11% had consistently large conic tubercles. Collections were not made at any other sites in Butte County, but collections from Shasta County showed another pattern of tuberculation for var. alba which may well occur in Butte County also. This was the state of "no tubercles." Overall, the study concluded that tuberculation was related to the microhabitat in which each specimen was growing. Limnanthes alba var. alba has ". . . several nutlet types of which the least tuberculate classes are associated with the most xeric sites. Relatively smooth nutlet populations occur in drier habitats, and those with highly tuberculate ones occur in wetter sites."

Distribution and habitat Limnanthes alba var. alba has been found in Butte County in vernal pools or in low, moist places at an elevation of 50 to 3500 feet. It occurs in the valley grassland, foothill woodland and yellow pine forest.

1b. LIMNANTHES ALBA Hartw. in Benth.
var. VERSICOLOR (Greene) C. T. Mason

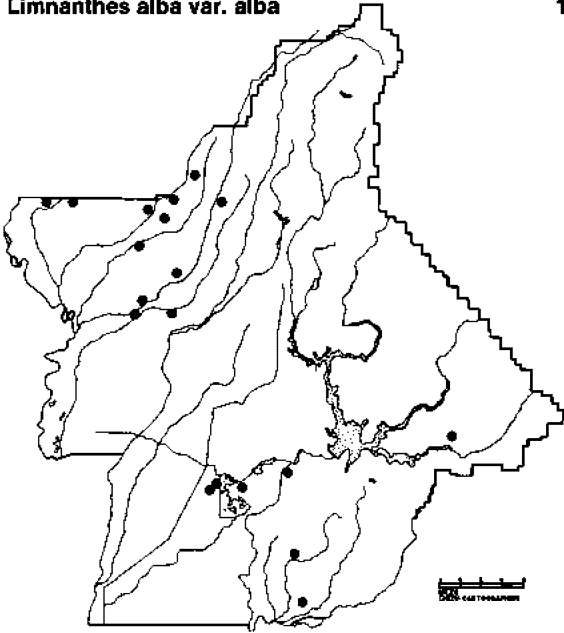
MAP 2

Shasta meadowfoam

Description Plants 8-15 cm high, generally smaller than var. alba; leaves 3-8 cm long; herbage mostly glabrous; sepals nearly to completely glabrous, or hairy only within, often with darkened edges.

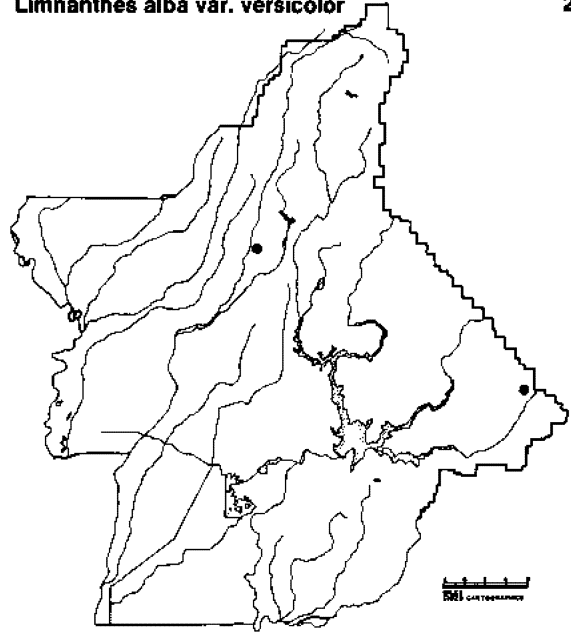
Limnanthes alba var. *alba*

1



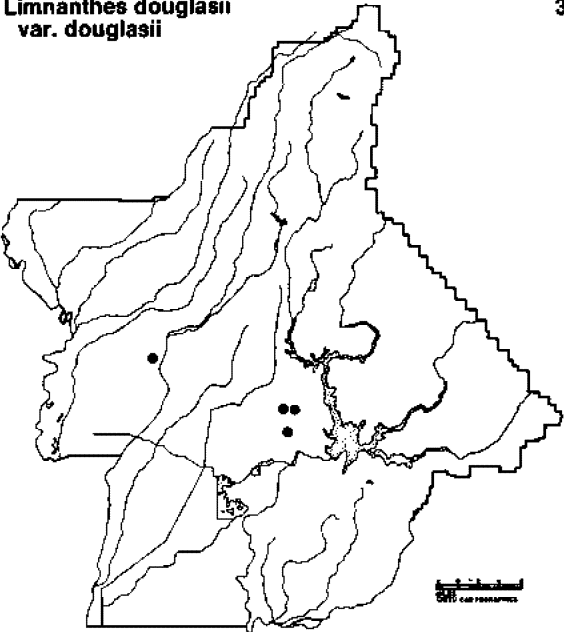
Limnanthes alba var. *versicolor*

2



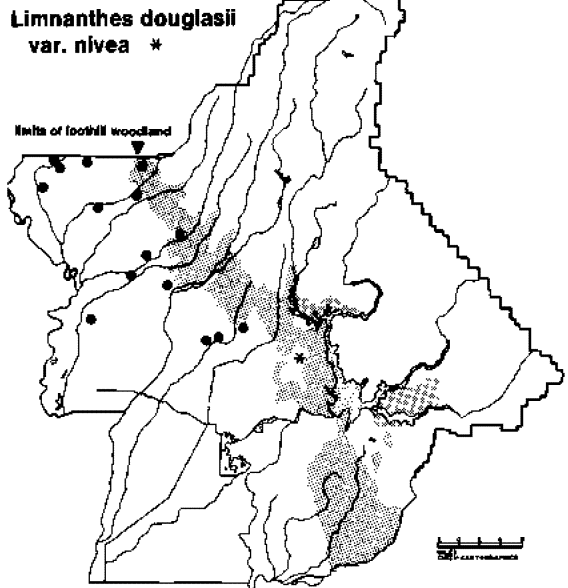
Limnanthes douglasii
var. *douglasii*

3



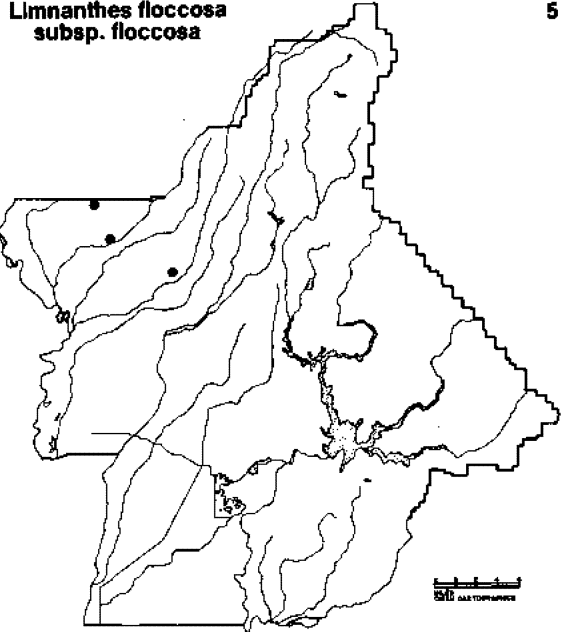
Limnanthes douglasii
var. *rosea*

4



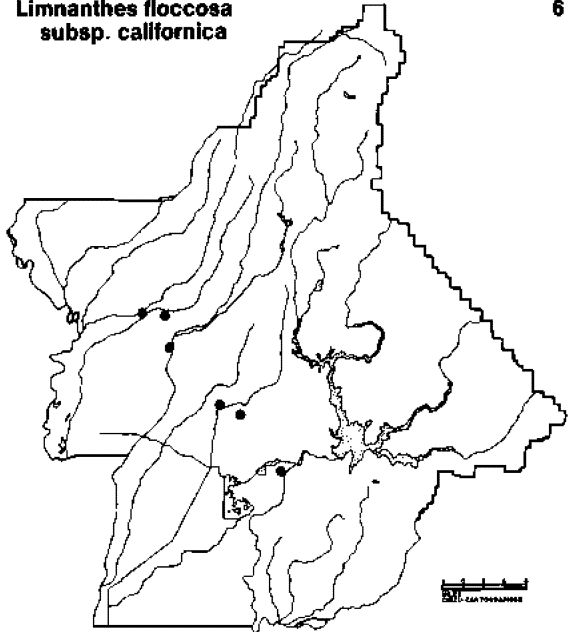
Limnanthes floccosa
subsp. *floccosa*

5



Limnanthes floccosa
subsp. *californica*

6



Reproductive biology Limnanthes alba var. versicolor generally flowers later (during May and June), and lives longer, than var. alba. This variety also produces fewer seeds per flower and fewer seeds per plant. However, var. versicolor produces more flowers per plant (Ritland and Jain, 1984a). A survey of 400 pollen grains showed viability of 99% (Mason, 1952).

Distribution and habitat This variety occurs in open, moist places at an elevation of about 1000 to 5300 feet in Butte County. It can be found in the foothill woodland and yellow pine forest (Munz, 1968).

2. LIMNANTHES DOUGLASII R. Br.
Common meadowfoam

Description Branched from the base, or with a single stem, 8-40 cm high; leaves 3-15 cm long (including the petioles), pinnately divided into 5-9 leaflets, these entire or toothed to 5-lobed, linear to ovate, glabrous; pedicels 2-14 cm long; sepals lanceolate, 5-10 mm long, glabrous, sharply pointed; petals cuneate-obovate to rounded, 8-18 mm long, entire to deeply notched at apex, white, cream, or yellow with white tips, some with pink or prominent dark purple veins, all with scattered and sparse hairs along veins and a U-shaped band of hairs at base; stamens 5-8 mm long; nutlets dark brown, smooth to covered with large, plate-like, dark, bone or pink tubercles, or with a crown of tubercles.

Reproductive biology Flowers of L. douglasii can be found in Butte County during the months of March to June. All three varieties of L. douglasii are able to intercross. Viable crosses have been done between L. douglasii var. douglasii and var. rosea, between var. douglasii and var. nivea (Mason, 1952) and between L. douglasii var. rosea and var. nivea (Ornduff, 1971). When different varieties of L. douglasii occur in the same vernal pool they occupy different parts or heights of the pool (Holland and Jain, 1980).

Key to varieties of LIMNANTHES DOUGLASII in Butte County

- A Leaflets ovate or obovate; nutlets smooth to wrinkled, or covered with triangular tubercles, or with a crown of tubercles
 - B Petals with deeply notched apex, yellow with white tips
 - 2a. LIMNANTHES DOUGLASII var. DOUGLASII
 - BB Petals cuneate, white, often with dark purple veins; nutlets often with crown of tubercles
 - 2b. LIMNANTHES DOUGLASII var. NIVEA
- AA Leaflets linear; nutlets with tall, plate-like tubercles
 - 2c. LIMNANTHES DOUGLASII var. ROSEA

2a. LIMNANTHES DOUGLASII R. Br.
var. DOUGLASII
Common meadowfoam

MAP 3

Description Leaflets ovate or obovate; petals cuneate, with deeply notched apex, yellow with white tips; nutlets smooth or with dark tubercles of varying sizes.

Some researchers believe that the Butte County specimens do not represent var. douglasii and should be included in the variety nivea.

However, since the herbarium sheet descriptions by collectors state "yellow with white tips" these specimens remain designated as var. douglasii and are shown on county range map 3. It should be noted that the collection dates of some specimens are from ten years or more ago, and populations may no longer be present at these sites [e.g., L. R. Alexander 2, 9 April 1967, 4 mi S of Chico on Hwy 99E; J. Cox 40, 10 March 1976, Table Mountain (both CHSC)].

Reproductive biology In Butte County flowers of this variety have been found during March through May. Mason (1952) found that the cross between L. douglasii var. douglasii and var. nivea gave good seed set, with a high percentage of germination. Since the ranges of these two varieties may cross or adjoin, Mason (1952) states ". . . it is conceivable that some of the variation of var. douglasii may be the result of hybridization and introgression from var. nivea." A survey of 167 pollen grains showed 98.8% viability (Mason, 1952).

Distribution and habitat Limnanthes douglasii var. douglasii has been found in moist, marshy areas below 300 feet elevation in the valley grassland of Butte County. It has also been collected on Table Mountain.

2b. LIMNANTHES DOUGLASII R. Br.
var. NIVEA C. T. Mason
Coastal meadowfoam

MAP 4

Description Plants much branched from base; petals white or cream, often with prominent dark purple veins; nutlets smooth or wrinkled, often with crown of tubercles.

Reproductive biology This variety flowers from March to May (Munz, 1968), but Butte County specimens have been collected in flower only from late March to early April. Out of 159 pollen grains surveyed, 100% were viable (Mason, 1952).

Distribution and habitat Limnanthes douglasii var. nivea is usually listed as having a coastal distribution, but this variety has been collected in vernal pools on Table Mountain in Butte County [J. D. Jokerst 1147 and L. Ahart s.n. (both CHSC)].

2c. LIMNANTHES DOUGLASII R. Br.
var. ROSEA (Hartw. in Benth.) C. T. Mason
Valleyfoam, rose-flowered meadowfoam

MAP 4

Description Leaflets linear; petals obovate, white with pink veins, or cream aging pink; anthers often dark; nutlets with plate-like tubercles about twice as high as long, bone or pinkish in color.

Reproductive biology Specimens of this variety have been collected in flower in Butte County from the first days of March to mid-April. Studies by Mason (1952) on the viability of pollen for this variety showed 99.8% of the 473 grains surveyed were viable.

The morphology of the nutlets in the genus Limnanthes seems to play a part in seed dispersal. The tuberculate structure of the seed coat seems designed to capture air bubbles, giving the nutlet increased bouyancy. The members of variety rosea are often found in rings at a consistent depth-level around vernal pools. "The nutlet weight and surface morphology of L. douglasii var. rosea appears to be relevant to its floating ability and settling in a zone" (Jain, 1976).

Distribution and habitat The distribution of L. douglasii var. rosea within a pool may change from year to year so that its distribution may be ". . .

more central (to the pool) in years of low rainfall and more peripheral in years of high rainfall" (Jain, 1978). This variety is found in moist and grassy spots, with sandy or loamy soils. It has been collected in Butte County at 300 feet or lower in valley grassland (but can occur up to 1500 feet elevation, according to Munz, 1968).

3. LIMNANTHES FLOCCOSA Howell
Wooly meadowfoam

Description Simple or branched from the base, 5-20 cm high; leaves 3-7 cm long (including petioles), densely hairy, pinnately divided into 5-7 entire, toothed or 3-parted leaflets; pedicels 2-5 cm long; sepals narrow-ovate, 4-12 mm long, wooly within and without; petals rounded at the apex, very narrow at the base, 5-12 mm long, 4-8 mm wide, white, with or without 2 rows of hairs on the petal claw; nutlets with conic-shaped tubercles of varying sizes.

Reproductive biology Members of this species flower from March through May (Munz, 1968), and flowering specimens have been collected in Butte County from late March to mid-April. Ritland and Jain (1984a) suggest that overall, there is less additive genetic variation in L. floccosa than in other Limnanthes species, and therefore L. floccosa cannot respond as well to environmental changes with adaptive changes in life history. They feel that L. floccosa shows more phenotypic plasticity in place of genetic variation.

There is a higher allocation of resources to seed biomass than in L. alba. Proportionally more resources are devoted to seed size than to the other structures involved in seed production. While L. alba sets the majority of seeds in the first flowers produced on the plant, members of L. floccosa almost always have at least one seed in every flower on the plant (Ritland and Jain, 1984a).

There also seems to be a greater seed dormancy factor in L. floccosa, with more seeds remaining in the soil bank each year than in other species. The seeds also seem to be slower to germinate than those of L. alba. Studies by Ritland and Jain (1984a) have shown juvenile and mature specimens of L. floccosa populations to be consistently 20-50% smaller than individuals in populations of L. alba. When both species occurred in the same site, the mature size was 33% smaller in the L. floccosa representatives. Limnanthes floccosa had a slower relative seedling growth rate although it flowered earlier than L. alba. Both of these traits may relate to the distribution of L. floccosa.

This species seems to grow in drier habitats, especially when compared to other species such as L. alba. Limnanthes floccosa is found on the borders of vernal pools and in seasonal, rocky drainages. The drier conditions may be the cause for the smaller size of plants in L. floccosa than in other species of Limnanthes, and may also induce L. floccosa to flower earlier, when moisture availability is more assured (Ritland and Jain, 1984a).

Key to subspecies of LIMNANTHES FLOCCOSA in Butte County

A Plants low, often branched from base; stems reddish; petals 5-8.5 mm long, usually not exceeding sepals, without 2 rows of hairs at petal base

3a. LIMNANTHES FLOCCOSA subsp. FLOCCOSA

AA Plant upright, less branched; stems greenish; petals 8-12 mm long, often exceeding sepals, with 2 rows of hairs at petal base

3b. LIMNANTHES FLOCCOSA subsp. CALIFORNICA

3a. LIMNANTHES FLOCCOSA Howell
subsp. FLOCCOSA
Woolly meadowfoam

MAP 5

Description Plants low, often much branched from the base; sepals 5-8 mm long; petals 5-8 mm long, usually not exceeding the sepals, without 2 rows of hairs at petal base.

Reproductive biology This subspecies has been collected in flower during late March in Butte County. The subspecies is mostly autogamous, and this trait makes it relatively immune to pollinator stress (Brown, 1976).

Distribution and habitat In Butte County, this subspecies occurs only north of Chico; this is the southern edge of its overall geographic range. There are two specimens in the California State University, Chico Herbarium, one collected at the Butte--Tehama County line [J. D. Jokerst 2188 (CHSC)] and one near Chico [J. D. Jokerst and J. Donovan 1257, N of Horseshoe Lake (CHSC)]. A third site in the county also known to contain L. floccosa subsp. floccosa is near the north boundary of the county (Kesseli, 1985). This subspecies occurs in valley grassland.

3b. LIMNANTHES FLOCCOSA Howell
subsp. CALIFORNICA Arroyo
Shippee Meadowfoam

MAP 6

Description Plants upright, with little branching from the base; sepals 7-12 mm long; petals 8-12 mm long, often exceeding the sepals, with 2 rows of hairs on petal base.

Reproductive biology Flowering specimens were collected in Butte County from late March to mid-April. While this subspecies is usually self-pollinating, samples collected in Butte County were in a group which has "relatively large corollas, anthers, sepals and nectaries; they are protandrous and retain nectar guides. Following pollination 3 to 5 of the 5 ovules mature to seed. Such populations, which are described as partially autogamous, are still visited by pollinators and have large amounts of self-pollination only in years of pollinator stress" (Arroyo, 1973).

Distribution and habitat The type specimen of this subspecies was collected in Butte County, 0.5 miles S of the junction of Hwy 99E and Shippee Road, 29 March 1970 [M. T. Kalin 7014 (University of California, Berkeley, Herbarium)]. This subspecies is endemic to Butte County. Its distribution is along the eastern edges of the Sacramento Valley (Arroyo, 1973). It is found on the edges of deep vernal pools and in vernal moist depressions in undisturbed areas in the valley grassland.

This subspecies is a rare and endangered plant (Smith and York, 1984). Current locations are threatened by the encroachment of human populations, and some past sites seem to have been lost. The northernmost and the southernmost sites shown on county range map 6 are locations originally given by Mason (1952) as Limnanthes floccosa. When the subspecies floccosa and californica were established by Arroyo (1973) These two sites were specified as containing L. floccosa subsp. californica. However, the newest information (Jokerst, 1987) indicates that these sites may no longer contain populations of L. floccosa subsp. californica (although they still fall within the overall range for the subspecies). One of the specimens collected by Mason in 1952 [Mason 1254 (University of California, Berkeley, Herbarium)] was from a population of L. floccosa subsp. californica occurring on Table Mountain (Arroyo, 1973). There have been no additional collections of subsp. californica from this site, and it is probable that the population no longer exists.

REFERENCES CITED

- Arroyo, M. T. K. 1973. A taximetric study of intraspecific variation in autogamous Limnanthes floccosa (Limnanthaceae). *Brittonia* 25: 177-191.
- Brown, C. R. 1976. Fecundity response to stress in three taxa of the genus Limnanthes. In *Vernal pools: their ecology and conservation*, S. Jain, ed. Institute of Ecology Publication 9, University of California, Davis, Calif.
- Hauptli, H., S. K. Jain, and B. D. Webster. 1978. Variation in nutlet morphology of Limnanthes. *American Journal of Botany* 65: 615-624.
- Holland, R. F., and S. K. Jain. 1980. Insular biogeography of vernal pools in the Central Valley of California. *American Naturalist* 117: 24-37.
- Jain, S. K. 1976. Evolutionary studies in the meadow-foam genus Limnanthes: an overview. In *Vernal pools: their ecology and conservation*, S. Jain, ed. Institute of Ecology Publication 9, University of California, Davis, Calif.
- Jain, S. K. 1978. Local dispersal of Limnanthes nutlets: an experiment with artificial vernal pools. *Canadian Journal of Botany* 56: 1995-1997.
- Jepson, W. L. 1943. *A flora of California*, vol. 2. Associated Students Store, University of California, Berkeley, Calif.
- Jokerst, J. D. 1987. Personal communication.
- Kesseli, R. V. 1985. Letter on file with the Natural Diversity Data Base, California Department of Fish and Game, Sacramento, Calif.
- Kesseli, R. V., and S. K. Jain. 1984. New variation and biosystematic patterns detected by allozyme and morphological comparisons in Limnanthes sect. Reflexae (Limnanthaceae). *Plant Systematics and Evolution* 147: 133-165.
- Krombein, K. V., P. D. Hurd, D. R. Smith, and B. D. Binks. 1979. *Catalog of Hymenoptera in America north of Mexico*, vol. 2. Smithsonian Institution Press, Washington, D. C.
- Mason, C. T. 1952. A systematic study of the genus Limnanthes R. Br. *University of California Publications in Botany* 25: 455-512.
- Moldenke, A. R. 1976. California pollination ecology and vegetation types. *Phytologia* 34: 352-365.
- Munz, P. A. 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. 1971. Systematic studies of Limnanthaceae. *Madrono* 21: 103-111.
- Ornduff, R., and T. J. Crovello. 1968. Numerical taxonomy of Limnanthes. *American Journal of Botany* 55: 173-182.

- Ritland, K., and S. K. Jain. 1984a. The comparative life histories of two annual Limnanthes species in a temporally variable environment. *American Naturalist* 124: 656-679.
- Ritland, K., and S. K. Jain. 1984b. A comparative study of floral and electrophoretic variation with life history variation in Limnanthes alba. *Oecologia* 63: 243-251.
- Smith, J. P., Jr., and R. York. 1984. Inventory of rare and endangered vascular plants of California. Special Publication Number 1, 3rd ed., California Native Plant Society, Berkeley, Calif.
- Thorp, R. W. 1976. Insect pollination of vernal pool flowers. In *Vernal Pools: their ecology and conservation*, S. Jain, ed. Institute of Ecology Publication 9, University of California, Davis, Calif.

Studies from the Herbarium
California State University, Chico

--Number 5--

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M A L V 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 lower photograph on the cover shows the fruit from one flower of Sidalcea calycosa (the upper is of Limnanthes alba var. alba, a member of the Limnanthaceae). Bob McNulty and Chris Ottinger, Department of Biological Sciences, CSUC, aided in taking these photos.

This treatment for the Malvaceae (the mallow family) in Butte County, California, covers the 14 species in 5 genera presently known to persist in the wild here. The introduced Anoda cristata, Modiola caroliniana, and Malva sylvestris are not included in the keys because they have been collected only once in the county and have probably not spread from the sites of introduction. The Anoda and Modiola are briefly described at the end of this report, and Malva sylvestris is mentioned at the end of the Malva section. The 14 species described as members of the Butte County flora do, however, include 4 introduced species that are common as weeds in North America.

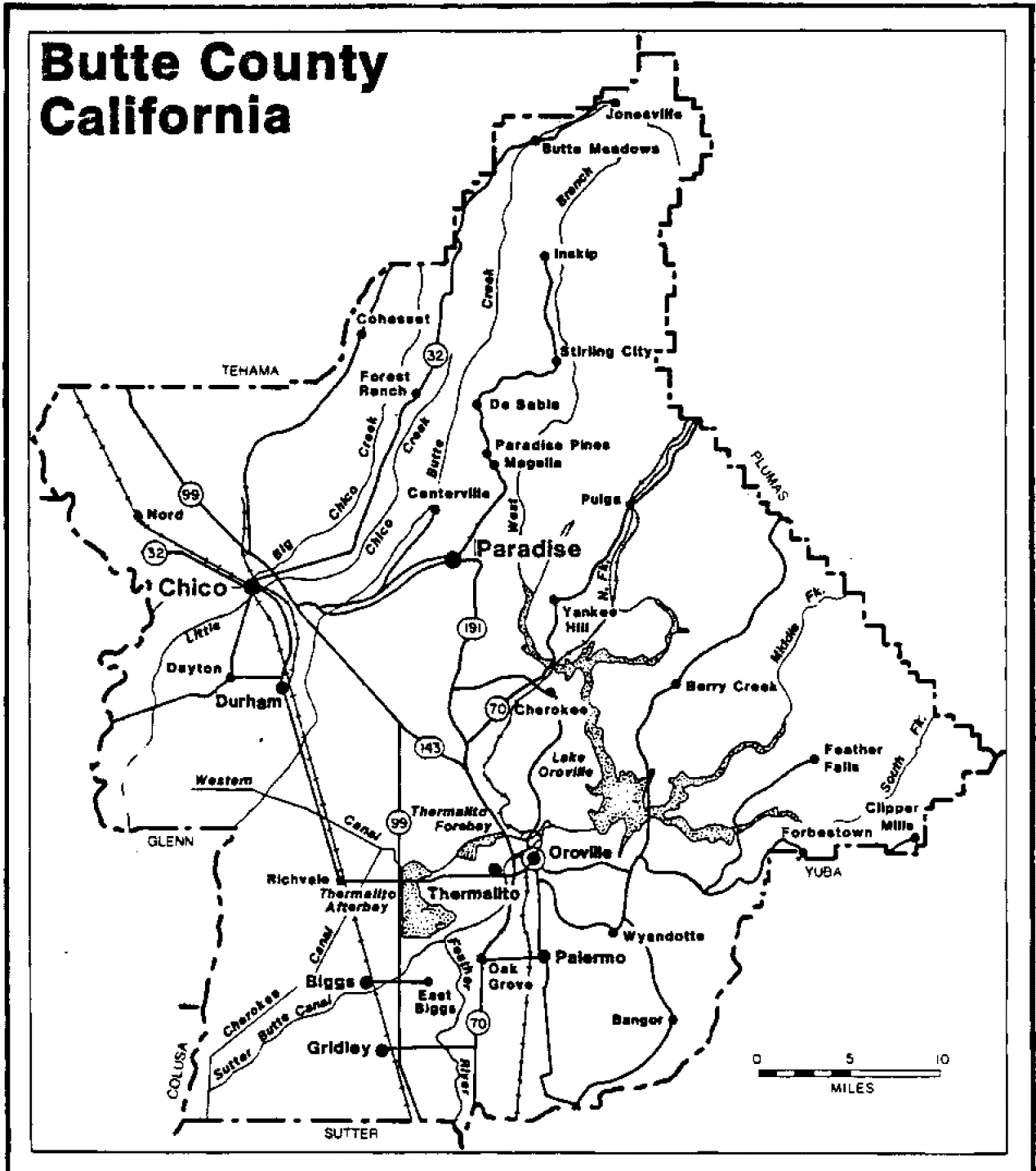
All 10 of the native species of Malvaceae are abundant in their respective habitats within the county. However, two of these, Hibiscus californicus and Sidalcea robusta, are considered rare and endangered in California (Smith and York, 1984). The Hibiscus, which occurs in Butte and several counties to the south, is restricted to increasingly rare freshwater marsh and streamside habitats. Sidalcea robusta, on the other hand, occurs in only a small region entirely within Butte County, in foothill woodland habitats on the Tuscan Formation volcanic mudflows that are widespread at low elevations throughout several northern California counties.

All of the plant communities in the county have at least one of the ten native mallows present in them, with chaparral and freshwater marsh containing the fewest. These native herbs have a great range in plant size, from 2-meter tall Hibiscus or Sidalcea malvaeflora subsp. celata to dwarfed Sidalcea hartwegii and S. calycosa, that may produce fruit when only 10 cm tall, under very dry conditions. The county's mallows range from being distinctive, easily identified plants to plants that are extremely difficult to distinguish, as with the perennial species of Sidalcea.

This report on the Malvaceae is based primarily on field studies conducted in the county during 1980-1984. In addition, it is based on the Butte County specimens in herbaria at California State University, Chico (CHSC); California Academy of Sciences, San Francisco (CAS, DS); California Department of Food and Agriculture, Sacramento (CDA); and in the University (UC) and Jepson (JEPS) Herbaria at the University of California, Berkeley. The keys and short descriptions are designed primarily for identification and separation of plants as they occur in Butte County. The two major floras used in the preparation of this study--Munz (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). Common names are based mainly on Abrams. Additional monographs and studies used are cited at the beginning of generic or specific descriptions.

A brief summary from the literature on floral or reproductive biology is given for genera and species having published information. The flowering dates listed pertain particularly to Butte County plants, but other information (e.g., flower-visitors) is given for taxa without special reference to this county. The ecological information presented for weedy taxa (i.e., Abutilon and Malva) is particularly brief, since studies on these genera have been done in eastern North America and Europe.

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 taxonomic literature when the identity of the taxon seemed certain. The Butte County outline maps (including the location map shown below) were provided by Charles Nelson, Department of Geography, California State University, Chico. Plant community boundaries drawn on some of the dot maps are from the "Land Use Element of the Butte County, California General Plan" (Nelson, 1979). Plant community names are the same as those used by Munz (1968), except that "valley grassland" is replaced by "grasslands".



The author thanks Craig Thomsen, for information on the collections of Anoda and Modiola in the Herbarium of the California Department of Food and Agriculture, and gratefully acknowledges Diane Ikeda and James Jokerst for their reviews of this report.

The MALVACEAE in Butte County

Annual or perennial herbs, several to 2 m or more high; leaves alternate, palmately veined, and mostly deeply palmately lobed, the lower usually on long petioles, the upper sessile; inflorescence a raceme or spike, or with flowers clustered in leaf axils; flowers hypogenous and regular; calyx of 5 sepals, often fused at base, in some species closely subtended by an involucl of 1-5 sepal-like bracts; corolla of 5 petals, slightly fused at base; stamens numerous, monodelphous (the filaments fused into a tube around the several styles and the anthers appearing as a tuft); pistil of several to numerous, mostly 1-seeded carpels that separate into triangular wedge-shaped sections when mature and dry (or a dry capsule in Hibiscus).

Key to genera of MALVACEAE in Butte County

- A Involucl of 1-several small bracts on flower pedicel immediately below the calyx (bracts may also be present at base of pedicel)
- B Petals over 6 cm long, white with crimson base; fruit a capsule greater than 3 cm long, opening, but not completely separating into free sections when mature and dry; tall, native perennial of freshwater marshes and streamsides in the Sacramento Valley
(1) HIBISCUS
- BB Petals less than 4 cm long, whitish or bluish, pink, or rose-lavender; fruit a circle of 8-15 (or more) wedge-shaped sections that separate completely when mature and dry; annuals and perennials not occurring in freshwater marshes
- C Bracts below calyx 3; flowers mostly in axils of regular stem leaves, much shorter than the leaves; introduced and weedy annuals of orchards, gardens, roadsides and waste places
(2) MALVA
- CC Bracts below calyx 1, or lacking in some species; flowers in racemes or spikes, not in axils of regular stem leaves; native annuals or perennials not occurring in cultivated or waste places
(5) SIDALCEA
- AA Involucl lacking on pedicel immediately below the calyx, but small bracts may be present at base of pedicel
- D Flowers in racemes ranging from few-flowered and spikelike to many-flowered and loosely elongated; petals light pink to deep rose or rose-lavender; upper leaves deeply palmately dissected
(5) SIDALCEA

DD Flowers solitary or several in leaf axils; petals orange, yellowish or white; upper leaves wavy-edged, toothed or shallowly lobed, but not deeply palmately dissected

E Petals orange; leaves ovate to heart-shaped, with margin toothed; tall, widely-branching weed of crop fields

(3) ABUTILON

EE Petals yellowish or whitish; leaves kidney-shaped or rounded, lobed or wavy-edged; low, spreading, white-scruffy plant of roadsides and saline places

(4) MALVELLA

(1) HIBISCUS L.

Rose-mallow

1. HIBISCUS CALIFORNICUS Kell.

MAP 1

[H. lasiocarpus Cav.]

California hibiscus

Description Stellate-pubescent perennial to 2 m high; leaf blades ovate or heart-shaped, 15 cm long, with petioles 15 or more cm long; flowers solitary, axillary, with several narrow bracts 3 or 4 cm long close beneath the sepals; petals white, crimson at base, 6-10 cm long; mature capsule ovoid, to 3 cm long, only partially separating into carpel-segments at the top.

Reproductive biology Flowers late July to September.

Distribution and habitat This species is considered rare and endangered in California (Smith and York, 1984). It is presently known in SW Butte County in four localities in the Butte and Little Chico Creek drainages. It grows on moist stream banks, along irrigation ditches, and in freshwater marshes (especially in sloughs with Scirpus acutus). Two additional populations are known in the county NE of here, both probably established in recent times by people. One occurs in a seep in the foothill woodland of Bidwell Park, Chico, at 420 feet elevation [Oswald 899, 22 July 1985 (CHSC)]. The second population grows along Clear Creek, on the Butte College campus, about 15 miles S of Chico, at about 200 feet elevation [Taylor and Hayes 1441, 16 August 1977 (CHSC)].

(2) MALVA L.

Mallow, cheeses

Description Annuals (occasionally biennials), sparsely hairy to smooth, variable in habit and often widely branched, 0.2-1.5 (-2) m high; leaves rounded or kidney-shaped, somewhat lobed, wavy-margined or toothed, on long petioles; flowers clustered or solitary in leaf axils, shorter than the petioles; involucrel of 3 small bracts below or sometimes fused with the sepals; petals purplish, pink or white; mature fruit disk-shaped, separating into numerous compressed carpel-sections.

Key to species of MALVA in Butte County

Petals shorter than, to barely longer than sepals; tops of mature fruits usually totally exposed by the wide, veiney, rolled-back or widely-spread sepals

1. MALVA PARVIFLORA

Petals about twice the length of sepals; mature fruits partially covered by the incurved sepals, but portions exposed

Bracts ovate; mature fruits reticulate, not hairy

2. MALVA NICAENSIS

Bracts linear to narrowly lance-shaped; fruits not reticulate, finely hairy throughout

3. MALVA NEGLECTA

1. MALVA PARVIFLORA L.
Cheeseweed

NO MAP

Description Stems erect, to 1 m or more high; bracts linear or nearly lance-shaped, 3-5 mm long, immediately below the sepals; sepals slightly hairy in flower, but later smooth, veiney and broadly expanded, completely exposing the fruits; petals 4-6 mm long; sections of fruit reticulate, hairy or smooth, with sharp margins.

Reproductive biology Flowers late April to November.

Distribution and habitat This species is introduced from Eurasia (Munz, 1968) and is common throughout agricultural areas in Butte County.

2. MALVA NICAENSIS All.
[M. borealis auth., not Wallr.]
Bull mallow

NO MAP

Description Stems erect, to 1 m or more high; bracts ovate, 4-8 mm long; sepals hairy in flower, becoming smooth and strongly incurved over mature fruit; petals 8-13 mm long; sections of fruit heavily reticulate on the back, smooth on the margins.

Reproductive biology Flowers April to September.

Distribution and habitat This weedy species is introduced from Eurasia (Munz, 1968). It occurs the length of Butte County in agricultural areas and yards, from Chico south to Grey Lodge Waterfowl Management Area and Honcut.

3. MALVA NEGLECTA Wallr.
[M. rotundifolia L.]
Round-leaved or dwarf mallow

NO MAP

Description Resembling M. nicaensis in habit, but stems more sprawling, 0.2-0.5 m long; bracts linear to lance-shaped, 3-5 mm long; sepals slightly hairy, at least partially covering the mature fruit; petals 8-13 mm long; sections of mature fruit at most very weakly reticulate on the back, finely hairy, rounded on the margins.

Reproductive biology Flowers May to October. Near Ottawa, Canada, this species was autogamous, and flower visitors were nine species of bees in seven genera (Agapostemon, Agochlorella, Bombus, Ceratina, Dialictus, Heriades, and Hylaeus) (Mulligan and Kevan, 1973). Other studies indicate that this weedy species has discontinuous seed germination, with seeds in the soil germinating over a period of months or years (Roberts and Boddrell, 1984). Kivalaan and Bandurski (1981) have even reported that at least one seed of this species that was 100 years old germinated.

Distribution and habitat This species, introduced from Eurasia (Munz, 1968), grows throughout low elevation Butte County in yards and agricultural areas.

MALVA SYLVESTRIS L. High mallow. Long-hairy biennial, with stems and habit similar to M. nicaeensis; bracts ovate or oblong, 4-5 mm long; petals showy, rose-purple, 2-2.5 cm long; sections of fruit reticulate on back, at maturity well covered by the incurved sepals. Introduced from Eurasia (Munz, 1968). This species was collected at the College Campus, Chico, 21 April 1929 [J. Baynes s.n. (CHSC)].

(3) ABUTILON Mill.

Indian mallow, flowering maple

1. ABUTILON THEOPHRASTI Medic.

MAP 2

Velvet leaf

Description Coarse, soft-hairy annual to 2 m high, often pyramid-shaped; leaves velvety, ovate to rounded or heart-shaped, to 30 or 40 cm long including the petioles; flowers axillary, with yellow petals 6-8 mm long; fruit short-cylindrical or disklike, flat on top, 2-3 cm wide, at maturity separating into 12-15 sections with stiff awns.

Reproductive biology Flowers July to October. In Illinois, plants had autogamous flowers, each flower lasting only about 3.6 hours (Parrish and Bazzaz, 1979). Insect flower visitors that were strongly implicated as pollinators include bees (Andrenidae, Anthophoridae, Apidae and Halictidae), wasps (Vespidae), and flies (Syrphidae).

Distribution and habitat This introduced species is native to South Asia (Munz, 1968). It has been collected mainly in low-elevation NW Butte County, in cultivated fields especially with beans, corn and sunflowers, and has occasionally been found in roadside habitats.

(4) MALVELLA Jaubert and Spach

References: Clement (1957), Fryxell (1974)

1. MALVELLA LEPROSA (Ortega) Krapov.

MAP 3

[Sida leprosa (Ortega) K. Schum.

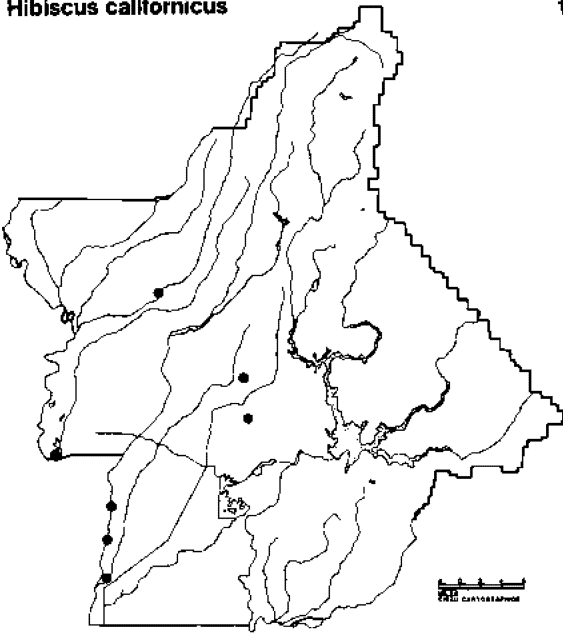
var. hederacea (Dougl.) K. Schum.]

Alkali-mallow

Description Perennial, white-scruffy throughout, with upright or prostrate stems to 5 dm long; leaves variable, rounded or kidney-shaped, with margin smooth to toothed or wavy, the veins prominent beneath, 1-5 cm wide, on petioles to 3.5 cm long; flowers with 1-3 small bracts at top of pedicel, each 3-5 mm long; petals obovate, 1-2 cm long, yellow to cream-colored or white, sometimes with rose markings; fruit conical-truncate, 4-5 mm high, of 6-10 triangular, sparsely hairy sections.

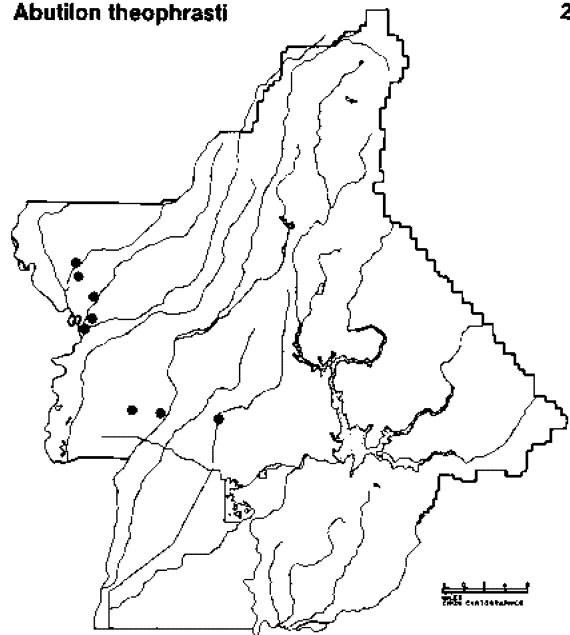
Hibiscus californicus

1



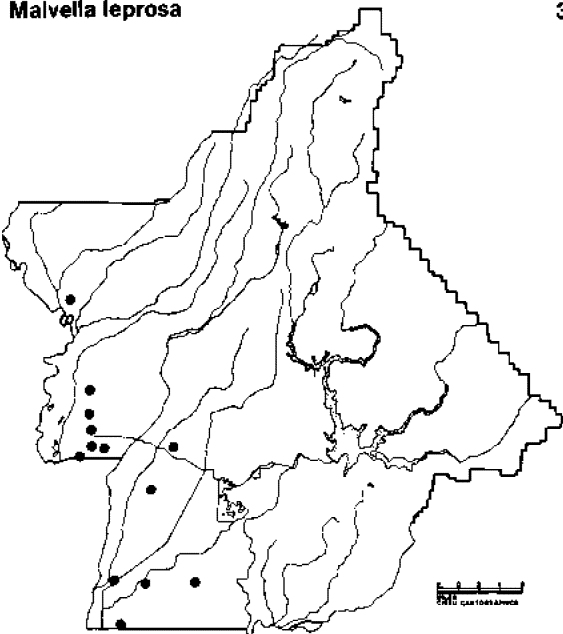
Abutilon theophrasti

2



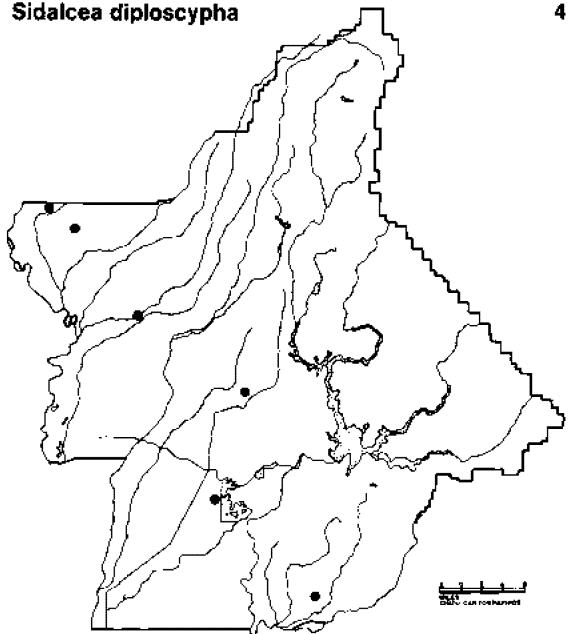
Malvella leprosa

3



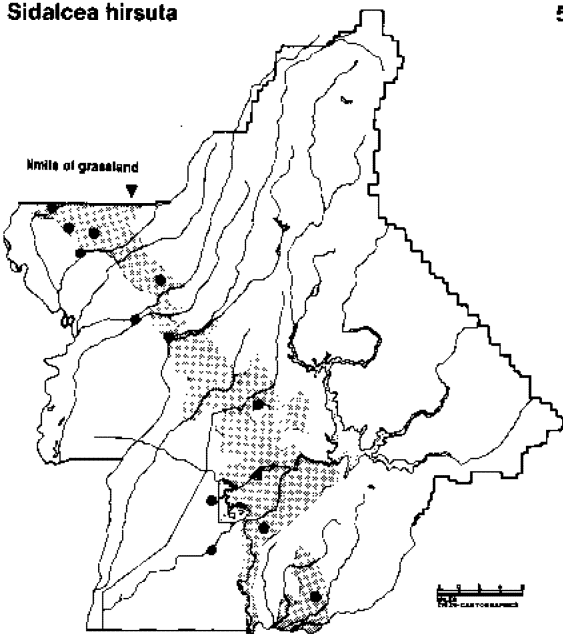
Sidalcea diploscypha

4



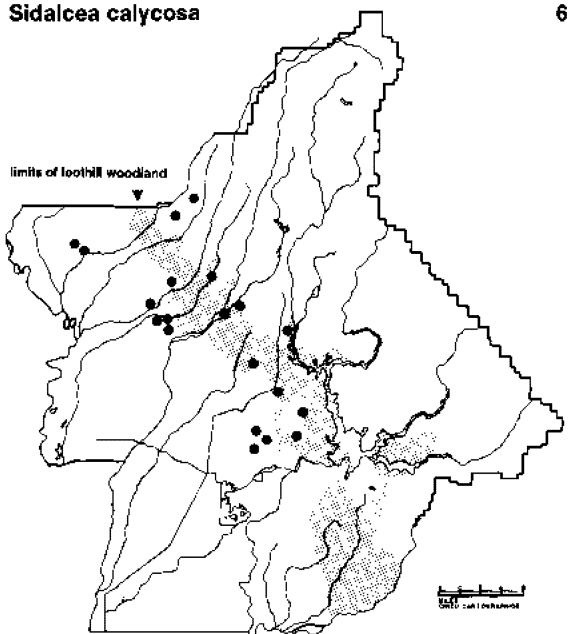
Sidalcea hirsuta

5



Sidalcea calycosa

6



Reproductive biology Flowers June to October. Studies of Linsley et al., (1952), with this species listed as Sida hederacea, note that each flower lasts one day, opening at about 11 a.m. early in the season and 9 a.m. in summer, and closing from 2:30 to 4 p.m. (in San Joaquin County). Stamens dehisce before the flower buds open, and pollen is removed by the anthophorid bee Diadasia consociata (which collects pollen principally from Sida), by forcing its way in between still-closed petals. These workers found no other species of bee gathering pollen, but the flowers produce nectar that is collected by other bees. Krombein et al. (1979) list other bees that collect Sida pollen: Exomalopsis sidae (probably only from Malvaceae, including Sida hederacea); Megachile brevis onobrychidia, Melissodes tepida timberlakei and M. t. yumensis (from Sida plus many other plants). Krombein et al. also list additional bees thought to take nectar from this plant: Hypomacrotera callops persimilis, Perdita latier, P. sidae, and Osmia kincaidii.

Distribution and habitat This species occurs mostly in the SW portions of Butte County, a region mainly cultivated in rice. The plant is often found at immediate roadsides, sometimes with the roots growing under the pavement. It occurs in disturbed areas, but probably favors habitats in low and saline places, as at Gray Lodge Waterfowl Management Area, SW of Gridley [e.g., L. Ahart 3012, 26 August 1981 (CHSC)]

(5) SIDALCEA Gray

Checker, sidalcea

References: Hitchcock (1957), Moore (1971), Roush (1931)

Description Annuals or perennials, glabrous to densely pubescent with simple, forked or stellate hairs; leaves petioled, rounded and unlobed or shallowly lobed at base of plant, to deeply palmately dissected on upper stem; inflorescence a raceme, sometimes crowded and spikelike, with large flowers; petals pink, rose or magenta (darker when pressed), unspotted (except sometimes spotted in S. diploscypha), 1-3.5 cm long; stamens forming two concentric filament-tubes around the several filiform styles, with the anthers on separate strap-shaped portions (phalanges) of the tubes; mature carpels wedge-shaped, reticulate on the surfaces.

Species of Sidalcea in Butte County can be very difficult to identify with certainty, without already having firsthand knowledge of several taxa for comparison. Mature carpels, stem bases, roots, and information on habitat are required to determine most species. In both the annuals and the perennials height, branching, leaf shape and dissection, and plant pubescence can be extremely variable within and between populations.

Reproductive biology According to Hitchcock (1957) considerable variation occurs in size of flowers in all species of Sidalcea, due to environmental conditions and also (mainly) due to their dimorphic condition. All species of the perennials have some plants with perfect flowers that are protandrous (have their styles protrude above the stamen masses only after the pollen has been shed). Other plants are pistillate, with no anthers present on the filament tubes, and "between the two extremes nearly every condition is to be found" (Hitchcock, 1957, p. 6). All individual plants apparently have functional carpels and normally set fruits. Hitchcock notes that the filiform style branches are "stigmatic full length on their inner faces" (p. 6). Moore (1971) found the annual species to have perfect flowers, and like the perennials to be protandrous and have styles "stigmatose on their entire inner surfaces" (p. 21). Moore believes related

species of annuals, even if they can be crossed in the garden, are intersterile in nature, and do not form hybrids.

Key to species of SIDALCEA in Butte County

- A Spring-flowering (late March to June) annuals; taproot often hidden by a mass of fine lateral roots; plants mostly occurring below coniferous forest elevations, in vernal pools, grasslands, savanna (foothill woodland), and chaparral openings
- B Flower bracts conspicuous, divided into 5-7 filiform segments exceeding the calyx in length; calyx lobes with deep purple midveins; plants of grasslands, often near margins of vernal pools
1. SIDALCEA DIPLOSCYPHA
- BB Flower bracts less conspicuous, undivided or once-divided, shorter than the calyx; calyx lobes lacking deep purple midveins; plants of vernal pools, grasslands, savanna or chaparral
- C Mature carpels pubescent on top and back, reticulate elsewhere; inflorescence a crowded spike; plants densely short-pubescent above; plants of vernal pools
2. SIDALCEA HIRSUTA
- CC Mature carpels glabrous, reticulate or deeply grooved on top or back; inflorescence a quite open and/or short raceme; plants weakly pubescent above; plants of vernal pools and other habitats
- D Mature carpels longitudinally ridged or grooved on top and back, reticulate on the sides only; outer straplike parts of stamen filament-column (the staminal phalanges) relatively broad, with anthers in rows of 6; basal leaves rounded, wavy-edged or only shallowly lobed, usually present at flowering; plants of vernal pools and low, moist sites with heavy soils
3. SIDALCEA CALYCOSA
- DD Mature carpels heavily reticulate on top, back and sides; outer straplike parts of filament-column relatively narrow, with anthers single or in pairs; basal leaves deeply lobed and usually dropping off before flowering; plants from better-drained soils of uplands in valley and foothills, not in vernal pools
4. SIDALCEA HARTWEGII
- AA Late spring- or summer-flowering (late April to September) perennials; roots tough, either rhizome-like and showing some lateral growth, or as thick taproots with side branches bearing upright stems; plants mainly from coniferous forests and meadow openings within forests (S. robusta from savanna), never occurring in treeless grasslands or vernal pools
- E Plants with rhizome- or stolon-like rootstalks, often with lateral offshoots; flowering stems usually 1 m or more high; racemes elongated, with the flowers not crowded, well separated with age; petals pink (deeper when dried), 2-3.5 cm long

- F Stem bases densely and very finely pubescent with stellate hairs; mature carpels with pale, often inconspicuous wing-margins along top edges and down back, the surfaces otherwise only lightly reticulate (these features not shown in immature carpels); plants of savannas below 1300 feet elevation
5. SIDALCEA ROBUSTA
- FF Stem bases coarsely harsh-pubescent, with simple, forked, or stellate hairs; mature carpels without wing-margins on top and back, the surfaces roughly reticulate; plants of forests, and less commonly, of upper margins of savannas
6. SIDALCEA MALVAEFLORA
- G Spring-flowering (late May to June) plants of summer-dry habitats; flowering stems usually less than 1 m high, often in dense mats, suggesting clonal growth; stem bases bristly-hairy with (mainly) simple or 2-forked hairs; basal and upper stem-leaves quite similar, little dissected; petals pale pink to deep rose; plants of dry to mesic, but not wet, sites in yellow pine forest, and savanna or chaparral ecotones with forest
6a. SIDALCEA MALVAEFLORA subsp. ASPRELLA
- GG Summer-flowering (July to September) plants of wet habitats; flowering stems usually well over 1 m high, usually up to 2 m or more high, with individual plants more or less apparent; stem bases coarse-hairy with mostly stellate hairs; basal leaves rounded, upper stem leaves deeply dissected; petals rose; plants of wet places (seeps, meadows and stream margins) in yellow pine and red fir forests, rarely lower at forest/chaparral ecotones
6b. SIDALCEA MALVAEFLORA subsp. CELATA
- EE Plants with taproots bearing somewhat branching crown at top, not rhizomatous; plants usually less than 1 m high; racemes sometimes with flowers densely arranged, sometimes with flowers spread up to 2 cm or more apart; petals pink to rose or magenta, (1-) 2-2.5 cm long
- H Plants glaucous throughout; most of stem with small, appressed 7-10-rayed stellate hairs; inflorescence often with no more than 12-15 flowers that are well separated; plants of open, dry forests, usually well above 4000 feet elevation
7. SIDALCEA GLAUDESCENS
- HH Plants usually not glaucous; basal parts of stems with coarse stellate hairs, or long-hirsute; inflorescence few to many flowered; plants of high, summer-wet sedge-meadows and stream-sides, or of lower elevation forests
- I Racemes spikelike, with buds and flowers usually crowded, but main axis elongating in fruit and spreading flowers apart; petals deep pink, rose or magenta, rarely over 2 cm long (sometimes less than 1 cm long); carpels smooth or only lightly reticulate; plants mainly of wet sedge- and grass-meadows over 4000 feet
8. SIDALCEA OREGANA subsp. SPICATA

- II Racemes with flowers relatively spread out when young, not spikelike or crowded; petals pink, lightly lined with white, usually over 2 cm long; carpels strongly reticulate; plants of dry forests or forest/savanna ecotones

6. SIDALCEA MALVAEFLORA (mostly subsp. ASPRELLA, possibly some subsp. CELATA)

1. SIDALCEA DIPLOSCYPHA (Torr. & Gray) Gray MAP 4
Fringed sidalcea

Description Annual with stem to 50 cm high, hairy throughout; basal leaves sometimes unlobed; flower-bracts below the calyx palmately divided into (3-) 5-7 filiform segments; petals in some plants with a deep red-violet base; mature carpels reticulate.

The large and highly-divided bracts make this species easy to identify. It is hairier than the other annuals, and has less-reticulate mature carpels than S. hartwegii. The red-violet petal bases are totally lacking in some plants and in some populations, but this is the only species known to have red-violet spots on petals.

Reproductive biology Flowers late April to early June.

Distribution and habitat This species is uncommon, but occurs the length of Butte County, in grasslands, occasionally near, but not in, vernal pools, as at Richvale Vernal Pools.

2. SIDALCEA HIRSUTA Gray MAP 5
Hairy sidalcea, vernal pool sidalcea

Description Annual, glabrous below, slightly soft-hairy above, up to 1.8 m high; bracts below calyx divided once, 4-8 mm long; flowers crowded in spikelike inflorescences; mature carpels reticulate, densely hairy on top and back.

Reproductive biology Flowers late April to early June. Large, black, unidentified anthophorid bees actively taking pollen from flowers, have been collected from S. hirsuta in the Vina Plains of Tehama County, just north of the Butte County line (Schlising, unpublished information).

Distribution and habitat Sidalcea hirsuta occurs uncommonly in grasslands the length of Butte County, strictly in vernal pools or in roadside ditches where standing water simulates the vernal pool habitat in its seasonal timing and duration.

3. SIDALCEA CALYCOSA Jones MAP 6
Annual sidalcea

Description Annual, glabrous to slightly pubescent above, and sometimes slightly succulent, (13-) 30-60 cm high; basal leaves only shallowly or not lobed, usually persistent at flowering time; mature carpels well ridged and grooved on back, reticulate on sides.

Reproductive biology Flowers March to June (rarely to July). Two species of bees known to collect pollen from many types of flowers (Hoplitis producta gracilis and Ceratina timberlakei), are recorded from flowers of S. calycosa (Krombein et al., 1979).

Distribution and habitat This species is most common in foothill woodland and chaparral openings with clay soils, up to about 1450 feet elevation.

This species is found in the northern two-thirds of Butte County, mostly on soils derived from the Tuscan Formation volcanic mudflows. It occurs in showy masses in areas that have been soggy, particularly in shallow vernal pools at grassland elevations (e.g., Humboldt Road Vernal Pools E of Chico).

4. SIDALCEA HARTWEGII Gray
Hartweg's sidalcea

MAP 7

Description Annual, similar to S. calycosa, glabrous to sparingly hairy above, 15-40 cm high; basal leaves usually drying and dropping off by flowering time; mature carpels prominently reticulate.

Reproductive biology Flowers late March to early June.

Distribution and habitat Sidalcea hartwegii is the most common of the four annual checkers in the county, and has the widest range. It is usually on well-drained "upland" soils of grasslands and foothill woodland, and can be found along roadsides, in openings within chaparral, and (rarely) up to the lower reaches of yellow pine forest [e.g., J. Baynes s.n., at 1800 feet in Paradise (CHSC)].

5. SIDALCEA ROBUSTA Heller ex Rousch
Butte checker, Butte County checker mallow

MAP 8

Description Tall perennial, with rhizome-like rootstalks producing clusters of unbranched stems; flowering stems usually 1-2 m high, with fine, stellate pubescence at bases only; leaves mainly on the lower third of flowering stems; inflorescence elongate, often 25-40 cm long; petals pale pink, 2-3.5 cm long; mature carpels lightly reticulate, with narrow, white and papery wings around margins.

This Sidalcea is the tallest in Butte County, usually has the most elongate inflorescences, and has flowers bearing the largest and the palest pink petals (which darken however, when dried, either on the plant or when pressed). The features just mentioned are shared to a certain extent with Sidalcea malvaeflora (see discussion under that species). Sidalcea robusta is separated from S. malvaeflora with certainty, although sometimes with difficulty, by the former's very fine-stellate pubescent stem bases, and the fine, white wing-margins on the fully mature carpels.

Reproductive biology Flowers late April to early June. Large, black, unidentified anthophorid bees were collected while taking pollen from Sidalcea robusta in Bidwell Park, Chico (Schlising, unpublished information).

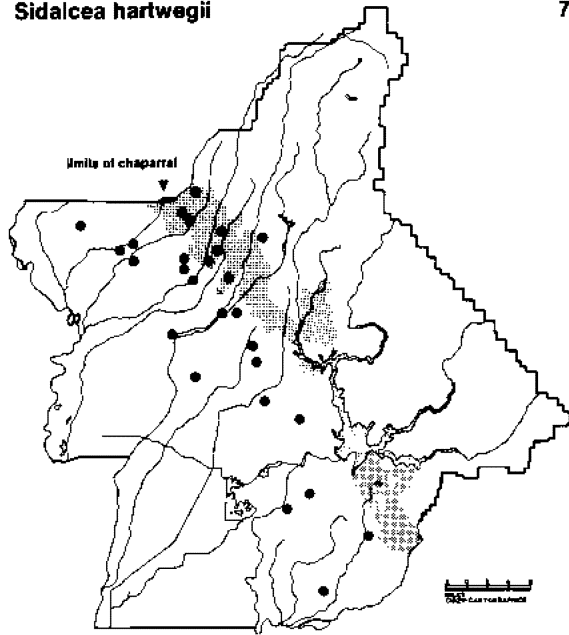
Distribution and habitat Sidalcea robusta is endemic to Butte County in the foothill woodland and its ecotone with chaparral. It is considered rare and endangered by the California Natural Diversity Data Base because of its small total range (Smith and York, 1984). Presently, S. robusta is common in Bidwell Park, Chico, and as far north as in section 1, T22N, R2E, on slopes above little Chico Creek. It ranges south as far as sections 21 and 28, T21N, R3E, in the region of Williams Road, Butte College, and the old village site of Clear Creek. The entire area occupied by this species is underlain by the more widespread Tuscan Formation volcanic mudflows. The plant is usually found growing with Quercus douglasii and associates, often in small drainages on slopes.

6. SIDALCEA MALVAEFLORA (DC) Gray ex Benth.
Checker-bloom

Description Highly variable perennial, with rhizome-like bases producing

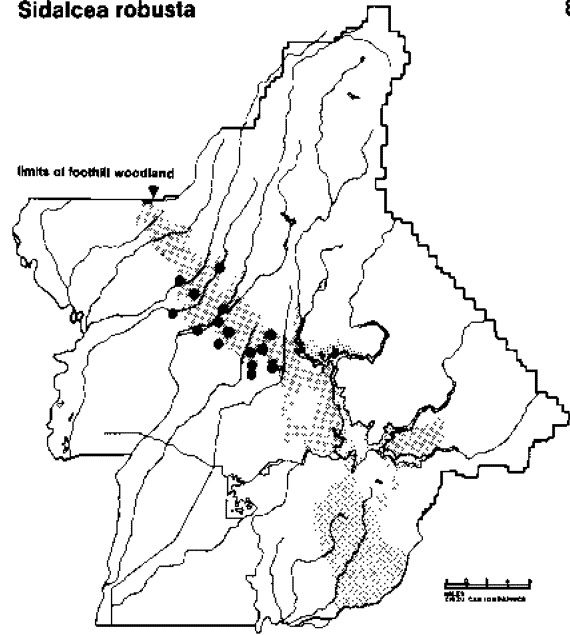
Sidalcea hartwegii

7



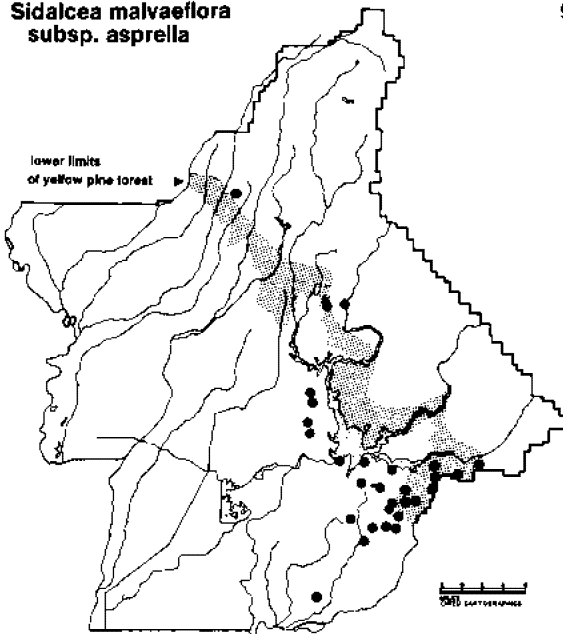
Sidalcea robusta

8



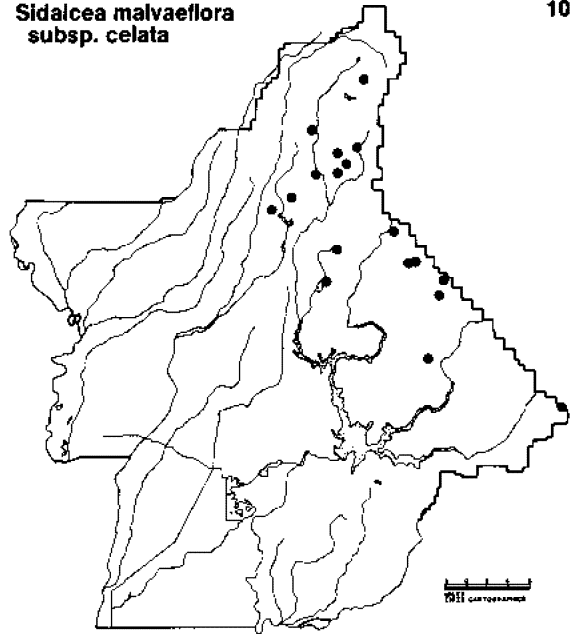
Sidalcea malvaeflora
subsp. *asprella*

9



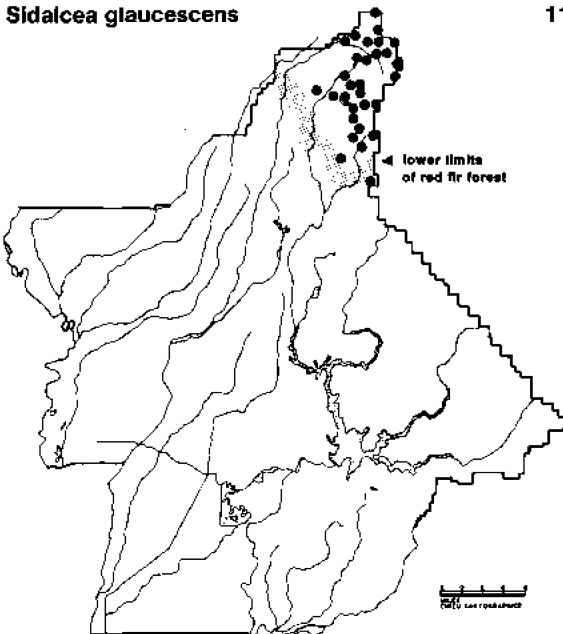
Sidalcea malvaeflora
subsp. *celata*

10



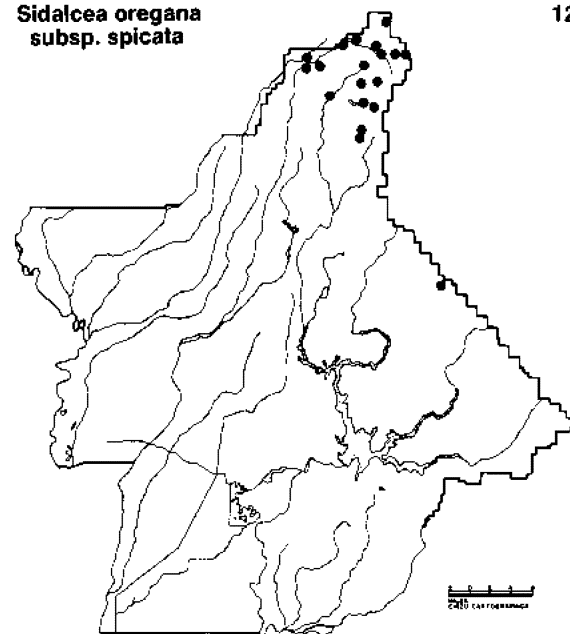
Sidalcea glaucescens

11



Sidalcea oregana
subsp. *spicata*

12



clumps of stems, rather coarsely hairy at bases; inflorescences short or elongated; petals pale pink to deep rose.

This is the most variable and confusing species of Sidalcea in Butte County. In the detailed study of perennial Sidalcea (Hitchcock, 1957), 12 subspecies were discussed for S. malvaeflora; two of these are now known to occur in Butte County, and the plants of several populations show a condition that is quite intermediate. The two Butte County subspecies are (rather poorly) distinguished as described in the key to the species already presented.

Reproductive biology Many species of bees are listed as collected from flowers of S. malvaeflora in Krombein et al. (1979); however, the subspecies of this wide-ranging plant are not listed, and it is not clear which, if any, of the following bees were collected from the two Butte County subspecies asprella and celata. Along with other plant species, Sidalcea malvaeflora is utilized for pollen by Megachile sidalcea, Synhalonia lunata, Ceratina acantha, Heriades occidentalis, Hoplitis fulgida platyura, and Ashmeadiella aridula aridula. Sidalcea malvaeflora flowers are also visited (in some cases, possibly for nectar only) by Chelostoma minutum, C. phaceliae, Osmia texana, O. bruneri, O. atrocyanea atrocyanea, O. albolateralis visenda, and Megachile pascoensis (Krombein et al., 1979). Baker and Baker (1977), also without specifying the subspecies of S. malvaeflora, reported on amino acid components of the nectar. In this species they found close similarity in the amino acids of flowers that were strictly pistillate and flowers that had both stamens and pistils.

6a. SIDALCEA MALVAEFLORA (DC) Gray ex Benth.

subsp. ASPRELLA (Greene) C. L. Hitchc.

MAP 9

[S. asprella Greene]

Harsh sidalcea

Reproductive biology Flowers April to June. Information provided above for the species very likely pertains to this subspecies.

Distribution and habitat This subspecies occurs mainly in central and south Butte County. It is particularly common in the area between Oroville and Forbestown, and also ranges south from there to Honcut. The Oroville-Forbestown plants are "good" subsp. asprella, but the populations seen farther N in the county appear intermediate to subsp. celata in some cases. Subspecies asprella is most common at lower reaches of yellow pine forest where the chaparral and foothill woodland plants mingle with the pines. Hitchcock (1957, p. 26) cites a 1932 collection from "near Durham" that fits this subspecies, but its location as reported by the collector, Bruce, is certainly not to be taken literally as near the village of Durham, and the collection is not shown on Map 9.

6b. SIDALCEA MALVAEFLORA (DC) Gray ex Benth.

subsp. CELATA (Jepson) C. L. Hitchc.

MAP 10

Reproductive biology Flowers July to September.

Distribution and habitat This subspecies occurs within coniferous forests. Most collections and field sightings made on these plants by the author are from seep and wet meadow-margin habitats at 3000 feet elevation or above. Most of these higher elevation forms of S. malvaeflora that are taller, have longer inflorescences and larger flowers, and are later-flowering than in subsp. asprella, can clearly be referred to subsp. celata. Two

collections from somewhat lower elevations in central Butte County are particularly enigmatic [Holt s.n., De Sabla, 2500 feet, August 1935 (CHSC); Schlisling and Lawler 4190, 8 August 1981, N end Concow Reservoir, ca. 2010 feet (CHSC)], but are tentatively placed with subsp. celata. Hitchcock (1957, p. 28) notes the close similarities of subsp. celata to subsp. asprella and adds "There seems to be complete transition between the two". He cites representative collections from near Redding (Shasta County) and near Sisson (Siskiyou County), probably from lower elevations than those of Butte County. He apparently did not see any intermediates, or any subsp. celata from Butte County. It should also be noted that Hitchcock (1957) considers subsp. celata as well as subsp. asprella closely related to the low elevation S. robusta, but maintains them as separate taxa, as is now followed in the keys and descriptions used in this report.

7. SIDALCEA GLAUDESCENS Greene
Glaucous sidalcea

MAP 11

Description Glaucous perennial, with 1 to several, often sprawling stems from a branching, woody base; stems weakly pubescent, but lower stems with small, appressed, stellate hairs only; upper leaves reduced in size and often like simple bracts; flowers well spread out in the inflorescence, usually 12 or fewer per stem.

Like all the perennial checkers in Butte County, this species of dry habitats shows wide variation in size, habit and leaves. The best identifying characters involve the stems, which are relatively slender and sprawling, glaucous, and rather sparsely covered with small, appressed, stellate hairs.

Reproductive biology Flowers latest June to early September.

Distribution and habitat This species occurs in the NE parts of the county, within yellow pine and red fir forests, in dry openings and dry meadows with grasses, lupines and penstemons. All known populations occur above 5000 feet elevation except for plants at the southernmost dot shown on Map 11. Here Sidalcea glaucescens occurs at 4400 feet, near Ramsey Bar on Little Kimshe Creek.

8. SIDALCEA OREGANA (Nutt.) Gray
subsp. SPICATA (Regel) C. L. Hitchc.
[S. spicata (Regel) Greene]
Oregon checker

MAP 12

Description Variable perennial, usually with a clump of several stems from the base; upper stem leaves bractlike, simple, or with only 2 or 3 long, narrow divisions; inflorescence narrow and spikelike, with flowers sometimes densely congested, sometimes widely separated; petals deep pink to rose.

This species has petals of variable length, but they tend to be shorter than petals of our other perennial species. Early in the season in some populations the dense, narrow, spikelike racemes first appear pyramidal, with flowers closely packed. The flowers can remain close together after the inflorescences have elongated. However, some of these smaller-flowered checkers [e.g., Schlisling and Taylor 3835, NE of Butte Meadows, 5 July 1980 (CHSC)] have very elongated racemes, with the flowers well spread out and short-pedicelled.

Reproductive biology Flowers latest June to early September. Large, green anthocerotid flies have been observed visiting flowers near midday at meadows in the Butte Meadows region.

Distribution and habitat This Sidalcea occurs in NE Butte County, within forested regions above 4200 feet elevation. It is consistently found at streamside (often near thickets of Alnus tenuifolia) and in the sod of wet meadows, usually growing with species of Carex and other perennials like Veratrum californicum, Prunella vulgaris and Senecio triangularis. One collection from De Sabla, at 2500 feet [Holt s.n., July 1935 (CHSC)] may be mis-labelled as to location, and is not shown on Map 12.

ANODA CRISTATA (L.) Schlecht. [Anoda cristata (L.) Schlecht. var. digitata (Gray) Hochr.]. Crested anoda. Pubescent annual to 1 m high; leaves narrow-ovate in outline, usually lobed, hastate at base, to 8 cm long; calyx lobes spreading in fruit; flowers in axils, with purplish or bluish petals 2-2.5 cm long; fruit a disk with alternating dark and pale bands, the sections hairy. This introduced weed is native to portions of SW North America outside California (Munz, 1968). It was collected in 1962, in a citrus grove at the end of Olive Avenue, 7 mi E of Oroville [T. C. Fuller 9953 (CAS, CDA)].

MODIOLA CAROLINIANA (L.) G. Don. Wheel mallow. Low, pubescent perennial with spreading stems to 6 dm long; leaves 2-5 cm wide, on slender petioles; flowers solitary in leaf axils, each with 3 small bracts below the calyx; petals obovate, red, 5-8 mm long; fruit a circle of pubescent, kidney-shaped sections, each section with a beak at top of outer edge. Introduced from tropical America (Munz, 1968). This species was reported from Oroville in 1959 by J. T. Howell (personal communication, 1981), and was also collected there in a trailer court on West Oro Dam Blvd. in 1970. [T. J. Heinrichs s.n. (CDA)].

REFERENCES CITED

- Abrams, L. 1951. Illustrated flora of the Pacific States, vol. 3. Stanford University Press, Stanford, Calif.
- Baker, H. G., and I. Baker. 1977. Intraspecific constancy of floral nectar amino acid complements. *Botanical Gazette* 138: 183-191.
- Clement, I. D. 1957. Studies in Sida. Contributions of the Gray Herbarium, Harvard University 180: 3-191.
- Fryxell, P. A. 1974. The North American Malvellas (Malvaceae). *The Southwestern Naturalist* 19: 97-103.
- Hitchcock, C. L. 1957. A study of the perennial species of Sidalcea (Malvaceae). University of Washington Publications in Biology 18: 1-79.
- Kivilaan, A., and R. S. Bandurski. 1981. The one hundred-year period for Dr. Beal's seed viability experiment. *American Journal of Botany* 68: 1290-1292.
- 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.
- Linsley, E. G., J. W. MacSwain, and R. P. Smith. 1952. The bionomics of Diadasia consociata Timberlake and some biological relationships of

emphorine and anthophorine bees. University of California Publications in Entomology 9: 267-281.

Moore, J. G. 1971. A systematic study of the annual species of Sidalcea (Malvaceae). M. A. thesis, California State University, Chico.

Mulligan, G. A., and P. G. Kevan. 1973. Color, brightness, and other floral characteristics attracting insects to the blossoms of some Canadian weeds. Canadian Journal of Botany 51: 1939-1952.

Munz, P. A. 1968. A California flora and supplement. University of California Press, Berkeley.

Nelson, J. R. 1979. The assessment and protection of rare and endangered plants of Butte County, California. M. A. thesis, California State University, Chico.

Parrish, J. A. D., and F. A. Bazzaz. 1979. Difference in pollination niche relationships in early and late successional plant communities. Ecology 60: 597-610.

Roberts, H. A., and J. E. Boddrell. 1984. Seed survival and seasonal emergence of seedlings of some ruderal plants. Journal of Applied Ecology 21: 617-628.

Roush, E. M. F. 1931. A monograph of the genus Sidalcea. Annals of the Missouri Botanical Garden 18: 117-244.

Smith, J. P., Jr., and R. York. 1984. Inventory of rare and endangered vascular plants of California. Special Publication No. 1, 3rd ed., California Native Plant Society, Berkeley, Calif.

