1983

A comparative study of the Allium obtusum comples

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A COMPARATIVE STUDY OF THE *ALLIUM OBTUSUM* COMPLEX

A Thesis

Presented to

the Faculty of the Graduate School

University of the Pacific

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

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May 1983

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Dated 6 May 1983

ACKNOWLEDGMENTS

Much gratitude is expressed to Dr. Dale W. McNeal for suggesting the problem investigated and for his participation and supervision during all phases of this investigation. To Dr. Alice Hunter I am indebted for her reading of the manuscript and her identification of the insects collected during this study. To Dr. Steve Anderson I would like to extend appreciation for his reading of the manuscript and for making valuable suggestions. In addition I would like to extend much gratitude to the following: Dr. Hannah Aase for use of her chromosomal data, Dr. Lee Christianson for aid with the statistical analysis, Dr. Paul Richmond for advice concerning photography, and Dr. Robert Smutney of the Classics department for the Latin diagnosis of A. obtusum var. robustum. Also I would like to thank Tom Hathorn for many helpful suggestions and Mona Nahhas for assistance in the typing of this manuscript.

Lastly I would like to extend greatful acknowledgement to the curators of the herbaria from which material was borrowed during this investigation. These herbaria are indicated below by the standard abbreviations of Holmgren and Keuken (1974).

CAS	California Academy of Sciences
CHSC	Chico State University Herbarium
CPH	University of the Pacific Herbarium
DAV	University of California Herbarium, Davis
DS	Dudley Herbarium, Stanford University
FSC	California State University Herbarium, Fresno
GH	Grey Herbarium, Harvard University
JEPS	Jepson Herbarium, University of California, Berkeley
MO	Missouri Botanical Garden
ND	University of Notre Dame Herbarium
NY	New York Botanical Garden
POM	Pomona College Herbarium
RSA	Rancho Santa Ana Botanic Garden
UC	University of California Herbarium, Berkeley
UCSB	University of California Herbarium, Santa Barbara
US	United States National Herbarium
WS	Marion Ownbey Herbarium, Washington State University

ABSTRACT

The taxa of the *Allium obtusum* complex were examined morphologically, chromosomally, and with the use of the scanning electron microscope. Additional field studies included ultraviolet photography, caging experiments, and collection of insect visitors.

Based on the cumulative information gathered during this investigation, of the 7 taxa previously proposed in this complex, 4 are considered to be valid: *A. cratericola*, *A. obtusum*, *A. tribracteatum*, and *A. yosemitense*. A new variety of *A. obtusum*, var. *robustum* is described.

The base chromosome number among all members of the complex is seven. All species are diploid (2n=14), except for one population of *A. cratericola* which was found to be tetraploid (2n=28).

Scanning electron microscope studies demonstrated the usefulness of outer bulb coat reticulation as a taxonomic character in differentiating between the species of the complex.

Preliminary data collected during field investigations suggest that the strong absorption of ultraviolet radiation by all members of the complex relative to their reflecting soils may act as a visual cue to insects whose visual spectrum includes UV. Furthermore, in mature flow-

ers the sexual parts of the inflorescence were found to be reflective under UV, perhaps acting as a guide to foraging insects.

Caging experiments revealed that all members of the complex are capable of seed set in the absence of insect visitors. It was found, however, that the relative number of seeds produced was significantly higher among control populations.

From the cumulative evidence obtained from these various approaches, supported by morphological resemblances, it can be concluded that the *Allium obtusum* complex represents a distinct and homogeneous assemblage of interrelated species and varieties.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure | Page

INTRODUCTION

The genus *Allium* traditionally has been placed in the family Liliaceae. Hutchinson (1926), moved *Allium* from the Liliaceae to the Amaryllidaceae on the basis of inflorescence type. Cronquist (1968) on the other hand, tentatively reduced the Amaryllidaceae including it within the Liliaceae, doubting the validity of separating the two families on the single character of ovary position. More recently Takhtajan (1980) split *Allium* and a few closely related genera from the Amaryllidaceae and erected the family Alliaceae, which he recognizes as different from the Amaryllidaceae in ovary position. The work of Williams (1975) supports this move and points out that members of Alliaceae are closely related to the Liliaceae but distinct. Differences include the absence of cardiac glycosides and the presence of the odorus allyldisulphides, propy- and vinil-sulfides, and the presence of laticifers, in addition to the differences in inflorescence type.

Allium contains approximately 500 species predominantly of Northern Hemisphere distribution (Stearn, 1946). In North America, the genus is represented by about 70 species (Ownbey and Aase, 1955). More than a thousand specific names have been proposed in the genus, half of which may be synonyms (Saghir et al., 1966). Factors contributing to problems in classification include: the size and wide distribution of the genus, its great diversity of structure, and a lack of adequate material available to prior researchers working in the group.

Of the many possible problem areas within the genus *Allium*, this investigation was restricted to one particular group, that characterized by the species related to *A. obtusum*. Since the last monographic treatment dealing with the *A. obtusum* complex numerous collections have been made of its members. This greatly expanded the material available for studying morphological diversity within this group. As this material has been investigated it has become apparent that some of the characters used in existing treatments are not dependable and often render the keys in these treatments virtually useless. This being the case, the aim of this study was to examine the *A. obtusum* complex so as to delimit its members and devise a workable key to its species and varieties.

Historical Review

Although the literature dealing with *Allium* in the Old World is substantial, comparatively little has been written dealing with the genus in North America. Both Don (1827) and Regal (1875) dealt with those *Allium* species known to them, but many of the members remained unknown until after the extensive botanical exploration of the western United States in the latter part of the nineteenth century (Ownbey and Aase, 1955). The only definitive treatment of the North American species was by Watson (1879), and dates from the middle of this period. As a result, the amount of material available to Watson was inadequate by modern standards; however, most of the 46 species he recognized for North America are still considered valid (Ownbey and Aase, 1955).

After Watson, various new species were proposed and old ones misinterpreted. As a result, much confusion existed as to the number and delimitation of *Allium* in North America. Such a situation resulted from various researchers working with the genus in restricted geographic areas and not paying attention to previous studies in other localities. Perhaps the most illustrative example of this is the work of Jones (1902) which attempted to update the work of Watson. As Ownbey and Aase (1955) point out "Jones's field knowledge of the genus was extensive; but he paid little attention to the mechanics of nomenclature, and of all of the treatments of *Allium* which have appeared in the last seventy years, this is perhaps the most confused." On the other hand, the work of Abrams (1923) is perhaps the most consistent. He recognized 45 species for the three Pacific Coast States, most of which represent valid taxa (Ownbey and Aase, 1955).

Ownbey investigated the North American *Allium* and wrote three papers dealing with the genus in the states of Arizona (1947), Idaho (1950a), and Texas (1950b). More recently he grouped the New World *Allium* into nine well defined alliances based on similarities in morphology.

Ownbey and Aase (1955) provided the first extensive cytotaxonomic survey of one of these alliances, that typified by *Allium canadense*. Following this treatment the composition of volatiles in *Allium* was studied in relation to the taxonomic scheme proposed by Ownbey (Saghir et al., 1966). This investigation supported much of the work done by Ownbey which was based mainly on morphological evidence.

A second alliance, that typified by *Allium falcifolium*, consists of 31 taxa and is the largest alliance proposed by Ownbey. The widespread and variable species *A. tolmiei* from this alliance was investigated by Ownbey (1948) in order to delimit the species and identify its varieties. The only comprehensive study of the alliance was by Mingrone (1968). Despite the fact that Mingrone had available morphologic, cytotaxonomic, and chromatographic evidence, parts of his work are both confusing and inconsistent.

In particular Mingrone's treatment of the *A. obtusum* complex relies upon leaf number (1 or 2) as an important character in separating the species. This has proved unreliable because two of the species, *A. obtusum* and *A. cratericola* have one and two leaved forms, a fact not taken into account by Mingrone. Additionally he annotated several herbarium sheets as one leaved forms of *A. tribracteatum*, a two leaved species, while making no mention of this anywhere in his treatment. And lastly, he accepts Munz's species, *A. jacintense*, which this investigation found fitting quite well into the existing taxon *A. cratericola*.

Geographic Distribution

The *Allium obtusum* complex is restricted to western North America, from southern California north to southern Oregon, and east to western Nevada. Two of the species of this complex are geographically highly restricted: *A. tribracteatum* occurring only in Tuolumne County, California; and *A. yosemitense* only from Madera to Mariposa Counties. Specific information concerning the ranges and habitats of the various taxa are included in the taxonomic treatment.

Species Concept

The question of what constitutes a species has been asked by botanists of every generation. It is a question which appears to have no single answer. Various schools of thought have attempted to produce a universally acceptable definition, and by now the number of botanists holding different views is diminishing. Currently, the most accepted answer to the question "What is a species?" is that a species is the product of each individual's judgement (Lawrence, 1951). This being the case, it becomes important to make one's own statement about how a species is to be delimited after careful appraisal of the characters of the group being studied.

In the present investigation correlated resemblances have been considered as representative of phyletic relationship. As pointed out by Ownbey and Aase (1955) this postulate is sound both genetically and statistically. Genetically, it has been demonstrated that similar characters result from the expression of similar genes, which is indicative of a common genetic background (Sturtevant, 1948). Statistically the probability of similar characters being derived from separate origins is so small that chance may be ruled out for any significant number of correlated characters. Thus it stands to reason that taxa which share a number of correlated morphological characters may safely be considered as related, but the question remains: at what taxonomic level does one distinguish between closely correlated populations?

In so far as this study is concerned a species was considered to represent populations which appear not only morphologically distinct and recognizable in a combination of several characters, but which also share similar environmental situations. Of course, two species should be more or less reproductively isolated. In the case where two morphologically distinct populations were recognized but these were not ecologically or environmentally differentiated, no means of assessing the presence or absence of reproductive isolation was practical, thus warranting a conservative approach in assigning the two populations specific or varietal status.

It should be stressed that the difficulties which are inherent in such taxonomic decisions are further complicated when dealing with the genus Allium. It is a highly diverse and widespread genus whose members typically display considerable morphologic diversity, and as a result many similar characters are shared among related taxa, creating much overlap among its species (Stearn, 1944). This becomes an important consideration when analyzing any morphological evidence within *Allium*. For this reason both morphological and cytological evidence must be considered in relation to ecology and environmental conditions.

TAXONOMIC STUDIES

Materials and Methods

Herbarium Studies

After a preliminary study of the *Allium obtusum* complex had been made, collections of this complex were obtained from most of the larger American herbaria. Using the monographic techniques of Ownbey and Aase (1955), the herbarium specimens were sorted geographically by state, county, and locality, and under each locality collectors were arranged alphabetically. By bringing together these widely dispersed collections, an appreciation of the variation which exists from locality to locality and over time at the same locality was gained.

With the amassing of the above herbarium material the problems and difficulties of nomenclature within the complex were clearly observable. Some of the existing names were based merely on geographical variants which differed only slightly from known and accepted species, thus these names have been reduced to synonymy. One new and previously undescribed variety was discovered and named according to the International Code of Botanical Nomenclature (Stafleu et al., 1978).

Only after the limits of biological variation had been determined, and the fundamental evolutionary lines were delimited without bias, were the nomenclatural types examined. These specimens were then placed into the various groups to provide additional records.

Scanning Electron Microscope Studies

Bulb and seed coats of the members of the *Allium obtusum* complex were examined with the use of the scanning electron microscope. Specimens were collected in northern California (Table 1) during the months of April-June 1982. Seeds were collected at the same time from mature ovaries. Bulbs were unearthed, cleaned, and placed in brown bags to dry for three months before peeling off the outer bulb coat.

Both seed and bulb specimens were mounted on aluminum stubs with a combination of Duco cement and DAG in isopropyl alcohol. Once mounted all samples were sputter coated for three minutes with Gold-Palladium in an Argon enriched vacuum atmosphere of 50 millitorr.

All samples were examined on an ETEC SEM and recorded on Kodak 4127 (4 x 5 in.) commercial sheet film. Scope parameters for all specimens were as follows: 10 KV accelerating voltage, 25mm working distance, 1.5 amp lens current, 45° tilt, and magnification 400X (seeds) and 80X (bulb coats).

Chromosomal Studies

The chromosome numbers of the *Allium obtusum* complex are known from the unpublished work of Dr. Hannah C. Aase and Dr. Dale W. McNeal.

Table 1. Sources of Materials Used in the Field and Laboratory Investigation of the Allium obtusum Complex

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A. cratericola. Calif., Tuolumne Co., hillside e. of Sims Rd., 1.7 mi. s. of Hwy. #120 between Yosemite Jct. and Chinese Camp, April 17, 1982, Mortola 1.

A. obtusum var. obtusum. Calif., Amador Co., above Hwy. #88, 1.0 mi. e. of Lumberyard R.S., June 4, 1982, Mortola 4.

A. obtusum var. robustum. Calif., Amador Co., above Hwy. #88, 1.0 mi. e. of Lumberyard R.S., June 14, 1982, Mortola 5.

A. tribracteatum. Calif., Tuolumne Co., hillside s. of Hwy. #108, 2.3 mi. e. of Long Barn, May 21, 1982, Mortola 3.

A. yosemitense. Calif., Mariposa Co., w. side, s. fork of the Merced River, 5.5 km below Wawona, May 12, 1982, Mortola 2.

Vouchers have been deposited at CPH.

Chromosome counts were usually made during the metaphase or anaphase stages of the first meiotic division of the pollen mother cells. Aceto-carmine (Aase) or aceto-orcein (McNeal) smear techniques were used.

Results and Discussion

The *Allium falcifolium* alliance as proposed by Ownbey (Saghir et al., 1966) contains taxa with one or two leaves per scape. The leaves are flat and linear with the two margins typically of unequal length, thus forming a falcate shape. The scape is often strongly flattened with the leaves and scape usually breaking at the ground level at maturity, resulting in a "tumbleweed" type of seed dispersal.

Members of the *Allium obtusum* complex are distinctive within the *A. falcifolium* alliance. Their leaves have equal or nearly equal margins and hence are not falcate, and their scapes are never flattened but are always terete in cross section. Members of this group have their center of distribution in the Sierra Nevada of California and are geographically distinguishable from other closely related taxa in the *A. falcifolium* alliance.

These related taxa include *Allium burlewii* and *A. hoffmanii* which resemble members of the *A. obtusum* complex in leaf shape but differ in other characters, such as stamen length and width of the perianth segments. These taxa occur in the south and north Coast Ranges of

California respectively. Other closely related taxa include *Allium parvum* which is sympatric with *A. obtusum* but has falcate leaves; and *A. brandegii* from the Colorado Plateau which has similar perianth features to members of the *A. obtusum* complex but has a scape and leaves that are persistent at maturity.

Various morphological characters have been used as taxonomic markers to distinguish species and varieties within the *A. obtusum* complex. Below is a discussion of such characters in light of the findings of this investigation.

Bulb

The presence or absence of cellular patterning (reticulation) on the outer bulb coat and shape of the cells are the most consistent characters available for separating the members of the complex at the species level (Figs. 1-4). It should be pointed out, however, that these characters are of little use when attempting to distinguish between the varieties of *A. obtusum* because of the similarity between the two.

Leaves

The leaves are basal, more or less linear, and deciduous at ground level at maturity. Leaf number varies from one (*A. obtusum* var. *robustum*), to two (*A. tribracteatum* and *A. yosemitense*), or both one and two (*A. obtusum* var. *obtusum* and *A. cratericola*).

Fig. 1

Fig. 2

Fig. 3

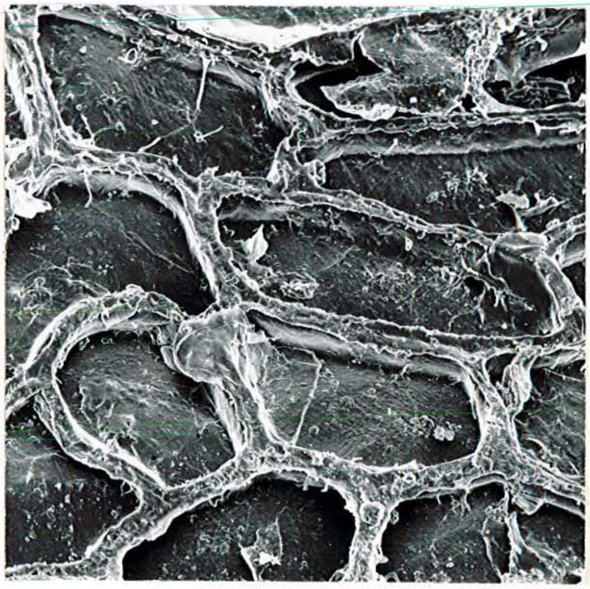

Fig. 4

It is leaf number which was used by previous researchers (Ownbey, 1959 and Mingrone, 1968) to separate *A. tribracteatum* from *A. obtusum* and *A. cratericola* from *A. yosemitense*. Their failure to recognize both one and two leaved forms of *A. obtusum* and *A. cratericola* in their keys led to the problems in distinguishing between the members of this complex.

Inflorescence

The bracts of the inflorescence are variously shaped but generally are ovate and obtuse to acute, or apiculate. Bract number varies from 2-6 per umbel, although there are typically 2-3. Both bract shape and number have been used by Ownbey and Mingrone as characters to separate members of this group. It was found, however, that such a distinction was not representative of differences between species rather the character is more closely related to umbel size (ie. flower number).

Flowers

Perianth segments are variable in shape throughout the complex, but fairly consistent within species, proving to be an important taxonomic character. Pedicel length, especially in comparison with perianth length, can also be used to differentiate between species, but only when other characters are also taken into consideration.

Stamens

The length of stamens in relation to perianth and style length appears consistent in nearly all species. Color of the anthers varies, from yellow to more typically purplish.

Ovary

The ovary is trilocular with axile placentation. Ovarian crests are present on all species of the complex, but are well developed only in A. *cratericola*.

The style is included in all species with the exception of A. *yosemitense* which characteristically displays an exserted style.

SEM

Fine morphological detail of the outer bulb coat (Figs. 1-4) and outer seed coat (Figs. 5-8) are revealed by the scanning electron microscope. The characteristic reticulation of the outer bulb coat of all four species of the complex is distinctive. A. *cratericola* typically displays no evidence of cellular patterning (Fig. 1); while A. *yosemitense* has only an occasional and obscure reticulation (Fig. 2). On the other hand, A. *tribracteatum* displays an irregular reticulation which is transversely compressed and often warped (Fig. 3). In contrast, the bulb reticulation of A. *obtusum* consistently appears oval to somewhat rectangular (Fig. 4). Thus it was found that outer bulb coat reticulation consistently varies among the

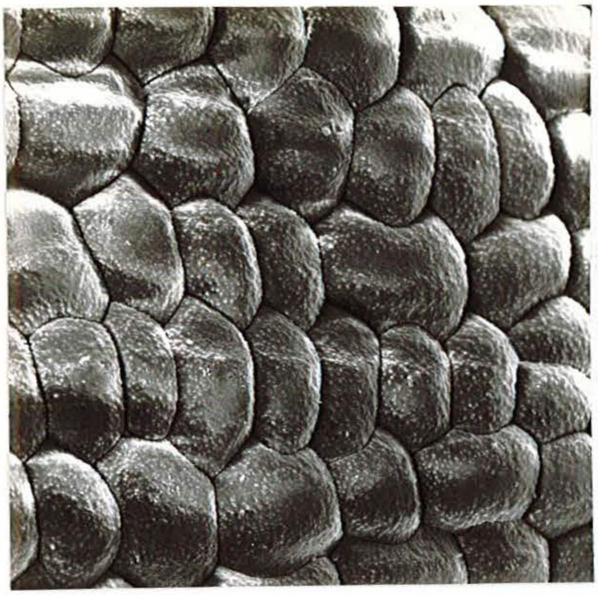

Fig. 5

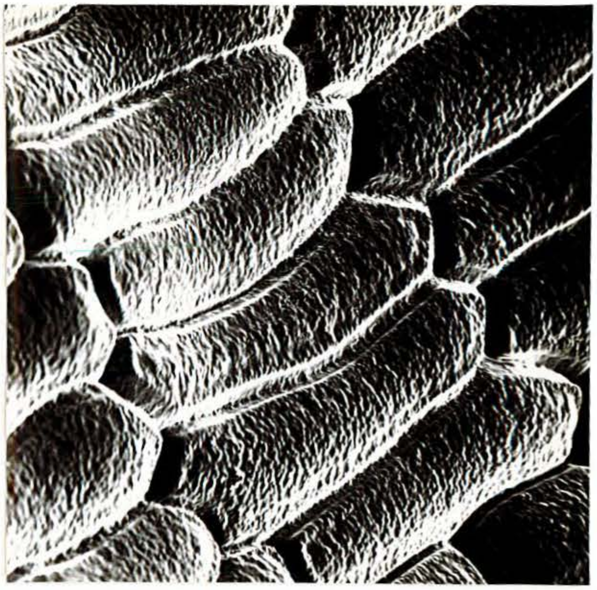

Fig. 6

Fig. 7

Fig. 8

species of the *A. obtusum* complex and is a valuable taxonomic character for the group.

The cellular pattern of the seed coat is typically oblong hexagonal for all members of the complex. Since no consistent differences are observed amoung seed coats they are of little value as taxonomic markers. However, the obvious similarity in seed cell shape may be interpreted as representative of phyletic relationship.

Chromosome Number

The base chromosome number is seven among all members of the complex (Table 2). All species are typically diploid (2n=14) with the exception of one population of *A. cratericola* from Table Mt., Butte Co., California, which is tetraploid (2n=28).

Chromosome numbers may be of taxonomic value, but this is only true when such evidence is supported by other independant approaches (Ownbey and Aase, 1955). On this conservative basis it was decided not to recognize the tetraploid population of *A. cratericola* at the specific or varietal level because of the lack of supportive evidence for such a separation from other areas of this investigation.

Table 2. Chromosome Numbers in the Allium obtusum Complex

Taxon	n	Collection
A. cratericola	14*	Table Mt., 6.2 mi. n. of Oroville-Chico Hwy., Butte Co., March 19, 1951, Hoffman 3771 (UC, WS).
	14	Table Mt., w. of Cherokee Rd., 6.1 mi. s. of Hwy. #70 at the Cherokee exit, Butte Co., April 1, 1977, McNeal 2011 (CPH).
	7*	Bear Valley, Colusa Co., March 19, 1961, Mann s.n. (DAV).
	7*	Bear Valley, Colusa Co., April 2, 1961, Mann & Mann s.n. (DAV).
	7	2.8 mi. n. of Hwy. #140 on Hwy. #49, Mariposa Co., April 17, 1970, McNeal 491 (CPH).
	7*	Slope s. of Peanut, Trinity Co., May 18, 1954, Barnaby 11554 (RSA, WS).
	7	Hillside e. of Sims Rd., 1.7 mi. s. of Hwy. #120 between Yosemite jct. and Chinese Camp, Tuolumne Co., April 19, 1973, McNeal 1278 (CPH).
A. obtusum var. obtusum	7	Ridgetop above Hwy. #88, 1.0 mi. e. of Lumberyard R.S., Amador Co., June 23, 1975, McNeal 1813 (CPH, NY).
	7*	Siberian Pass Creek, Tulare Co., July 25, 1949, Munz 14209 (RSA, WS).
	7*	Ridge w. of Strawberry Lake (now Pinecrest Lake), Tuolumne Co., June 30, 1946, Ownbey & Ownbey 2936 (WS).

Table 2. Continued

Taxon	n	Collection
A. obtusum var. obtusum	7*	Southwest of Strawberry Lake (now Pinecrest Lake), Tuolumne Co., June 30, 1946, Ownbey & Ownbey 2964 (WS).
A. obtusum var. robustum	7	Ridge above Hwy. #88, 1.0 mi. e. of Lumberyard R.S., Amador Co., June 23, 1975, McNeal 1814 (CPH, NY).
	7*	Ridge before Little Butte Creek on Rd. from Magalia to Lovelock, Butte Co., May 1, 1951, Hoffman 3773 (WS).
A. tribracteatum	7*	Between Long Barn and Pinecrest, Tuolumne Co., May 23, 1953, Howell 29006 (CAS, DAV, RSA, WS).
	7	Hillside just s. of Hwy. #108, 2.3 mi. e. of Long Barn, Tuolumne Co., McNeal 1902 (CPH).
A. yosemitense	7	Slope ca. 1/2 mi. n. of Signal Peak Lookout and 1/3 of the way down the s.w. slope of the ridge, Mariposa Co., May 25, 1976, McNeal 1913 (CPH, NY).
	7*	0.5 mi. n. of Signal Peak Lookout, Chowchilla Mts., Mariposa Co., June 17, 1951, Quick s.n. (CAS).

* Indicates previously unpublished counts by Dr. Hannah C. Aase

POLLINATION STUDIES

Materials and Methods

Field Photography

Flowers from five populations representing the various species of the *Allium obtusum* complex were recorded in the field (Table 1) using ultraviolet, normal black and white, and color photography. In each case a single lens reflex camera (Nikon F2SB) equiped with a Nikkor 55 mm micro lens was used.

For the ultraviolet photography a Wratten 18A filter was utilized to transmit only longwave ultraviolet radiation (300-400 nm); while a Kodak grey scale was used to permit calibration of the exposure times as advocated by Keevan (1979). Film type was Kodak Panatomic X (ISO 32). Because of the long exposure times needed the camera was mounted on a tripod.

Normal black and white photography utilized the same equipment and film lacking only the filter and grey scale.

All color photographs were taken on Kodak Kodachrome slide film (ISO 64) with the same equipment used for the normal black and white photographs.

Caging Experiments

In order to determine the relative importance of insect visitors to seed production, cages were placed over unopened umbels to prevent insects from visiting these umbels for the duration of the flowering period. Cages were constructed by modifying tomato cages and covering the frame with a 0.5 mm white nylon mesh material (Fig. 9). A representative population of each member of the *Allium obtusum* complex was caged (except for A. tribracteatum) at the times and places listed in Table 1.

After fruit maturation, the caged umbels were collected along with an equal number of uncaged umbels from as near to the cages as possible. All flowers were immediately dissected and the number of seeds produced per flower and the number of flowers per umbel were recorded.

Pollinators

Insect visitors to each of the members of the *Allium obtusum* complex were collected at the times and places indicated in Table 1. All insects were captured with a net as they visited umbels. Every attempt was made to collect all visitors observed, but inevitably some infrequent visitors were not collected. Once captured, insects were immediately placed into a killing jar containing ethyl acetate. All specimens were placed in containers, labeled, and frozen until identified by Dr. Alice Hunter of the University of the Pacific (Table 3).

Fig. 9. Cages Used During the Field Investigations

Table 3. List of Insect Visitors to Members of the *Allium obtusum* Complex

Species	Specimen Description	Coll. No.	Specimen Name
A. cratericola	Bee	C-1	*Apis mellifera*
	Bumble Bee	C-2	(Bombinae) *Bombus*
	Small Black Beetle	C-3	*
A. obtusum var. *obtusum*	White Moth	O-1	(Pieridae) *Pieris rapae*
	Small Bee	O-2	(Megachilidae)
	Small Bee	O-3	(Halictidae) (Halictinae)
	Fly	O-4	(Syrphidae) *Scaeva*
	Ants	O-5	(Formicidae)
	Fly	O-6	(Bombyliidae) *Bombylius*
	Brown Moths	O-7	(Lycaenidae) *Incisalia eryphon*
	Bumble Bee	O-8	(Bombinae) *Bombus*
	Fly	O-9	(Syrphidae) *Eristalis*
	Honey Bee	O-10	*Apis mellifera*
	Bee	O-11	(Anthophorinae)
	Honey Bee	O-12	*Apis mellifera*

Table 3. Continued

Species	Specimen Description	Coll. No.	Specimen Name
A. obtusum var. *obtusum*	Bee	O-13	(Anthophoridae) (Nomadinae)
	Fly	O-14	(Sarcophagidae)
	Black Fly	O-15	(Megachilidae) (Megachilinae)
	Fly	O-16	(Andreninae)
	Orange Beetle	O-17	(Alleculidae) *Mycetochara*
	Fly	O-18	(Megachilidae)
	Bumble Bee	O-19	(Bombinae) *Bombus*
	Wasp	O-20	(Halictinae)
A. obtusum var. *robustum*	Bumble Bee	R-1	(Bombinae) *Bombus*
	Brown Moth	R-2	(Lycaenidae) *Incisalia eryphon*
	Small Fly	R-3	(Syrphidae) (Nansigaster)
	Bee	R-4	*
	Wasp	R-5	(Andrenidae)
	Honey Bee	R-6	*Apis mellifera*
A. tribracteatum	Fly	T-1	(Anthophoridae) (Nomadinae)

Table 3. Continued

Species	Specimen Description	Coll. No.	Specimen Name
A. tribracteatum	Bee	T-2	(Colletidae) (Hylaeinae)
	Black Fly	T-3	*
	Honey Bee	T-4	*Apis mellifera*
	Small Fly	T-5	(Ephydridae)
	Small Bee	T-6	(Halictinae)
	Orange Beetle	T-7	*
A. yosemitense	Fly	Y-1	(Syrphidae) *Eristalis*
	Bumble Bee	Y-2	(Bombinae) *Bombus*
	Red Mites	Y-3	*
	Small Black Beetle	Y-4	(Alleculidae)

See Table 1 for list of collection localities and dates.
* Not identified.

Results and Discussion

Preliminary studies were conducted to identify any visual cues which might be utilized by insect visitors. When observed under visible light there is a marked lack of contrast between the onions and the soils on which they occur (Fig. 10). However, when photographed selectively under UV, the perianth segments of all members of the complex strongly and uniformly absorb UV in comparison to their reflecting soils, thus appearing dark against a bright background (Fig. 11). While the degree of contrast varied among the onions and their soils, the general trend of absorptive umbels against a bright background was always evident. Frohlich (1976) pointed out the importance of such situations in serving as visual cues to insects whose vision includes UV.

It has further been found that the mature sexual parts of the inflorescense, pistil and anthers, were reflective under UV. The contrast between the reflective sexual organs within the absorbing background of the perianth segments is quite conspicuous (Fig. 12). Preliminary observations would indicate that only mature pollen and unfertilized ovaries with receptive stigmas are reflective of UV and so may be conveying a visual cue to insect visitors. Such a speculation is also supported by observations of foraging behavior of visiting insects. Despite numerous open flowers being available in an umbel only a few flowers per umbel are visited by insects as they forage. This indicates some means by which insects are able to differentiate between

Fig. 10. Onions and Their Soils Under Visable Light

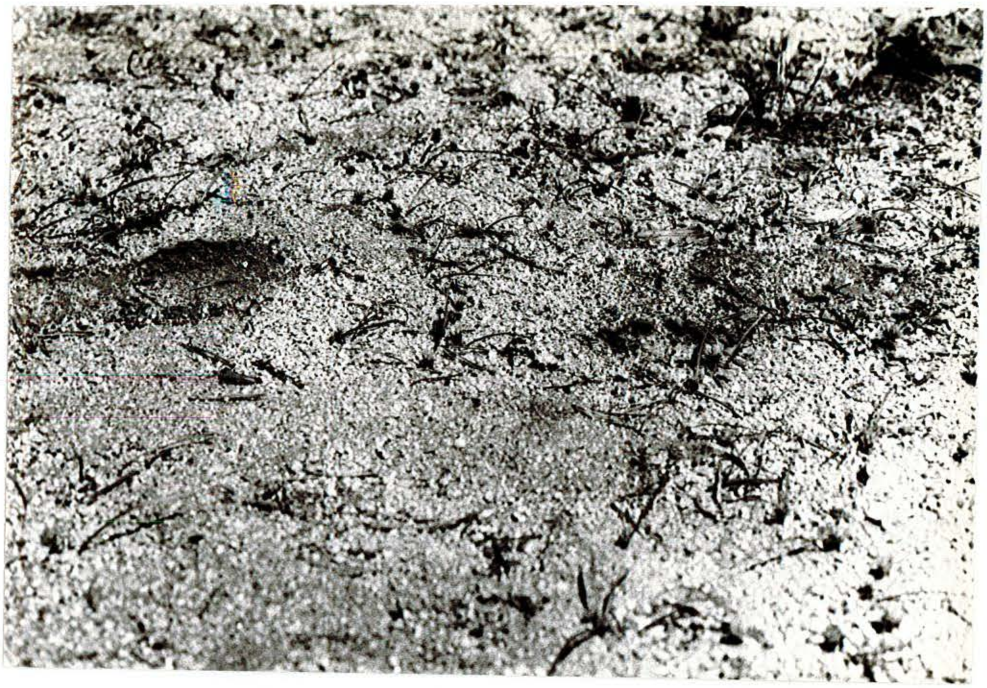

Fig. 11a

Fig. 11b

Fig. 12. Close-up of Onions and their Sexual Parts under UV Light

flowers with nectar and those without.

It was found that seed production occurred in all taxa even when pollinators were excluded (Table 4). This demonstrates that all members of the complex are capable of seed set in the absence of pollinators, but whether this represents self fertilization or wind pollination was not determined because of time limitations. However, comparative length of style and stamens would tend to support the position that these species are self fertile.

Among the control populations (ie. those not caged) a significantly higher level of seed set was observed for all taxa sampled (Table 4). These results demonstrate that pollinators (Fig. 13-16) significantly contribute to seed production for all members of the complex, but are not the only vector for pollen transport to the stigma.

One further trend emerges from the caging results in connection with the insect collections (Table 3). It was found that relatively few species of insects visited both *A. cratericola* and *A. yosemitense* in comparison to the numerous visitors to *A. obtusum* (and *A. tribracteatum*). Likewise a correlation in seed production was found between these two above mentioned groups. Those species with few insect visitors showed a similar low seed production figure; while the two varieties of *A. obtusum* with their numerous visitors were found to have similar, relatively higher rates of seed production. Such results appear to suggest that a correlation exists between the number of different insect visitors and relative amount of seed production. It should

Table 4. Comparative Seed Production Between Caged and Uncaged Members of the *Allium obtusum* Complex

Taxon	Umbel number	Flower number	Number of florets with 0 seed	1 seed	2 seeds	3 seeds	4 seeds	5 seeds	6 seeds	Seeds/flower
A. matericola (caged)	39	911	880	17	11	2	1	0	0	0.054
A. cratericola (uncaged)	42	1025	862	84	51	19	2	2	0	0.255
A. obtusum var. *obtusum* (caged)	10	294	275	10	4	4	1	0	0	0.116
A. obtusum var. *obtusum* (uncaged)	10	188	86	22	40	29	10	0	1	1.229
A. obtusum var. *robustum* (caged)	22	348	282	29	23	12	1	1	0	0.121
A. obtusum var. *robustum* (uncaged)	22	358	146	59	96	56	1	0	0	1.145
A. yosemitense (caged)	37	1390	1220	127	32	11	0	0	0	0.161
A. yosemitense (uncaged)	37	912	763	88	55	6	0	0	0	0.236

Note: all differences between caged and uncaged plants were significant at the 0.05 level.

Fig. 13. *Apis mellifera* Visiting *A. obtusum* var. *obtusum*

Fig. 14. *Incisalia eryphon* Visiting *A. obtusum* var. *obtusum*

Fig. 13

Fig. 14

Fig. 15. *Apis mellifera* Visiting *A*. *cratericola*

Fig. 16. *Apis mellifera* Visiting *A*. *obtusum* var. *robustum*

Fig. 15

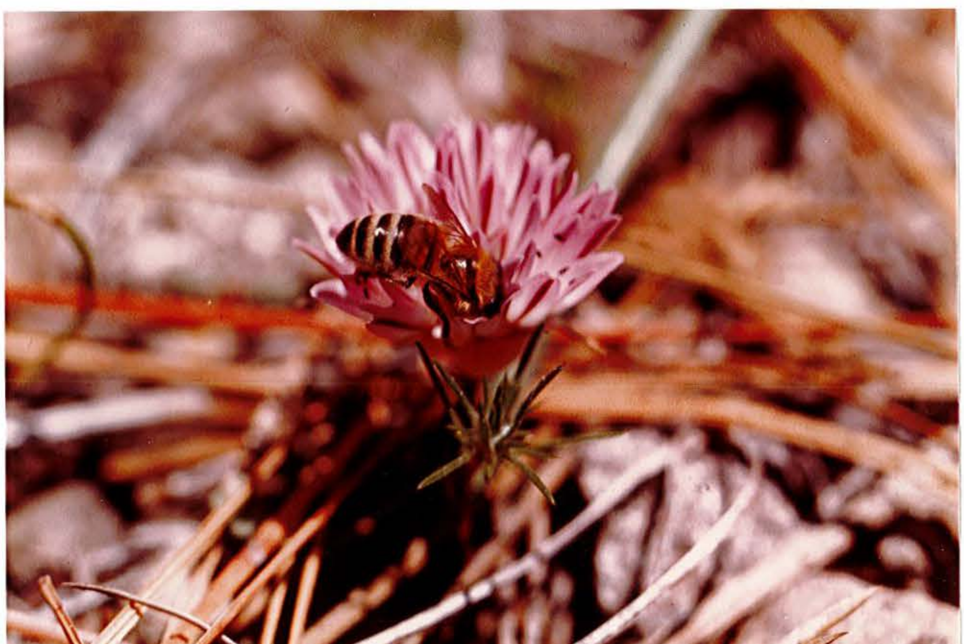

Fig. 16

be pointed out, however, that such a correlation can not be verified without further investigation to determine the flower constancy of each insect and their effectiveness as pollinators.

TAXONOMIC TREATMENT

Key to the Species and Varieties of the *Allium obtusum* complex[1]

1. Outer bulb coat with evident reticulation.

    2. Bulb reticulation transversely oblong and irregular; style shorter than the stamens; ovarian crests not closely surrounding the style; perianth segments pinkish-purplish (rarely whitish); known only from Tuolumne Co., CA. 1. *A. tribracteatum*

    2. Bulb reticulation oval or squarish-rectangular; style equal to or longer than the stamens; ovarian crests closely surrounding the style; perianth segments white to rose-purple.

        3. Umbels small 6(2)-20(32) flowered; perianth segments oblong-elliptic, obtuse (rarely acute), whitish with a prominant dark midrib; leaves narrow 0.5-4(5) mm broad. 2. *A. obtusum* var. *obtusum*

        3. Umbels larger 10(9)-64 flowered; perianth segments lanceolate, acute, pinkish-purple (rarely whitish); leaves broad 2(1)-9(14) mm. 3. *A. obtusum* var. *robustum*

1. Outer bulb coat lacking evident reticulation.

    4. Scape tall 6.2-22.5 cm; pedicels long, 1-3 times the length of the perianth; stamens 9/10-exceeding the perianth segments; crests minute. 4. *A. yosemitense*

    4. Scape shorter 2-12.5 cm; pedicels shorter, 1-1.5 times the perianth; stamens shorter, 1/2-9/10 the length of the perianth segments; crests prominant. 5. *A. cratericola*

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[1]The characters used in the construction of the key are the best that have been discovered for this purpose. Many of these are subject to rather wide variation, therefore it can be used successfully only with considerable understanding of the natural units involved, their distribution and comparison with descriptions and accurately named specimens.

1. Allium tribracteatum Torrey

Allium tribracteatum Torrey in Pacif. Rail. Rep. 4 (Bot): 148. 1857. TYPE: USA, CA, Tuolumne Co., hillsides Duffield's Ranch, Sierra Nevada, May 10, 1853-54, Bigelow s.n. According to Jepson (Fl. Calif., p.276) this locality is east of Sonora, Tuolumne Co., CA. (Holotype: NY, (Fig. 17); Isotype: GH!, US!; photographs of the Holotype: CAS!, WS!).

Bulb ovoid, outer coats brownish, inner coats whitish, both with obvious transversely oblong and irregular reticulations; leaves 2 per scape, flattened, linear, 1-3.5 mm broad, 1.5-3 times as long as the scape, scape 2.1-7 cm tall, more or less terete in cross section, purplish, deciduous with the leaves at the soil line at maturity; bracts of the inflorescence 2-4 (usually 3), ovate, abruptly acuminate, rarely apiculate; pedicels 4-9(16) mm long, 1-2 times as long as the perianth; perianth segments 6.5-8 mm long, lanceolate to more or less elliptic, acute, white to pinkish or purplish with darker midrib, stamens 2/3-9/10 the length of the perianth segments, anthers dark purple, ovary obscurely crested with 3 acute processes not closely surrounding the style, style included, shorter than the stamens, stigma punctate to capitellate (sometimes more or less 3 lobed); capsule obscurely crested with 3 small processes or crestless; seeds black and dull, cells exhibiting a more or less oblong hexagonal patterning. n=7.

The prominant transversely oblong and irregularly arranged bulb reticulation is unique to A. tribracteatum. The placement of ovarian crests at a distance away from the style, and a style which is shorter than the stamens are

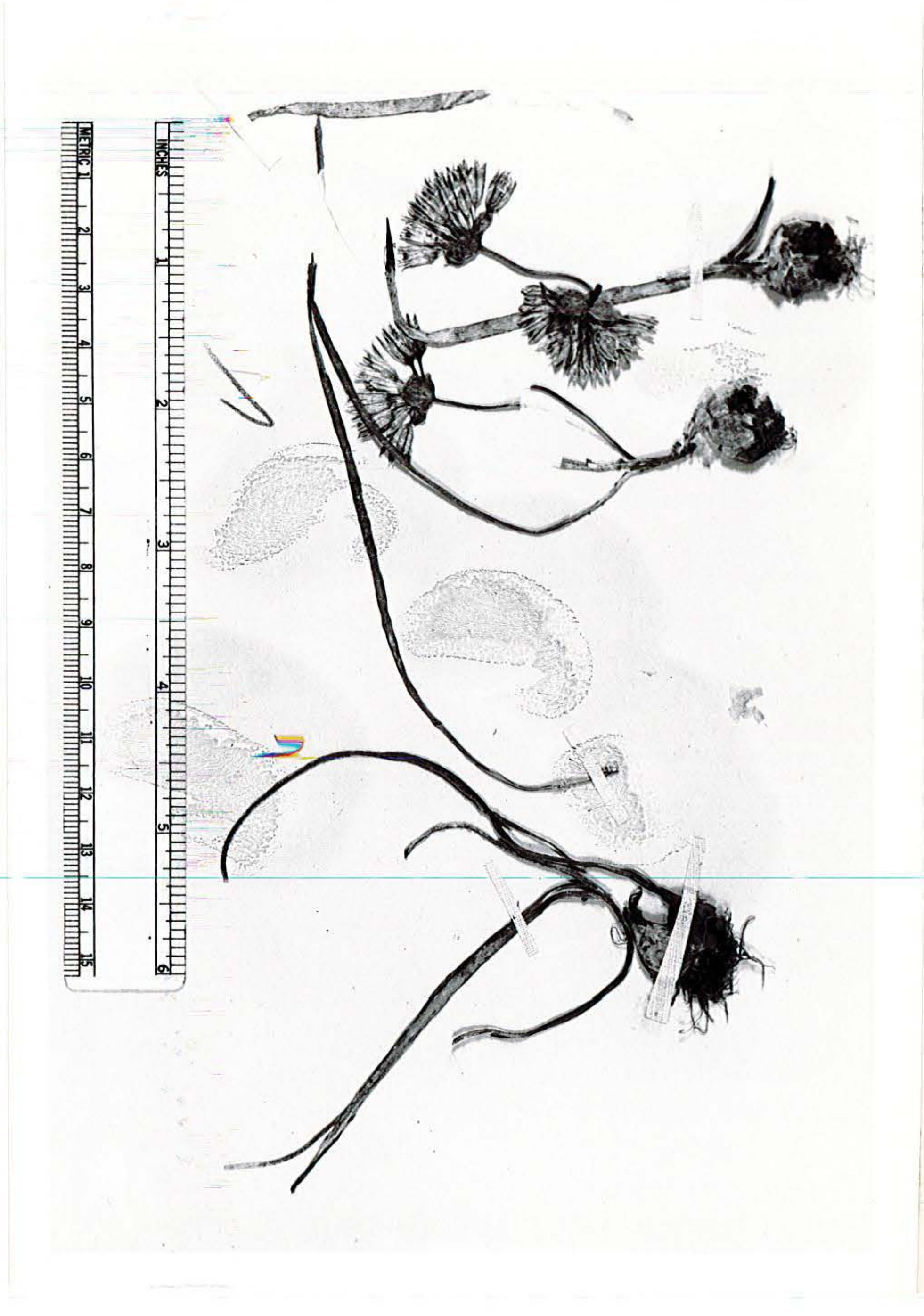

Fig. 17. Holotype of A. tribracteatum

other characters which set A. tribracteatum apart from the closely related A. obtusum. This taxon is geographically restricted to Tuolumne Co., CA.

Illustrations: Abrams, Ill. Fl. Pac. States 1:384. 1923. Fultz, Lily, Iris, and Orchid S. Calif. 15. 1928. (Fig. 18).

Distribution: Barren and rocky volcanic slopes and ridges, 4000-9300 ft., Tuolumne Co., CA, (Fig. 19).

CALIFORNIA. Tuolumne Co.: 1.5 mi. sw. of Confidence, 4000 ft., March 24, 1978, Heckard et al. 4740 (JEPS); Ridge between Long Barn and Pinecrest, 5600 ft., May 23, 1953, Howell 29006 (CAS, DAV, RSA, WS); Bailey Ridge, 9300 ft., July 25, 1938, Mason 12026 (UC); Hillside s. of Hwy. #108, 2.3 mi. e. of Long Barn, May 16, 1971, McNeal 572 (CPH); Hillside s. of Hwy. #108, 2.3 mi. e. of Long Barn, May 5, 1973, McNeal 1311 (CPH); Hillside just s. of Hwy. #108, 2.3 mi. e. of Long Barn, April 30, 1976, McNeal 1902 (CPH); 4 mi. e. of Long Barn on Hwy. #108, June 15, 1967, Mingrone and McNeal 9 (WS); Slope sw. of Strawberry Lake (now Pinecrest Lake), June 30, 1946, Ownbey 2964, grown at Pullman, May 3, 1947 (WS); 4 mi. e. of Long Barn, 5400 ft., May 15, 1955, Wiggins 13422 (DS, UC).

2. Allium obtusum Lemmon var. obtusum

Allium obtusum Lemmon in Green, Pittonia 2:69. 1890.
TYPE: USA, CA, Plumas Co., sub-alpine region of Gold Lake, June 26, 1889, Lemmon s.n.; after a careful search of major U.S. herbaria no extant type collection of Allium obtusum by Lemmon could be found. This leads to the conclusion that the type collection no longer exists. I therefore designate as NEOTYPE: (Fig. 20),

Fig. 18. A. tribracteatum in the Field

Fig. 19. Distribution Map of A. tribracteatum

Fig. 19

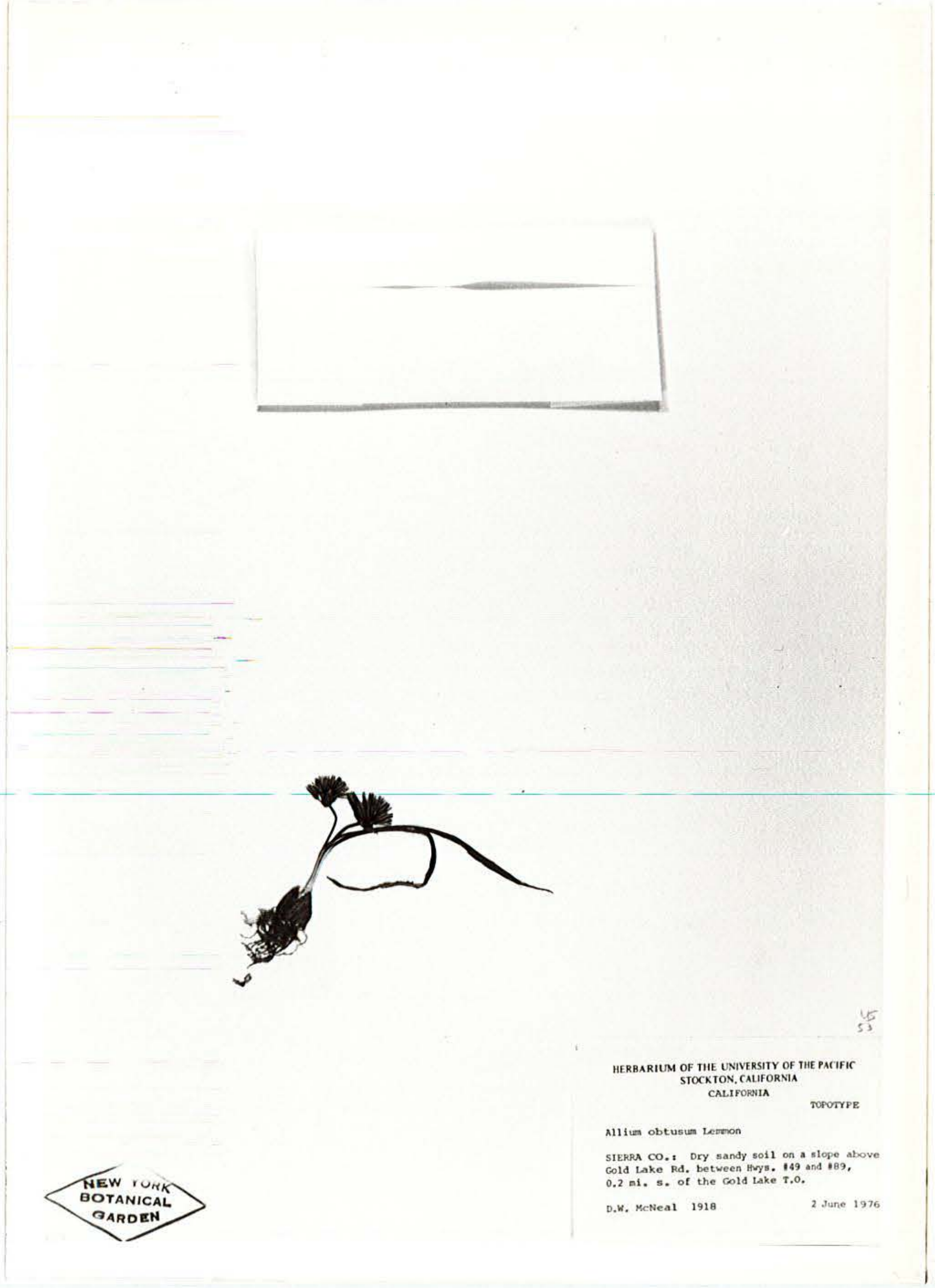

Fig. 20. Neotype of A. obtusum var. obtusum

USA, CA, Sierra Co., above Gold Lake turn off, June 2, 1976, McNeal 1918 (NY!; Isoneotype: CPH!).

Allium ambiguum Jones in Contrib. West. Bot. 10:18, Fig. 35. 1902. TYPE: USA, CA, summit Sierra Nevada Mts., July 26, 1900, Jones 6660 (Holotype: POM!; Isotype: GH!).

Bulb ovoid, outer coats brown, inner coats white, both with evident oval, squarish, or somewhat rectangular reticulation; leaves 1 or 2 per scape, concave-convex, linear, relatively narrow 0.5-4(5) mm broad, 2(1.5)-3(4) times the length of the scape; scape 2(1.4)-6.5(12) cm tall, more or less terete in cross section, purplish, deciduous with the leaves at the soil line at maturity; bracts of the inflorescence 2-3(5), ovate, abruptly acuminate, pedicels 2-7(11) mm long, as long as the perianth; perianth segments 4(3.5)-7(9) mm long, oblong-elliptic, obtuse (rarely lanceolate, acute), white (rarely pinkish), often with a prominant dark midrib, stamens 3/4 (1/2-9/10) the length of the perianth segments, anthers purplish, ovary obscurely to moderately crested with 3 acute or obtuse processes closely surrounding the style, styles included, equal to or longer than the stamens, stigma punctiform to capitellate (sometimes more or less 3 lobed); capsule obscurely or moderately crested with 3 acute or obtuse processes; seeds black and dull, cells exhibiting a more or less oblong hexagonal patterning. n=7.

This taxon comprises a morphologically diverse group which is widely distributed throughout the Sierra Nevada generally at high elevations. The outer bulb coat reticulation is similar to that of the closely related taxon *A. obtusum* var. *robustum* but the plants are smaller in stature, the scape and pedicels being shorter, flowers fewer, leaves narrower, and the perianth segments differently shaped, typically being oblong and obtuse.

Several populations examined exemplified characters not typical of this taxon and are worth mention. A collection from Mt. Tallac, El Dorado Co., CA, Eastwood 1189 (CAS), contained individuals with obvious reticulation on the ovarian wall. Several individuals collected near Swede Lake, Fresno Co., CA, Bacigalupi and Quibell 7430 (FSC), possessed obvious appendages at the apex of the stamens. And lastly, collections from Table Rock, Jackson Co., Oregon, Howell 654 (GH, ND) and Wagner 2012 (CPH), contain individuals with unusually prominant crests, acute perianth segments, and obscure outer bulb coat reticulation.

Though the above collections show one or more unique features they are obviously closely related to *A. obtusum* var. *obtusum* in all other morphological characters. Since the genetic bases for these unusual characters is unknown they are treated conservatively recognizing the many points of resemblence rather than the few differences that have been noted.

Illustration: Abrams, Ill. Fl. Pac. States 1:388. 1923. (Fig. 21).

Distribution: Sandy, rocky slopes from 3274-11350 ft., north from Tulare Co., throughout the Sierra Nevada to Siskiyou Co., California up to Jackson Co., Oregon, and easterly to Washoe Co., Nevada (Fig. 22).

Fig. 21. A. obtusum var. obtusum in the Field

Fig. 22. Distribution Map of _A_. _obtusum_ var. _obtusum_

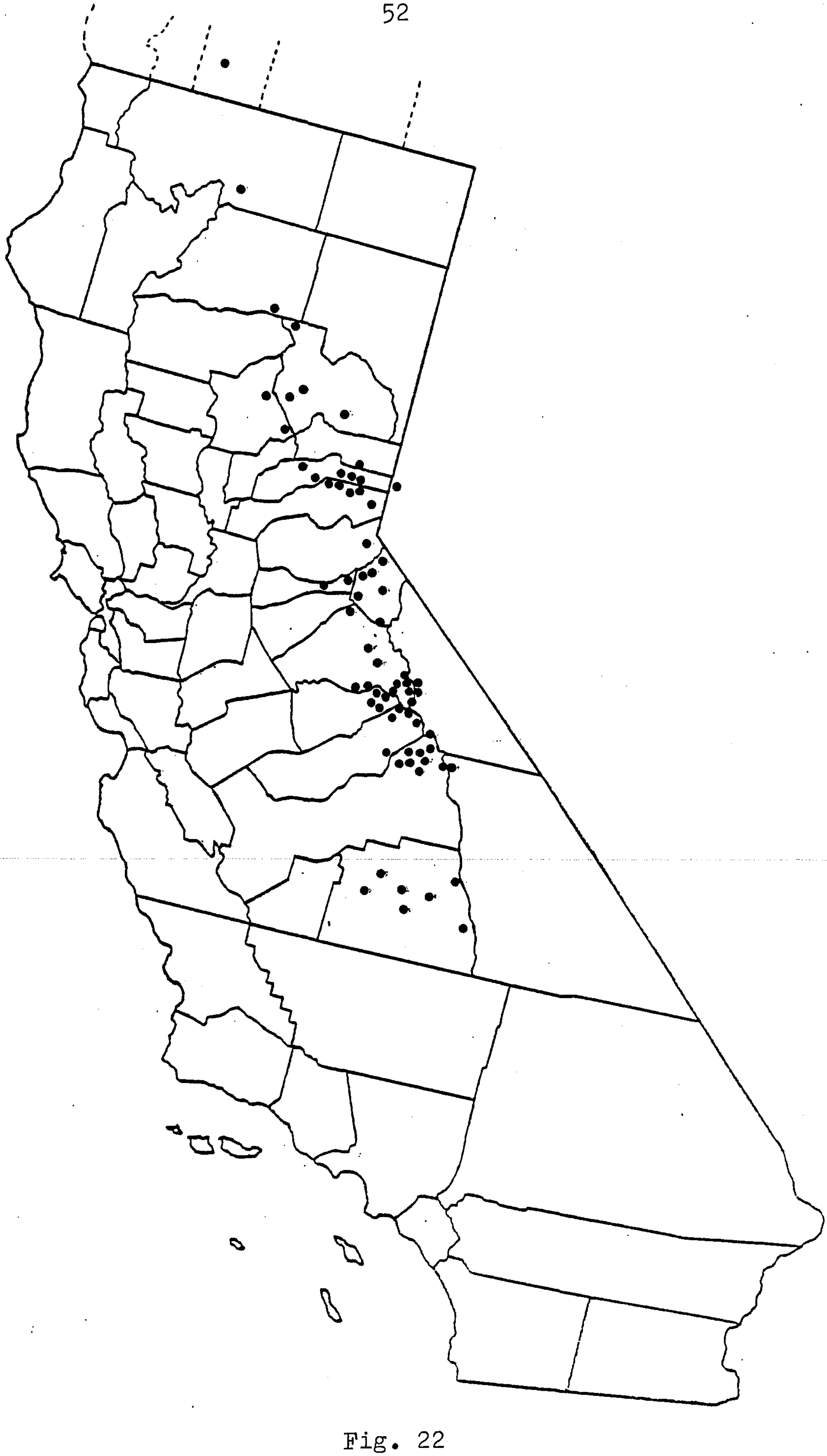

Fig. 22

OREGON. JACKSON CO.: Table Rock, Rogue River Valley, April 16, 1887, Howell 654 (GH); On Table Rock, April 18, 1887, Howell s.n. (ND); Top of Upper Table Rock, April 23, 1978, Wagner 2012 (CPH); Top of Upper Table Rock, April 26, 1981, Wagner 2012A (CPH).

NEVADA. WASHOE CO.: Stream bank on trail to Mt. Rose through Tahoe Meadows, 8600 ft., June 2, 1939, Henrichs 505 (NY); Near Mt. Rose, 8500-10500 ft., August 4, 1938, Howell s.n. (CAS, UC).

CALIFORNIA. ALPINE CO.: Hillsides s. slope, Lake Alpine, June 21, 1935, Allen 505 (UC); West slope of hill, Ebbett's Pass, 8730 ft., August 8, 1963, Armstrong 93 (FSC); Carson Pass, June 17, 1940, Eastwood and Howell 8460 (CAS); Tamarack, ca. 1-2 mi. w. of Ebbett Pass Rd., June 24, 1956, Gankin 188 (DAV); South slope of Bald Peak, June 29, 1936, Hoover 1430 (UC); Beside Hwy. #4 at Ebbett's Pass, 8700 ft., June 23, 1979, McNeal 2262 (CPH, NY); Summit of Carson Pass, 8600 ft., June 17, 1940, Rose 40624 (MO); South facing slope 1-2 mi. e. of Thimble Peak, 9500 ft., June 9, 1974, Taylor 3679 (DAV); 3/4 mi. nne. of Emigrant Lake, 8600 ft., June 16, 1974, Taylor 3872 (DAV); West slope, base of Jeff Davis Peak near border of Ruffian Flat, 8100 ft., June 30, 1974, Taylor 4027 (DAV). AMADOR CO.: Peddler Hill, 3 mi. ne. of Lumberyard, 8700 ft., June 13, 1937, Crum 1929 (UC, US, WS); Northwest side of Silver Lake, June 20, 1956, Gankin 169 (DAV); Peddler, 7000 ft., 1894, Hansen s.n. (UC); Above Hwy. #88, 1 mi. e. of Lumberyard R.S., June 16, 1973, McNeal 1315 (CPH);

Ridgetop above Hwy. #88, 1 mi. e. of Lumberyard R.S., McNeal 1813 (CPH, NY); Below Hwy. #88, 4.9 mi. sw. of the Silver Lake Dam, June 10, 1979, McNeal 2243 (CPH, NY); Ridgetop w. of Hwy. #88 (Silver Lake), 8000 ft., June 3, 1973, Taylor 2365 (DAV). BUTTE CO.: Lumpkin Ridge, ne. of Camp 18, May 19, 1982, Jokerst and Schlising 1573 (CHSC); Big Bald Rock, ca. 1/4 mi. e. of Lake Madrone, ca. 13 mi. ne. of Oroville, April 24, 1976, Taylor 1072 (CHSC). EL DORADO CO.: Summit between Lucille and Lake of the Woods near Lake Tahoe, July 17, 1904, Baker s.n. (UC); Tamarack Trail, Lake Tahoe region, July 27, 1923, Blasdale s.n. (UC); Mt. Tallac, July 21-August 15, 1906, Eastwood 1189 (CAS); Fallen Leaf, Gilmore Lake, June 30, 1920, Ehlers 692 (UC); Trail between Eagle Lake and the Velma Lakes, Lake Tahoe region, June 28, 1925, Howell 1241 (CAS); Above Hwy. #50, 4.4 mi. w. of Echo Summit, May 27, 1975, McNeal 1614 (CPH, NY); Echo Lake divide, 8500 ft., July 7, 1925, Peirson s.n. (WS); Desolation Valley trail, 8600-8800 ft., June 21, 1930, Randall s.n. (UC); Trail to Mt. Tallac, July 24, 1907, Reed and Pendleton 1650 (UC); 41 mi. beyond Placerville, April 29, 1928, Robbins s.n. (POM); Shoulder of Mt. Ralson, 8000 ft., July 6-21, 1901, Setchell and Dobie s.n. (UC); On trail from Upper Echo Lake to Desolation Valley, just beyond Haypress Meadows, 8700 ft., July 6, 1964, Smith 2141 (JEPS); Meadow, Lake Gilmore, 8400 ft., July 20, 1972, Smith 3340 (JEPS). FRESNO CO.: Slope above French Fork, July 6, 1933, Bacigalupi and Ferris 2246 (DS, NY); Above Swede Lake between South Lake, Dinkey Lakes region, 9360 ft., August 15, 1958, Bacigalupi and Quibell 6633 (JEPS, WS); Low ridge between South and Swede Lakes, 9450 ft., August 12, 1958, Bacigalupi and Quibell 7430 (FSC); Ridgetop, South Dragon Pass, 11720 ft., August 6, 1978, Burke 705 (DAV); Near summit of Kaiser Peak, Huntington Lake region, July 20, 1935, Everett and Johnson 7504 (WS); Huntington Lake, 7000 ft., July 1920, Ferguson 387 (JEPS); Below Nellie Lake, 8000 ft., July 4, 1917, Grant 1019 (JEPS); North of rd. between Huntington Lake and Mono Hot Springs (Hwy. #168) 1.3 mi. e. of Kaiser Pass, June 22, 1979, McNeal 2253 (CPH, NY); Dinkey Lakes, 1 mi. n. of Three Sisters, 9500 ft., July 13, 1952, Quibell 1010 (NY); Slope above ne. corner of Swede Lake, 9400 ft., July 15, 1952, Quibell 1040 (NY); Slope sw. of Strawberry Lake on n. slope of Red Mt., 9100 ft., August 8, 1952, Quibell 1165 (CAS, NY); Above the nw. shore of Steelhead Lake, 11350 ft., August 6, 1955, Quibell 5395 (FSC); Lake in Red Mt. Basin, 10500 ft., August 10, 1952, Raven 5019 (CAS); Hilgard Branch, Bear Creek, 9800 ft., July 5, 1954, Raven 7209 (CAS); Dinkey Lakes, 14 mi. e. of Camp Ducey, 9500 ft., July 4, 1937, Roth 1049 (FSC); Kaiser Pass, June 8, 1928, Russell 56 (DS); Jackass Meadow, 7500 ft., June 19, 1937, Winblad s.n. (CAS). LASSEN CO.: Lassen Peak, August 1896, Austin 433 (UC); Lassen Peak, June 1914, Valentine s.n. (UC). MADERA CO.: Thousand Island Lake, 9850 ft., July 19, 1917, Clemens s.n. (CAS); Near Garnet Lake, 9700 ft., July 24, 1941, Howell 16431 (CAS); Near Iceberg Lake, 9800 ft., August 12, 1958, Howell 34321 (CAS); Mt. Lyell, 10500 ft., July 16, 1909, Jepson 3332 (JEPS); Ridge above Upper Merced Lake, Yosemite National Park, July 25, 1980, McNeal and Botti 2374 (CPH). MARIPOSA CO.: Gin Flat near Yosemite Valley, June 1964, Ashley s.n. (CAS); Porcupine Flat, August 13, 1907, Eastwood 329 (CAS); Mt. Hoffman, August 14, 1907, Eastwood s.n. (CAS); Top of Chilnualna Falls, 7500 ft., Yosemite National Park, May 27, 1923, Howell 23 (CAS); Sunrise Trail to Merced Lake, 8500 ft., July 7, 1909, Jepson 3166 (JEPS); Summit El Capitan, 7600 ft., July 6, 1911, Jepson 4360 (JEPS); Cathedral Lake, August 5, 1936, Lee 2460 (JEPS); Above trail ca. 0.5 mi. above Chilnualna Falls, Yosemite National Park, May 20, 1980, McNeal 2323 (CPH, NY); Yosemite, May 1922, Michaels s.n. (CAS); Summit El Capitan, 7649 ft., Yosemite National Park, June 21, 1936, Sharsmith 2152 (UC). MONO CO.: South side of Slate Creek Valley, e. of Mt. Conness, 10300 ft., June 30, 1934, Abrams et al. 2869 (UC); Above Mono Lake, 10000 ft., July 6, 1863, Brewer 1799 (US); Slate Creek Valley, between Split Lake and Alpine Lake, 10350 ft., July 29, 1932, Clausen 535 (DS); Bridgeport, July 22, 1936, Hawbecker 18697 (UC); Dana Plateau, August 10, 1944, Howell 20299 (CAS); South end of Saddle Bag Lake, 10100 ft., July 12, 1936, Kirkwood 245 (CAS); Top of Duck Pass, 10900 ft., July 26, 1944, Polland s.n. (CAS); Mt. Donohue, Yosemite National Park, July 23, 1935, Schreiber 2068 (UC). NEVADA CO.: Castle Peak, July 9, 1902, Jones s.n. (CAS, GH); Bank above hwy. near A.S.U.C. Lodge, May 26, 1944, Jorgensen 447 (DS); Ridge above rd. to Graniteville, ca. 6 mi.

e. of North Columbia, 4200 ft., May 9, 1975, McNeal 1598 (CPH); Below rest area on Hwy. #20, 17 mi. e. of the jct. of Hwys. #20 and #49 in Nevada City, May 27, 1975, McNeal 1606 (NY); Andesite Ridge between Andesite Peak and Castle Peak n. of Hwy. #80 at Boreal Ridge of Castle Peak Rd., July 23, 1975, McNeal and True 1842 (CPH); 100 yards sw. of dam at Sterling Lake, June 5, 1959, Neilson 92 (DAV); Andesite Ridge between Castle Pass and Andesite Peak, 7900 ft., July 6, 1972, True and Howell s.n. (CPH). PLACER CO.: Yuba Pass, 6000 ft., June 2, 1936, Balcock and Stebbins 1579 (GH, UC); Summit, June 10, 1898, Eastwood s.n. (NY); Deer Park, Lake Tahoe Region, June 15-19, 1912, Eastwood s.n. (CAS, GH); Five Lakes, Lake Tahoe Region, June 15-19, 1912, Eastwood s.n. (CAS); Seven Lakes (Five Lakes?), Lake Tahoe Region, June 15-19, 1912, Eastwood s.n. (CAS, GH, US); Pyramid Creek, 6250 ft., Placerville Rd., May 28, 1933, Mason s.n. (GH, UC); Rainbow, n. of Crisco, 5700 ft., June 23, 1946, Rose 46207 (GH); 1/2 mi. n. of summit of Snow Mt., s. of Soda Springs, July 25, 1971, Stebbins 8047 (WS); Donner Pass, ca. 80 mi. ne. of Sacramento, 7000-7800 ft., July 21-22, 1956, Thomas and Thomas 6087 (DS). PLUMAS CO.: East of Drakesbad, s. side of Soda Creek, July 4, 1938, Cantelow 2299 (CAS); Along Rd., Spanish Peak, 7000 ft., July 4, 1933, Fritz s.n. (JEPS); North shore Lower Buck's Lake, July 16, 1975, Griggs and Pass 196 (CHSC); Near Blairsden, Feather River Region, July 27, 1921, Head s.n. (CAS, UC). SHASTA CO.: Near Lake Helen, 8500 ft., August 3, 1927, Brues s.n. (GH); South slope of

Diamond Peak, ca. 7400 ft., June 20, 1961, Howell s.n. (CAS); Central to upper portion of trail to summit of Lassen Peak, Lassen National Park, June 23, 1926, Peirson 6839 (RSA); Drakesbad, Lassen National Park, June 1927, Sutliff s.n. (CAS). SIERRA CO.: Lake Independence, Feather River region, 7000 ft., June 17, 1921, Head s.n. (CAS). SISKIYOU CO.: Upper edge of Panther Meadow, sw. of Mt. Shasta, 7500 ft., July 1, 1959, Bacigalupi 7200 (JEPS); Panther Creek Sand Flats, Mt. Shasta, 6500 ft., July 1, 1938, Cooke 11163 (CAS, DS, GH, UC); Panther Creek cascade between the two upper meadows, Mt. Shasta, 7800 ft., July 28, 1941, Cooke 16119 (MO); Along trail from Horse Camp to Wagon Camp, Mt. Shasta, June 17, 1946, Cooke 17501 (WS); Meadows along Squaw Valley Creek, Mt. Shasta, 8000 ft., July 10, 1947, Cooke 17659 (WS). TULARE CO.: Near Mineral King, August 7, 1891, Coville and Furston 1543 (US); Five Lakes Basin, near Long Lake, 10300 ft., July 28, 1943, Ferris and Lorraine 10886 (DS, GH, UC, WS); Alta Peak, ca. 11211 ft., July 1902, Grant s.n. (DS); Little Five Lakes Basin, August 2, 1942, Howell 17593 (CAS); Columbia Lake, 11000 ft., August 7, 1942, Howell 17801 (CAS); Siberian Pass Creek, 11000 ft., July 25, 1949, Howell 25722 (CAS); West side Franklin Pass, 11000 ft., July 18, 1951, Howell 27915 (CAS, NY, WS); Siberian Pass Creek, 11000 ft., July 25, 1949, Munz 14209 (RSA, WS); Ridge n. from Indian Rock toward Kern's Peak, July 3, 1963, Reveal 478 (WS); Ridge between s. and middle forks of Kaweah River, 8000 ft., May 29, 1972, Smith 44 (DAV); Balch Park (Pack Station), 6400 ft., June 7, 1937, Winblad s.n. (CAS). TUOLUMNE CO.: Gaylor Lakes, 10800 ft., August 12, 1944, Howell 20364 (CAS); Tuolumne River near Conness Creek, 8300 ft., July 18, 1909, Jepson 3361 (JEPS); Tuolumne Falls, 8500 ft., Yosemite National Park, July 20, 1911, Jepson 4474 (JEPS); Macomb Ridge, 9400 ft., Yosemite National Park, July 30, 1911, Jepson 4558 (JEPS); Near Gaylor Lakes, vicinity of Tioga Pass, 9500 ft., July 5, 1928, Mason 4878 (UC); White Mt., Mt. Conness Range, July 24, 1936, Mason 11322 (UC); Twin Lakes, 9000 ft., August 1, 1937, Mason 14840 (UC, WS); Slopes of Mahan Peak, 8500 ft., Yosemite National Park, July 25, 1938, Mason 11993 (UC, WS); Above Hwy. #120, 8.1 mi. w. of Siesta Lake, Yosemite National Park, June 27, 1975, McNeal 1817 (CPH, NY); Above Hwy. #120, 3 mi. e. of Siesta Lake, Yosemite National Park, June 27, 1975, McNeal 1818 (CPH, NY); East edge granite dome just n. of Hwy. #120, w. edge of Tuolumne meadows, June 27, 1975, McNeal 1819 (CPH, NY); Ridge w. of Strawberry Lake (now Pinecrest Lake), June 30, 1946, Ownbey 2963 (WS) from bulbs grown at Pullman, Washington, May 3, 1947; Upper Cow Creek, 7250 ft., July 3, 1938, Quick s.n. (CAS); Glaciated benches above Jack Main Canyon, Mahan Peak, 7800 ft., July 25, 1938, Sharsmith 3688 (WS); Dana Fork meadows (upper end Tuolumne meadows), Yosemite National Park, 9800 ft., August 20, 1916, Smiley 855 (GH); Tuolumne Meadows R.S., 8500 ft., June 22, 1958, Smith 561 (CHSC). COUNTY UNDETERMINED: Top of Bear Ridge, Feather River Region, July 25, 1921, Head s.n. (CAS); American River, April 29, 1928, Robbins 963 (DAV).

3. Allium obtusum Lemmon var. robustum Mortola and McNeal, var. nov.

Folium 1, latum, concavo-convexum, 2-9(14) mm latum; Scapo 2.7-11(17.3) cm longo; umbella 9-64 floribus; segments perianthii lanceolatis, acutis, roses-purpureis (raro albus).

TYPE: (Fig. 23), USA, CA, Amador Co., hillside above Hwy. #88, 1.0 mi. e. of Lumberyard R.S., El Dorado National Forest, T.8N, R.15E, Sec. 10, June 16, 1973, McNeal 1316 (NY!).

Bulb ovoid, outer coats brown, inner coats white, both with evident oval, squarish, or somewhat rectangular reticulation; leaves 1 per scape, linear, concave convex, relatively broad 2(1)-9(14) mm, 1-2.5 times the length of the scape; scape 2.7-11(17.3) cm tall, more or less terete in cross section, purplish, deciduous with the leaves at the soil line at maturity; bracts of the inflorescence 2-3(4), ovate, long acuminate-apiculate, pedicels 3-14(20) mm long, 1-2 times the length of the perianth; perianth segments 4-11.5 mm long, lanceolate, acute (rarely elliptic, obtuse), pinkish-purplish (rarely whitish) with darker midrib, stamens 3/5-9/10 the length of the perianth segments, anthers deep purple, ovary obscurely to prominantly crested with 3 acute or obtuse processes closely surrounding the style, styles included, equal to or longer than the stamens, stigma punctiform-capitate (sometimes more or less 3 lobed); capsule obscurely to prominantly crested with 3 acute or obtuse processes; seeds black and dull, cells exhibiting a more or less oblong hexagonal patterning. n=7.

Allium obtusum var. obtusum and the closely related Allium obtusum var. robustum are similar in many superficial characters, most notably outer bulb reticulation.

Fig. 23. Holotype of A. obtusum var. robustum

Characters which separate the former taxon from the latter include the larger size of the scape and umbel, the more numerous flowers, greater bredth of the leaves, and the lanceolate, acute perianth segments.

A notable collection of this taxon comes from Omega Mine Rd., Nevada Co., California, True 7118 (CPH). This collection contains the only two leaved specimen collected, this however may merely amount to an oddity as this collection contained only one specimen. Other collections, McNeal and Smookler 1909 (CPH) and Mott s.n. (CAS), from the same locality showed only single leaved plants.

Illustration: (Fig. 24).

Distribution: Sandy or rocky serpentine or granitic soils from 2600-9200 ft., north from Fresno Co., along the Sierra Nevadas and into north-eastern Butte Co., California (Fig. 25).

CALIFORNIA. ALPINE CO.: West of Kit Carson Pass, 6000 ft., May 30, 1926, Mason 3332 (GH, UC); Above Hwy. #88, 1.8 mi. e. of Capels Lake Resort, June 16, 1973, McNeal 1318 (CPH); Ridge ca. 2 mi. n. of Lake Alpine, 8400 ft., July 25, 1935, Peirson 11590 (UC); Ridge n. of Capels Lake, 8700 ft., June 3, 1972, Taylor 1479 (DAV). AMADOR CO.: No locality, May 1886, Brandegee s.n. (MO); Slope along Hwy. #88, 2.3 mi. e. of Pine Grove, 5400 ft., June 14, 1962, Breedlove 3639 (CAS, DS, WS); Armstrong's Station, 5000 ft., 1895, Hansen 1255 (DS, MO, UC); Above Hwy. #88, 0.3 mi. ne. of Omo Ranch Rd., and 11.4 mi. ne. of Pioneer, May 10, 1973, McNeal 1312 (CPH); Above Hwy. #88, 1.0 mi. e. of Lumberyard R.S.,

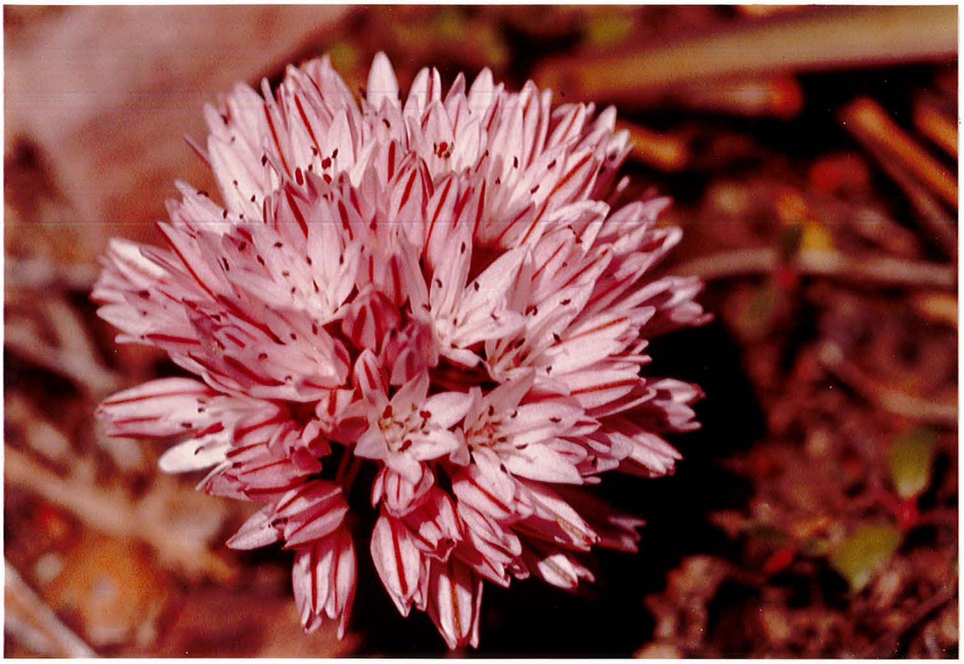

Fig. 24. A. obtusum var. robustum in the Field

Fig. 25. Distribution Map of *A. obtusum* var. *robustum*

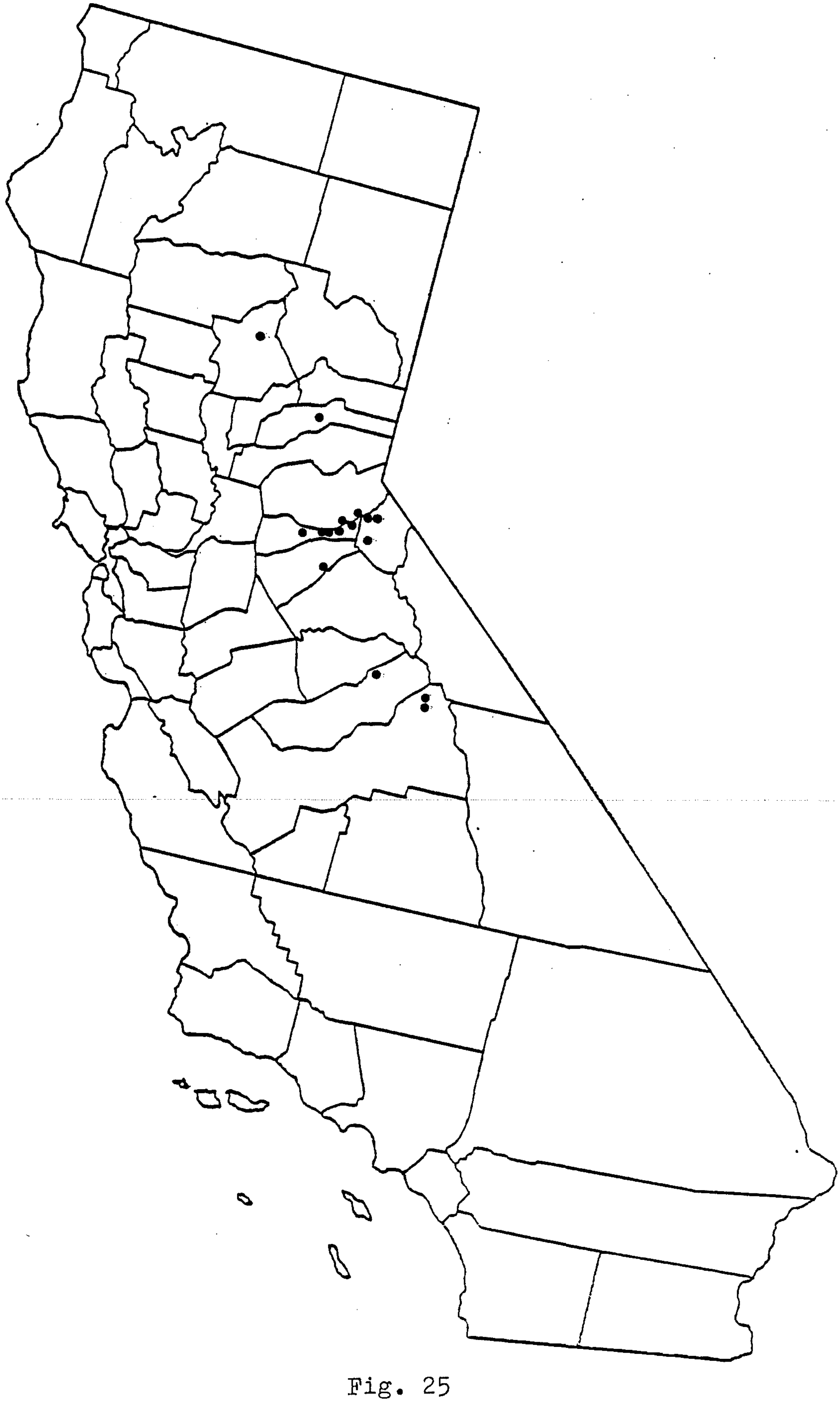

Fig. 25

June 16, 1973, McNeal 1316 (CPH); Ridge above Hwy. #88, 1.0 mi. e. of Lumberyard R.S., June 23, 1975, McNeal 1814 (CPH, NY); Ridge above Hwy. #88, 1.0 mi. e. of Lumberyard R.S., June 10, 1979, McNeal 2242 (CPH, NY); Above Hwy. #88, 2.3 mi. ne. of the Siver Lake Dam, June 10, 1979, McNeal 2244 (CPH); Along stream above Hwy. #88, 2.4 mi. ne. of the Silver Lake Dam, June 10, 1979, McNeal 2245 (CPH, NY); 22 mi. e. of Pine Grove, June 15, 1967, Mingrone and McNeal 12 (DS, GH, NY). BUTTE CO.: Rise between Mosquito Creek and Little Butte (Creek), 2600 ft., May 1, 1951, Hoffman 3773 (WS); Rise between Mosquito Creek and Little Butte Creek, 2600 ft., May 10, 1952, Ownbey and Hoffman 3773 (WS). CALAVERAS CO.: Slope above Dardenells view point on the road to the South Grove, Calaveras Big Trees State Park, May 9, 1976, McNeal 1911 (CPH, NY); Hill above Dardenelle View Trail, Calaveras Big Trees State Park, ca. 5000 ft., May 23, 1953, Raven 5519 (CAS, WS). EL DORADO CO.: Armstrong's Station, 5300 ft., June 14, 1895, Hansen 1255 (US); Above Hwy. #88, 4.0 mi. ne. of Silver Lake turn off, June 16, 1973, McNeal 1317 (CPH). FRESNO CO.: Beside Hwy. #168, 8.8 mi. w. of the extension to Kaiser Pass at Huntington Lake, June 22, 1979, McNeal 2257 (CPH, NY); Flat along Pitman Creek, 3-4 mi. s. of Huntington Lake, 7500 ft., July 5, 1936, Robinson 192 (RSA). MADERA CO.: Marraine Meadows near Givens Creek, ca. 9200 ft., July 7, 1941, Mason 12501 (UC); Ridge above Upper Merced Lake, July 25, 1980, McNeal 2374 (NY). NEVADA CO.: Hillside above s. Fork of the Yuba River ca. 1/2 mi. w. of Washington, May 9, 1975, McNeal 1596 (CPH); Below rest area on Hwy. #20, 17 mi. e. of the jct. of Hwy. #49 e. of Nevada City, May 7, 1976, McNeal and Smookler 1909 (CPH); Slopes in back of Omega Historical Marker, June 2, 1962, Mott s.n. (CAS); South side of s. Yuba River, ca. 1 mi. below Washington, May 5, 1974, Mott s.n. (CAS); North slope Hwy. #20, near Sardine Spring ca. 17 mi. e. of Nevada City, May 12, 1966, True 2803 (CAS); Omega Mine Rd., 16 mi. e. of Nevada City and 1 mi. n. of Hwy. #20, May 2, 1972, True 7118 (CPH). SISKIYOU CO.: Scree near Hwy., May 31, 1951, Vollmer and Beane s.n. (DS). TUOLUMNE CO.: Morrison Creek Trail, 6800 ft., June 25, 1980, Botti 43 (CPH).

4. *Allium yosemitense* Eastwood

Allium yosemitense Eastwood in Leafl. West. Bot. 1:132. 1934. TYPE: (Fig. 26), USA, CA, Mariposa Co., head of Bridal Veil Falls, Yosemite Valley. 1922. Michaels s.n. (Holotype: CAS!; Isotype: GH!).

Bulbs ovoid, outer coats dark brown, inner coats white, both lacking definite reticulation; leaves 2 per scape, flat, linear, 2-18 mm broad, 1-3 times as long as the scape; scape 6-23 cm tall, terete in cross section, reddish-purplish, deciduous with the leaves at the soil line at maturity; bracts of inflorescence 2-4 (usually 3), ovate, acuminate-apiculate; pedicels 7-34 mm long, 1-2 times the perianth length; perianth segments 7-15 mm long, linear-oblong, acute, white to pink or purplish with a darker mid-rib, stamens 9/10 to slightly exceeding the length of the perianth segments, anthers purple; ovary obscurely to moderately crested with 3 2-lobed obtuse processes, styles exserted, stigma capitellate-capitate; capsule crested with

Fig. 26. Holotype of A. yosemitense

3 2-lobed obtuse processes; seeds black and dull, cells exhibiting an oblong hexagonal patterning. n=7.

The large stature and exserted stamens are characters which set A. yosemitense apart from other related taxa. The absence of definite reticulation on both the inner and outer bulb coats and the long spreading pedicels are also features unique to this taxon.

Collections of A. cratericola from the Redhills area, Tuolumne Co., and A. obtusum var. robustum from Nevada Co., approach the size of A. yosemitense, but differ in all other morphological criteria.

Illustration: (Fig. 27).

Distribution: Rocky granitic soil, 2500-7000 ft., Iron Mt., Madera Co., Signal Peak (Devil Peak), Chowchilla Mts. and the southwestern section of Yosemite National Park, Mariposa Co., California (Fig. 28).

CALIFORNIA. MADERA CO.: Iron Mt., May 15, 1981, Botti 101-102 (CPH). MARIPOSA CO.: Head of Bridal Veil Falls, May 18, 1980, Botti s.n. (CAS); Between Pigeon Gulch and Cold Canyon opposite El Portal, ca. 2500 ft., April 12, 1981, Botti s.n. (CPH); Merced River, 5.5 km below Wawona, May 14, 1981, Botti 104 (CPH); Chowchilla Mt., 0.5 mi. n. of Signal Peak Lookout, ca. 6900-7000 ft., May 25, 1976, McNeal 1913 (CPH, NY); Head of Bridal Veil Falls, May 19, 1980, McNeal et al. 2322 (CPH, NY); Between Pigeon Gulch and Cold Canyon opposite El Portal, May 4, 1981, McNeal and Botti 2464 (CPH); Merced River, 5.5 km below Wawona, May 4, 1981, McNeal and Botti 2467 (CPH); Chowchilla Mt.,

Fig. 27. *A. yosemitense* in the Field

Fig. 28. Distribution Map of *A. yosemitense*

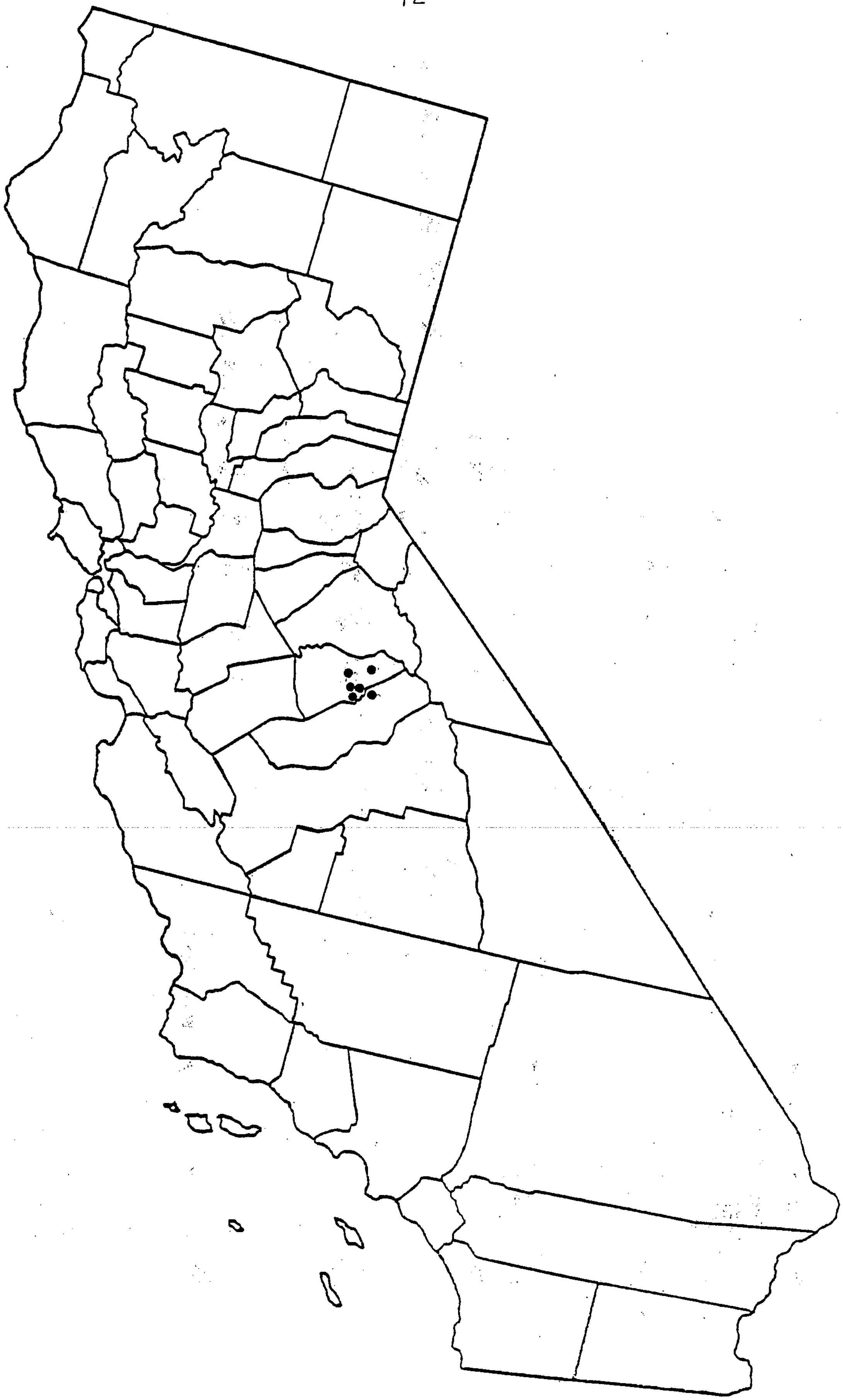

Fig. 28

0.5 mi. n. of Signal Peak Lookout, ca. 6900-7000 ft., June 17, 1951, Quick s.n. (CAS); Chowchilla Mt., 0.5 mi. n. of Signal Peak Lookout, ca. 6900-7000 ft., June 20, 1952, Quick s.n. (CAS).

5. Allium cratericola Eastwood

Allium cratericola Eastwood in Leafl. West Bot. 1:132. 1934. TYPE: (Fig. 29), USA, CA, Napa Co., crater area Mt. St. Helena, May 1, 1918, Eastwood s.n. (Holotype: CAS!; Isotype: DS!, GH!, POM!, US!).

Allium parvum var. brucae Jones in Contrib. West. Bot. 10:12., Fig. 16. 1902. TYPE: USA, CA, Butte Co., Yankee Hill, April 1897, Bruce 1907 (Holotype: POM!; Isotype: US!).

Allium parvum var. jacintense Munz in Man. So. Calif. Bot. 86, 597. 1935. TYPE: USA, CA, Riverside Co., Kenworthy, San Jacinto Mts., 4650 ft., May 21, 1922, Munz and Johnson 5512 (Holotype: POM!; Isotypes: DS!, GH!, POM!, UC!, WS!).

Bulb ovoid, outer coats brownish (sometimes grayish), inner coats white, reticulation lacking or obscure, when present squarish-rectangular; leaves 1 or 2 per scape, flat, more or less linear, relatively broad 1-13(21) mm, 1.5-3(4.5) times as long as the scape, relatively thick; 3.5(2)-9(12.5) cm tall, more or less terete in cross section, purplish, deciduous with the leaves at the soil line at maturity; bracts of the inflorescence 2-4(6) per umbel, ovate, broadly acuminate often apiculate; pedicels relatively stout, 5(3)-18 mm long, 1-1.5 times the length of the perianth; perianth segments 7-14 mm long, lance-oblong, elliptic, or more or less oblanceolate, obtuse (rarely acutish), pinkish-purplish (rarely white) with darker midrib, stamens 1/2-3/4 (equal to) the length of the perianth segments, anthers

Fig. 29. Holotype of A. cratericola

yellowish, ovary moderately to prominantly crested with 3 acute or obtuse processes, styles included, shorter or equal in length to the stamens, stigma capitellate-often capitate (globose); capsule moderately to prominately crested with 3 acute or obtuse processes; seeds black and dull, cells exhibiting a more or less oblong hexagonal pattern. n=7 or 14.

Allium cratericola represents a diverse taxon which is well dispersed throughout California, from as far south as Riverside Co. northerly into Siskiyou Co.. Characteristically A. cratericola occurs at lower elevations than the closely related taxa A. obtusum and A. tribracteatum. The combination of characters which set A. cratericola apart from the aforementioned taxa include: wanting or obscure bulb reticulation, relatively broad and obtuse perianth segments, stout pedicels, prominant ovarian crests, and a style which is typically much shorter than the stamens.

While various characters can be used to distinguish A. cratericola, a number of collections examined contained specimens with notable unique characters. From Table Mt., Butte Co., a population containing the only known tetraploids (2n=28) was found. These were morphologically identical with diploid populations in all characters except for their smallish stature and a style which was longer than the stamens. From the Greenhorn Mts., Kern Co., come collections with uncharacteristically narrow perianth segments and small bulbs. From the San Jacinto Mts., Riverside Co., are collections with lance-oblong perianth segments and leaves which tend to appear somewhat falcate. A collection from Scott Mt., Siskiyou Co., contains specimens with relatively narrow perianth segments, smallish umbels, and short pedicels. This collection may actually be A. obtusum var. robustum, but without the presence of outer bulb coats certain identification is difficult. Also, collections from south of Peanut, Trinity Co., contain specimens with uncharacteristically narrow perianth segments and smallish stature. And lastly, a collection by Bruce 2488 (DS), labled "plains 1899", contains specimens with denticulations on the veins of the leaves, a style which is longer than the stamens, and ovarian walls which are prominantly reticulate.

Despite the fact that the above collections contain one or more anomalous features they are obviously closely related to A. cratericola in all other morphological characters. And since the genetic basis for the above listed anomalies is undetermined, they will be treated conservatively recognizing the numerous points of resemblence rather than the few differences that have been noted.

Illustration: (Fig. 30).

Distribution: Granitic and serpentine soils from 1150-7000 ft., Riverside Co. north to Ventura and Kern Cos., through the foothills of the Sierra Nevada in Mariposa, Tuolumne, and Calaveras Cos., and into the North Coast Ranges of Napa, Lake, Colusa, Glenn, Butte, Trinity, and Siskiyou Counties (Fig. 31).

CALIFORNIA. BUTTE CO.: Foothills, March 1898,

Fig. 30. A. cratericola in the Field

Fig. 31. Distribution Map of *A. cratericola*

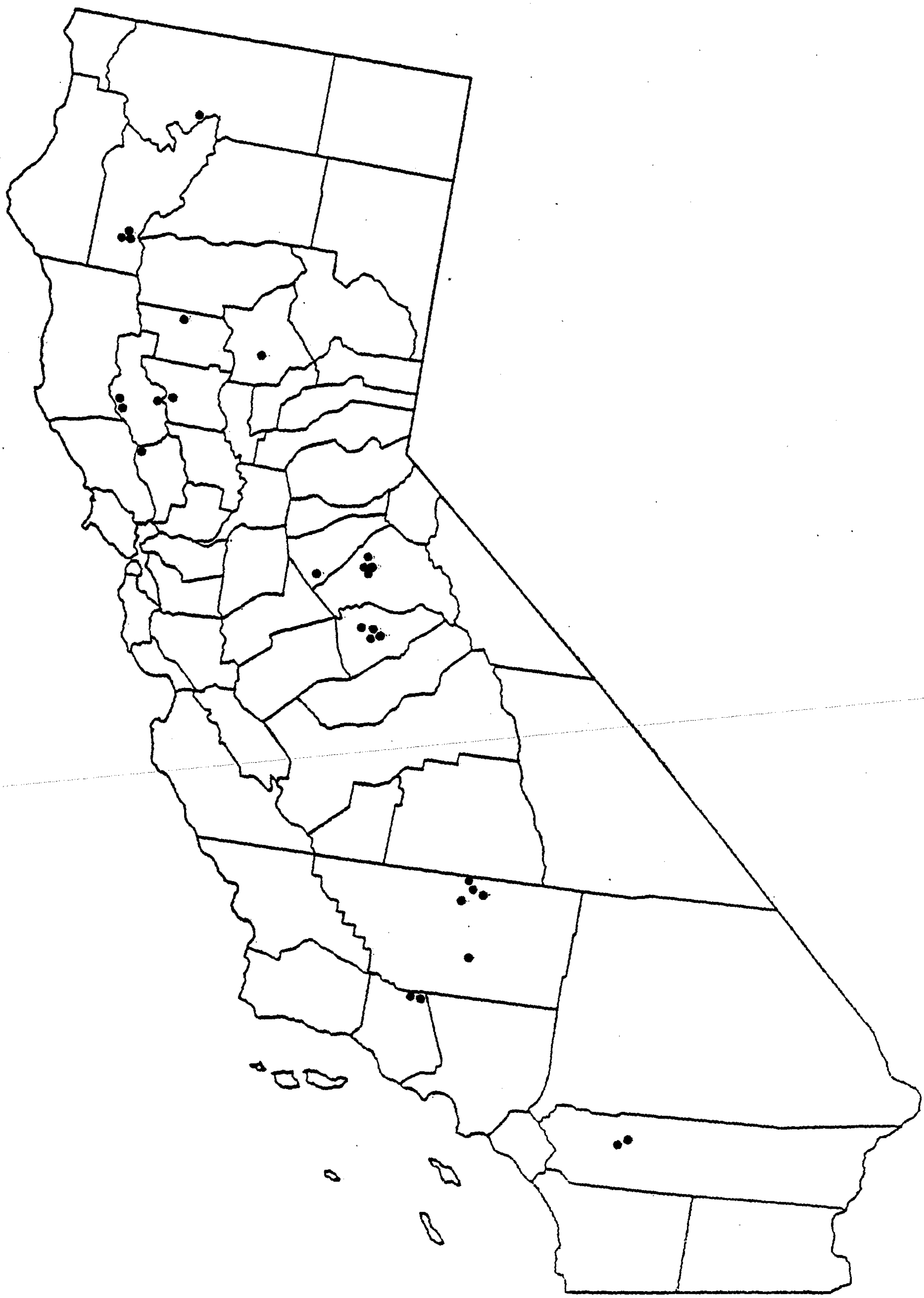

Fig. 31

Bruce 1901 (NY); No locality, 1899, Bruce s.n. (DS); Table Top grassland, March 28, 1966, Dutton 152 (CHSC); Table Mt., March 28, 1966, Francis 89 (CHSC); Table Mt., Cherokee Rd. n. of Oroville, March 28, 1966, Gregg 58 and 59 (CHSC); Summit of Table Mt., April 3, 1938, Heller 15012 (DS, JEPS, MO, NY, POM, RSA, UC, US, WS); Table Mt., 6.2 mi. n. of Oroville-Chico Hwy., March 19, 1951, Hoffman 3771 (UC, WS); Table Mt., near Oroville, ca. 1500 ft., March 1941, Holt s.n. (CHSC); Table Mt., e. of Chico near Cherokee, April 12, 1959, Mann s.n. (WS); Table Mt., e. of Chico, April 4, 1956, McClintock s.n. (CAS); Table Mt., Cherokee Rd., 6.0 mi. s. of Hwy. #70, April 24, 1974, McNeal 1428 (CPH); Table Mt., w. of Cherokee Rd., 6.1 mi. s. of Hwy. #70, April 1, 1977, McNeal 2011 (CPH); Table Mt., Cherokee Rd., 7 mi. s. of Hwy. #70, 5 mi. s. of Cherokee, 1250 ft., April 20, 1975, Snider s.n. (CHSC); Table Mt., ca. 1/4 mi. w. of Cherokee Rd., ca. 1.5 mi. s. of Cherokee, April 21, 1973, Taylor 15 (CHSC); Table Mt., 4 mi. s. of Cherokee, 3000 ft., March 27, 1961, Vincent 2 (DAV). CALAVERAS CO.: Salt Springs Rd., 4.2 mi. w. of Copperopolis, 1150 ft., March 23, 1973, Stebbins 73016 (FSC). COLUSA CO.: Bear Valley, 1300 ft., March 19, 1961, Mann s.n. (DAV); Bear Valley, 1300 ft., April 2, 1961, Mann s.n. (DAV, WS). GLENN CO.: Ridge w. of Red Mt., 3300 ft., April 18, 1971, Stebbins 8003 (WS). KERN CO.: Tehachapi, June 1884, Curran s.n. (GH); Tehachapi, May 13, 1913, Eastwood 3238 (CAS, WS); The ne. slope of Black Mt., 6600-7000 ft., July 11, 1962, Howell s.n. (CAS); Tiger Flat Camp, Greenhorn Mts., s.

slope, May 11, 1974, Levin 149 (DAV); Eastern slope Greenhorn Mts., ca. 1 mi. ne. of Evans Flat, 5800 ft., June 11, 1942, Smith 657 (JEPS, WS); Saddle between Cane Peak and Black Mt., 6550 ft., July 23, 1964, Twisselmann 9797 (CAS). LAKE CO.: Foot of grade w. of Lakeport, May 1, 1938, Baker 8950 (CAS); Along Walker Ridge Rd., 3.7 mi. n. of junction with access road to Indian Valley Dam, April 19, 1980, Bartkowski et al. 33 (CHSC); Rocky slope 2.9 mi. w. of Lakeport on road from Hopeland, April 29, 1929, Mason 5241 (UC). MARIPOSA CO.: Mariposa, April and May, 1893, Congdon s.n. (ND); West side Mariposa Valley, April and May, 1893, Congdon s.n. (UC); No locality, April 10 and May 9, 1893, Congdon s.n. (UC); No locality, April 16, and May 10, 1893, Congdon s.n. (UC); No locality, April 1894, Congdon s.n. (UC); West water ditch, April 19, 1896, Congdon s.n. (NY); Slope w. side of Mariposa Valley, May 10 and 17, 1903, Congdon s.n. (GH); Hills, w. side of Mariposa Valley, May 15, 1903, Congdon s.n. (US); West water ditch, Mariposa, April 25, 1904, Congdon s.n. (WS); Mariposa, April 25, 1904, Congdon s.n. (UC); Mt. Bullion, Mariposa, April 25, 1941, Eastwood and Howell 8779 (CAS, GH, US); Rocky wash, 2.8 mi. n. of Hwy. #140 on Hwy. #49, April 17, 1970, McNeal 491 (CPH, WS); West of Hwy. #49, 2.8 mi. n. of Hwy. #4 at Mariposa, March 28, 1974, McNeal and Weber 1386 (CPH); 1 mi. nw. of Mt. Bullion, 2100 ft., April 25, 1941, Rose 41188 (MO, NY, UC). NAPA CO.: The Crater, 3 mi. s. of Mt. St. Helena Inn, April 10, 1926, Baker 174 (DS); Mt. St. Helena, June 6, 1915, Eastwood s.n. (CAS); Old Crater, Mt. St.

Helena, May 9, 1923, Eastwood s.n. (CAS); Crater Country, Mt. St. Helena, April 4, 1931, Howell 6168 (CAS); Crater Country, Mt. St. Helena, April 4, 1931, Keck 1090 (DS, POM). RIVERSIDE CO.: Kenworthy, San Jacinto Mts., 4650 ft., May 21, 1922, Munz and Johnston 5512 (DS, GH, JEPS, POM, UC, WS); Small side canyon, e. side of Hemet Valley, 4500 ft., San Jacinto Mts., May 21, 1922, Peirson 3069 (POM, RSA, UC). TRINITY CO.: 0.5 mi. w. of turn off to Peanut and Hayfork from Hwy. #36, May 12, 1952, Balls and Lenz 17209 (RSA, NY); Slope s. of Peanut, 2600 ft., May 18, 1954, Barneby 11554 (RSA, WS); 1.2 mi. w. of Peanut, Philpot Campground, 100 yards n. of Plummer Creek Rd., May 12, 1979, Clark 267 (CPH); Along State Route #3 at junction with road to Philpot Campground, May 6, 1978, Nelson and Smith 3984 (CPH); Philpot Campground, 1.2 mi. w. of Peanut, 2500 ft., May 7-8, 1977, Runyon s.n. (CPH). TUOLUMNE CO.: Red Hills above Peoria Flat, 1150 ft., April 11-16, 1919, Ferris 1606 (CAS, DS, NY, US); Creek w. of Table Mt. on Oakdale Sonora Hwy., April 11, 1936, Gregory 1148 (JEPS); East of Sims Rd., 1.7 mi. s. of Hwy. #120, April 19, 1973, McNeal 1278 (CPH); East of Sims Rd., 1.7 mi. s. of Hwy. #120, April 9, 1974, McNeal 1393 (CPH, NY); East of Red-hills Rd., 1.7 mi. s. of Hwy. #120, April 25, 1975, McNeal 1586 (CPH); Redhills Rd., 0.75 mi. e. of junction with La Grange Rd., March 25, 1978, Morey 9 (CHSC); Hilltop, hills w. of Rawhide, April, 1918, Williamson s.n. (DS). VENTURA CO.: Slope 2.0 mi. s. of Lockwood Valley Rd., on Rd. to Thorn Meadows, San Emigdio Range, 5800 ft., May

12, 1962, Breedlove 2737 (DS, WS); West side Frazier Mt., June 3, 1933, Epling and Wheeler 1780 (ND, POM, RSA); Summit Frazier Mt., May 19, 1934, Epling s.n. (RSA).

UNKNOWN: Plains California, 1899, Bruce 2488 (DS).

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