1976

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Recommended Citation

Lenz, Lee W. (1976) "A Biosystematic Study of *Triteleia* (Liliaceae). II. Chromosome Numbers and Karyotypes of the Species of Section *Calliprora*," *Aliso: A Journal of Systematic and Floristic Botany*. Vol. 8: Iss. 4, Article 2.

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A BIOSYSTEMATIC STUDY OF *TRITELEIA* (LILIACEAE).
 II. CHROMOSOME NUMBERS AND KARYOTYPES OF
 THE SPECIES OF SECTION *CALLIPRORA*

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INTRODUCTION

Although one of the most conspicuous spring wildflowers along the foothills of the Sierra Nevada in California, as well as in certain other areas of the state, the 'yellow brodiaeas' have received little attention from cytologists. Working with material received from Carl Purdy, a commercial supplier of California plants, Burbanck (1941) reported the first counts for members of section *Calliprora*: *Triteleia ixioides* (Ait. f.) Greene var. *scabra* (Greene) Hoover, $n = 5(6)$, $2n = 10(11)$; and *T. ixioides* var. *anilina* (Greene) Hoover, $2n = 50$. The next counts were those of Niehaus (1965) who reported $2n = 16$ for *Brodiaea dudleyi* (Hoover) Munz and $n = 20$ for *B. lutea* (Lindl.) Mort. var. *anilina* (Greene) Hoover. Lenz (1966) reported $2n = 14$ for *Triteleia ixioides* (Ait. f.) Greene and $2n = 10$ for *T. ixioides* ssp. *scabra* (Greene) Lenz [as *T. anilina* (Greene) Hoover].

Since 1965 an effort has been made to collect members of this section from as many localities and as many habitats as possible. Even now it is not possible to consider that all the taxa have been adequately sampled. Although 104 chromosome determinations are reported here, additional numbers and karyotypes may be expected and the investigation is continuing. I would very much appreciate receiving corms from areas where I have not collected. In this regard, it might be pointed out that at the time the plants bloom the corm is nearly mature. An herbarium specimen should be made to serve as a voucher and the corm needs only to be placed in a small paper bag and air dried.

Meiotic studies of species and hybrids, as well as the evolution of the karyotype will be discussed elsewhere. The taxonomy of the group has already been considered (Lenz, 1975).¹

MATERIALS AND METHODS

Somatic counts were made from root tips. Corms were planted in small pots in a mixture of peat moss, sand, and Spong Roc and placed on the green-

¹ Errata: p. 230, l. 13 from bottom—change to $\equiv$ *Ornithogalum ixioides*; p. 233, l. 18 from bottom—change to $\equiv$ *Calliprora scabra*; legends on pp. 235, 236, 250, 254—change *analina* to *anilina*.

house bench. As soon as roots appeared at the outer edge of the rooting medium they were harvested and placed in vials containing a 0.004 M solution of 8-Quinolinol (Eastman Organic Chemicals) to which was added one drop of naphthalene monobromide. The vials were stored at 12 C for 4 hr and the root tips then fixed in 3:1 absolute alcohol:glacial acetic acid. After 24 hr the root tips were transferred to 70% alcohol and stored at -20 C. After the root tips had been harvested the corms were planted in loam in 5-in pots and placed on the greenhouse bench where they were allowed to continue their growth. If required, the inflorescences could later be harvested for meiotic studies, or the flowers used for hybridization.

Root tips were stained using the feulgen technique. For meiotic studies the young inflorescences were fixed in 3:1 absolute alcohol:glacial acetic acid for 24 hr and then stored in 70% alcohol at -20 C. Staining was with acetocarmine.

Photographs were made on Kodak Contrast Process Panchromatic Film using a Leitz Ortholux camera mounted on a microscope provided with a Kodak 58 filter. Film was processed with Kodak D-8 developer. The karyotypes were made by uniformly enlarging the photographs on Agfa Brovira BEH-1 paper. After the chromosomes were cut out and assembled they were photographed with Kodak 5069 film and printed on BEH-1 paper.

Karyotype designations and abbreviations are those of Rieger, Michaelis and Green (1968). Chromosome terminology follows that of Battaglia (1955) and Levan, Fredga, and Sandberg (1964).

CHROMOSOME MORPHOLOGY

The chromosomes may be separated into three size groups: large (L), $> 7.6 \mu$; medium (M), $4.8-7.5 \mu$ m and small (S), $< 4.7 \mu$ m. The centromeres may be located in a median, or nearly median position (subscript *m*) with an arm ratio (L/S), $r = 1-1.7$; submedian (subscript *sm*), $r = 1.8-3$; subterminal (subscript *st*), $r = 3.1-7$ and in one subspecies, a nearly terminal position (subscript *t*), $r = > 7.1$.

SATELLITES

In members of section *Calliprora* satellites vary in size from barely visible to large, i.e., the same diameter as the chromosome (Fig. 1c) and they may be single or tandem. If tandem both may be the same size (Fig. 1a) or the intercalary satellite may be small and the terminal one large (Fig. 1b). Some plants are heteromorphic for satellite size (Fig. 1d). The satellites may be on the end of the short arm of the chromosome or on the long arm (Fig. 2a). In numbers they vary from two per nucleus to as many as seven in some plants with $2n = 16$ chromosomes. In this case four are found on chromosomes with median centromeres and three on the long arms of chromosomes with subterminal centromeres (Fig. 2a).

B-CHROMOSOMES

B-chromosomes are present in about one third of the populations of *T. ixiodes* and are found in both diploids and polyploids. When present they

Fig. 1. Satellites.—a, c, d. *Triteleia ixioides* ssp. *scabra*.—a. Tandem; both small.—c. Tandem; both large.—d. Heteromorphic for size.—b. *Triteleia dudleyi*.—Tandem; intercalary small, terminal large.

vary in number from one to five per nucleus and the number appears to be constant within an individual. At present they are unknown in *T. dudleyi*, *T. guadalupensis* and *T. lugens*. However these species have not been as thoroughly sampled as has *T. ixioides*.

In mitotic divisions, at metaphase the B-chromosomes are similar in appearance to the A-chromosomes except that they are usually smaller (Figs. 3a, 4a, d). There may, however, be considerable size differences between B-chromosomes in plants from different populations of the same subspecies (Fig. 5). The centromere is located in a median to submedian position.

In plants possessing B-chromosomes the interphase nuclei show conspicuous chromocenters, usually the same number as the B-chromosomes present (Fig. 3c, 4b, c). In some instances the chromocenters appear

Fig. 2. *Tritileia ixioides* ssp. *scabra*, $2n = 16$.—a. Shows seven satellited chromosomes; four on long metacentric chromosomes, three on the long arms of medium-size chromosomes with subterminal centromeres.—b. B-chromosomes at meiosis.

double or dumbbell shaped and at times the two parts appear separated (Fig. 3b).

At meiosis the B-chromosomes may form associations of as many as five chromosomes either as rings or chains (Figs. 2b, 3d). Division may take place at either the first or second division and the resulting chromosomes may be included within the daughter nuclei or they may be eliminated as

Fig. 3. *Triteleia ixioides* ssp. *scabra*, $2n = 24 + 5B's$.—a. Chromosome complement; B-chromosomes indicated by arrows.—b. Five chromocenters, two of which appear double.—c. Same plant showing five chromocenters.—d. Association of five B-chromosomes at meiosis. (All figures from plant 13024-5 collected at Lake Success, Tulare Co.)

Fig. 4. *Tritileia ixioides* ssp. *scabra*, $2n = 24 + 4B's$.—a. Chromosome complement; B-chromosomes indicated by arrows.—b. Same plant showing four chromocenters.—c. Another plant with three chromocenters.—d. Chromosome complement of the latter plant; B-chromosomes indicated by arrows. The plant is heteromorphic for one pair of medium-size submetacentric chromosomes; the altered one is ringed, the other three are indicated by x.

Fig. 5. *Triteleia ixioides* ssp. *scabra*. B-chromosomes showing differences in size. Tulare Co.—a. Lake Success; 13024-3.—b. Middle Fork of Tule River; 12141-1C.—Fountain Springs; 13028-2. (Bar = 5 μ m.)

micronuclei. When present in even numbers, B-chromosomes may lead to erroneous counts. Although she did not mention it, it is likely that Burbank's counts for *T. ixioides* var. *scabra* of $2n = 10(11)$ and $n = 5(6)$ included plants with a single B-chromosome. Her figure for the plants with $2n = 11$ shows a single small chromosome which could well have been a B-chromosome. In the legend she called it a "metaphase with 1 extra chromosome."

CHROMOSOME NUMBERS

Unless otherwise indicated, all collections listed in the following table are those of the author and were made in California. The names of other collectors are shown in brackets. To conserve space the localities where the collections were made have been shortened but full particulars are available upon request. Numbers followed by a dash and a second number identify individual plants; otherwise the numbers include all the plants collected from a single population.

TRITELEIA DUDLEYI Hoover

Triteleia dudleyi is easily distinguished from the other taxa of section *Calliprora* by its long, nearly cylindrical perianth tube which is about the same length as the segments. It is most common at relatively high elevations from Mono Co. south to Los Angeles Co. It favors moist to wet situations around meadows and along streamsides. The chromosome number is $2n = 16$ and two karyotypes are known (Fig. 6).

$$12284: 4M_{sm} + 4M_{st}^{sat} + 2S_{sm} + 6S_{st} = 16 \text{ (k}_1\text{)}$$

$$13248: 4M_{sm} + 2M_{st} + 2M_{st}^{sat} + 2S_{st}^{sat} + 2S_{sm} + 4S_{st} = 16 \text{ (k}_2\text{)}$$

Name	Locality	Chromosome number	
		<i>n</i>	<i>2n</i>
<i>T. dudleyi</i>	Fresno Co.:		
	Rancheria Cr., 7,500 ft; 12843.	8	16
	Kaiser Pass, 9,175 ft; 12844.		16
	Los Angeles Co.:		
	N of Mt. Waterman, 6,000 ft; 13248.	8	16
	W of Cloudburst Summit, Angeles Crest Hwy; 13047.		16
<i>T. guadalupensis</i>	Mono Co.:		
	Streamside, nr. Mammoth Lakes P.O.; 12284.	8	16
<i>T. ixiooides</i> ssp. <i>anilina</i>	Mexico, Baja Calif.:		
	Guadalupe Is.; [Moran] 13063.	8	16
<i>T. ixiooides</i> ssp. <i>anilina</i>	Alpine Co.:		
	Bear Lake, 6,800 ft; 13527.	7	14
	Lake Alpine; 13528.	7	14
	Amador Co.:		
	E of Pioneer, hwy 88; 13522.		14
	Calaveras Co.:		
	Big Meadow campground, 6,200 ft; 13526.		14
	Placer Co.:		
	Dutch Flat, 4,500 ft; [Hannibal] 24883.		14+2B
	Shasta Co.:		
	Ponderosa Way, 5 mi S of Whitmore; [Hannibal] 24892.		14
	Hwy 44 between airport & McCumber Reservoir; [Hannibal] 24893.		14+0-2B
	Sierra Co.:		
	Snag Lake, 6,400 ft; 24896.		42
	Siskiyou Co.:		
	Wagon Camp, Mt. Shasta; [Jordan] 24912.	7	14
	Trinity Co.:		
	5 mi S of Deer Lick Springs, 2,500 ft; [Hannibal] 24897.		14
	19 mi N of Deer Lick Springs, 3,500 ft; [Hannibal] 24878.		14

SEPTEMBER 1976]

LENZ: *TRITELEIA II*

Name	Locality	Chromosome number	
		<i>n</i>	<i>2n</i>
Madera Co.:			
	Hwy 41 W of Coarsegold, 1,750 ft; 13515.	5	10+0-1B
	Wylie Ranch, 2,639 ft; 12181.		10+0-1B
	Nipinnawasee, 3,000 ft; 13516.		10+0-1B
Mariposa Co.:			
	Mariposa, 2,350 ft; 12735.		10+0-2B
	Hwy 140 W of Mariposa; 13517.		10
	Mt. Boullion, 2,000 ft; 13241.		10+2B
	Catheys Valley; 12737.		10+0-2B
Nevada Co.:			
	Hwy 20 & Pleasant Valley rd; [Hannibal] 24886.		10+1B
	Covered Bridge, Yuba River; [Hannibal] 24880.		10+1B
Placer Co.:			
	Virginia town rd below Auburn; [Hannibal] 24890.		10
Sacramento Co.:			
	Fair Oaks, 175 ft; [Hannibal] 24891.		10
	Nimbus Reservoir; 12195.	5	10
Tehama Co.:			
	20 mi W of Red Bluff, hwy 36; 12755.	5	10
Tulare Co.:			
	Kern Co. line, Glennville-White River rd; 12136.	5	10
	Milo rd; 12722.		10
	Dry Cr rd, 15 mi from hwy 198; 12729.		10
	Milo-Balch Park rd; 12800.	5	10
	Success Valley rd; 13025.		10
	Above junction rds to Indian Reservation; 13026.		10
	Tule Indian Reservation; 13027.		10
	Fountain Springs-Glennville, Tulare Co. line; 13031.		10
	Grapevine grade, M 15; 13041.		10+0-2B
	North River Drive, Three Rivers; 13222.	5	10
	Rd to Mineral King; 13223.		10
	Hwy 69 N of Grapevine; 13225.		10
	Rd to Balch Park, 4,900 ft; 13525.		10
	Ca. 3.5 mi from 198, rd to Mineral King; 24908.		10

CHROMOSOME NUMBERS IN *TRITELEIA*. *Continued.*

Name	Locality	Chromosome number	
		<i>n</i>	<i>2n</i>
	Hwy 198, Sequoia Nat'l. Park, 4,000 ft; 24909.		10
	Milo rd, 4 mi from junction rd to Balch Park; 12718.		10+0-2B
	Dry Cr.; 24916.		10
	Coffee Cr., middle fork Tule River; 12141.	8	16
	Above Springville; 12714.		16+0-3B
	Below Coffee Cr. campground; 12715.	8	16
	Camp Wishon rd, 3,800 ft; [Thorne] 12795.		16+0-2B
	Nr power plant, middle fork Tule River; [Thorne] 12796.		16
	Long Meadow campground; 13053.	8	16
	Rd to Camp Wishon, 2,800 ft; 13523.	8	16
	Camp Wishon, 3,900 ft; 13524.		16
	5 mi S of Redwood Meadow; [Beeks] 24910.		16
	Lake Success; 13024.		24+0-5B
	Fountain Springs; 13028.		24+0-4B
	Slopes above Lake Success; 12678.	12	24
	California Hot Springs; 13029.		24+0-1B
	Fountain Springs rd to California Hot Springs; 13030.		24+1B
	10 mi above Glennville, rd to Kernville; 13043.		24
	Hills above Lake Kaweah; 13220.	12	24
	Hwy 69 N of Elderwood; 13224.		24+0-2B
	Tule Indian Reservation; 24904.		24+2B
	Indian Reservation at beginning of yellow pine; 24905.		24
	Lake Kaweah; 12724.	16	32
	Horse Cr.; 24915.		32
	Tuolumne Co.:		
	Between Columbia and Vallecito; 13520.		10
	Yuba Co.:		
	2 mi W North San Juan; [Hannibal] 24885.		10
<i>T. ixioides</i>	Butte Co.:		
ssp. <i>unifolia</i>	Table Mt., 6,217 ft; [Gankin] 13035.	8	16
	Calaveras Co.:		
	4 mi E of Murphys, 3,000 ft; 13521.		14+0-2B

CHROMOSOME NUMBERS IN *TRITELEIA*. *Continued.*

Name	Locality	Chromosome number	
		<i>n</i>	<i>2n</i>
	Mariposa Co.:		
	N of Greeley Hill, hwy j-20, 3,400 ft; 13518.		14+0-2B
	Placer Co.:		
	Meadow Vista 0.5 mi S of school; 12210.		14, 15
	Meadow Vista, ca 2,000 ft; [Hannibal] 24881.	7	14
	E of Meadow Vista; [Hannibal] 24884.		14
	Ponderosa Way, S of Weimar, 2,250 ft; [Hannibal] 24882.		14
	Tehama Co.:		
	10 mi N of Cohasset; [Hannibal] 24894.		14+0-2B
	Tuolumne Co.:		
	W of Groveland Ranger Station, 2,295 ft; 13519.		14
<i>T. lugens</i>	San Benito Co.:		
	La Gloria rd, Bickmore Canyon; 13514A.	8	16

Fig. 6. *Triteleia dudleyi*.—12284, open circle, (k_1).—12844, open square, (k_{1a}).—13248, solid circle, (k_2).

Plants from Kaiser Pass (12844), karyotype (k_{1a}), are similar to those from Mammoth (12284), karyotype (k_1), except that they possess large satellites (Fig. 1b). Plants from Mt. Waterman (13248) differ from those at Kaiser Pass and Mammoth in having satellited chromosomes of two size

groups and in having one pair of medium subterminals rather than all small subterminals.

TRITELEIA GUADALUPENSIS Lenz

Triteleia guadalupensis is one of the most distinct species in the genus with its large umbels of golden-yellow flowers borne on tall scapes. The corms have thick fibrous coats which extend upward and form a neck above the corm unlike any other member of the section. The species is endemic to Guadalupe Island, Mexico, and only a single chromosome determination has been made. The chromosome number is $2n = 16$ and the karyotype (Fig. 7) may be characterized as follows:

$$[\text{Moran}] 13063: 4L_{sm} + 2M_{st}^{sat} + 2M_{sm} + 2S_{sm} + 6S_{st} = 16 (k_1)$$

TRITELEIA LUGENS Greene

Triteleia lugens occurs in Lake, Napa, and Solano counties north of San Francisco Bay and in San Benito and Monterey counties south of the Bay. This species is more closely related to *T. guadalupensis* than to any other member of the section but the morphological differences are considerable. The two species differ from all others in the section in having the stamen filaments rounded at the apex rather than with some sort of an appendage or tapering to a point. The only known chromosome number is $2n = 16$ and the karyotype (Fig. 7) may be characterized as follows:

$$13514A: 4L_{sm} + 2M_{st}^{sat} + 2M_{st} + 2S_{sm} + 6S_{st} = 16 (k_1)$$

It is worth noting that although *T. lugens* and *T. guadalupensis* are more closely related to each other than they are to any other member of the section, they are morphologically very distinct and have probably been separated for a considerable period of time. However, the karyotypes are similar if not identical.

TRITELEIA IXIODES (Ait. f.) Greene ssp. IXIODES

Triteleia ixioides ssp. *ixioides* is found from San Mateo Co. south to San Luis Obispo Co. where it occurs in the closed-cone coniferous forest and the foothill woodland communities at elevations of 100–5,000 ft. Subspecies *ixioides* is less variable than the other subspecies of *T. ixioides*. The only known chromosome number is $2n = 14$ and the single karyotype (Fig. 8) may be characterized as follows:

$$9028: 2L_m + 2M_{sm} + 2M_{st}^{sat} + 2S_{sm} + 2M_{st} + 4S_{st} = 14 (k_1)$$

TRITELEIA IXIODES (Ait. f.) Greene ssp. COOKII Hoover

Triteleia ixioides ssp. *cookii* is endemic to a few localities in San Luis Obispo Co. and it is usually found on serpentine and in association with

Fig. 7. *Triteleia guadalupensis*.—[Moran] 13063, below.—*Triteleia lugens*.—13514A, solid circle.

Fig. 8. *Triteleia ixioides* ssp. *ixioides*.—9028, open circle.—*Triteleia ixioides* ssp. *cookii*.—24901, open square.

cypress groves (*Cupressus sargentii* Jeps.). It is most closely related to *T. i.* ssp. *ixioides*. The only known chromosome number is $2n = 14$ and the karyotype (Fig. 8) may be characterized as follows:

$$24901: 2L_m + 2M_{sm} + 2S_{sm} + 2S_{st}^{sat} + 6S_{st} = 14 (k_1)$$

As can be seen in Fig. 8, the karyotypes of *T. ixioides* ssp. *ixioides* and *T. i.* ssp. *cooki* are very similar if not identical.

TRITELEIA IXIOIDES (Ait. f.) Greene ssp. *ANILINA* (Greene) Lenz

Triteleia ixioides ssp. *anilina* is widely distributed in California from Tulare Co. north to Jackson Co., Oregon. It is most common on the western slopes of the Sierra Nevada and in the southern Cascades at elevations of 2,800–10,000 ft in the upper montane coniferous forests growing in moist, sandy or gravelly soils. The known chromosome numbers are $2n = 14$ and $2n = 42$. Niehaus (1965) reported $n = 20$ for plants from Gold Lake in Sierra Co. [As *Brodiaea lutea* (Lindl.) Mort. var. *anilina* (Greene) Munz]. My count of $2n = 42$ was for plants from Snag Lake also in Sierra Co. At present two karyotypes are known but more will undoubtedly be discovered as additional populations are studied. The karyotypes (Fig. 9) may be characterized as follows:

$$24893: 2L_m + 4M_{sm} + 4M_{st} + 2S_{st} + 2S_{st}^{sat} = 14 (k_1)$$

$$13522: 4M_{sm} + 2M_{st}^{sat} + 4M_{st} + 2S_{st}^{sat} + 2S_{st} = 14 (k_2)$$

It is possible that 24893, (k_1) possesses a second pair of sat-chromosomes but I have been unable to detect them.

TRITELEIA IXIOIDES (Ait. f.) Greene ssp. *SCABRA* (Greene) Lenz

Triteleia ixioides ssp. *scabra* is the most widely distributed taxon in the section and the most variable morphologically and cytologically. It occurs from Kern Co. north to Siskiyou Co. usually at low to moderate elevations in valley grassland, foothill woodland and lower montane coniferous forests. The chromosome numbers presently known are $2n = 10, 16, 20, 24, 32$. The karyotypes may be characterized as follows:

$$12755: 6L_m + 2M_{st}^{sat} + 2S_{st} = 10 (k_1) \text{ (Fig. 10)}$$

$$12136: 4L_m + 2M_{sm} + 2M_{st}^{sat} + 2S_{st} = 10 (k_2) \text{ (Fig. 10)}$$

$$24907: 8L_m + 4L_{st} + 4M_{st}^{sat} + 4M_{st} = 20 (k_3) \text{ (Fig. 13)}$$

$$24919: 12L_m + 2M_m^{sat} + 2M_{st} + 4S_{st} = 20 (k_4) \text{ (Fig. 13)}$$

$$12141: 8L_m + 4L_{st}^{sat} + 3M_{st}^{sat} + 1M_{st} = 16 (k_5) \text{ (Fig. 12)}$$

$$12706: 24L_m = 24 (k_6) \text{ (Fig. 11)}$$

$$13224: 22L_m + 2L_{sm} = 24 (k_7) \text{ (Fig. 11)}$$

$$13220: 18L_m + 6L_{sm} = 24 (k_8) \text{ (Fig. 11)}$$

$$12724: 32L_m = 32 (k_9) \text{ (Fig. 12)}$$

It has been impossible to determine the exact number of sat-chromosomes

Fig. 9. *Tritelleia ixioides* ssp. *analina*.—24893, open square, (k_1).—13522, open circle (k_2).

in plants with $2n = 24$ and $2n = 32$ chromosomes. I have never been able to detect more than seven, which is the number in (k_5).

In *Tritelleia ixioides* ssp. *scabra*, plants with $2n = 10$ chromosomes are the most widely distributed, extending from Kern Co. north to Tehama Co.

Fig. 10. *Triteleia ixioides* ssp. *scabra*.—12755, open square, (k_2).—12136, open circle, (k_1).

Fig. 11. *Tritileia ixioides* ssp. *scabra*.—12706, solid circle, (k_6).—13224, open square, (k_7).—13220, open circle, (k_8).

They are found at elevations as low as 175 ft in Sacramento Co. and as high as 4,900 ft in Tulare Co. They are found in valley grassland but more commonly in the foothill woodland community in grassy openings either in full sun or light shade. Within the $2n = 10$ group there are two distinct

Fig. 12. *Triteleia ixioides* ssp. *scabra*.—12141, open circle, (k_8).—24692, open square, (k_2).

karyotypes (Fig. 10). Karyotype (k_2) is the most widely distributed and is found from Kern Co. north to Eldorado and Sacramento counties. To the north it is replaced by karyotype (k_1).

The next most widely distributed group are plants with $2n = 24$ chromo-

Fig. 13. *Triteleia ixioides* ssp. *scabra*.—24907, solid circle, (k_3).—24919, solid square, (k_4).

somes (Fig. 11) which occur from Kern Co. north to Fresno Co. Within the $2n = 24$ group there are three distinct karyotypes. Of the three, karyotype (k_8) is the most widely distributed and it is frequent in Kern and Tulare counties. Near Caliente in southern Kern Co. it is found on grassy hillsides but it is more common in the foothill woodland growing in sun or light shade under oaks, etc. It is very common in the vicinity of Lake Success (el. 650 ft) where it is growing on grassy hillsides and along roadbanks. In the Tule Indian Reservation it has been found as high as 3,600 ft, just below the yellow pine forest. Karyotype (k_8) of the $2n = 24$ group and karyotype (k_2) of the $2n = 10$ group may be found within the same geographical area but I have never found them in mixed populations. At least in many places (k_2) grows at lower elevations than (k_8) but the differences are not great and in Tulare Co. (k_2) has been found as high as 4,900 ft on warm exposed slopes above the highest known elevation for (k_8) which is 3,600 ft.

Karyotype (k_6) and (k_7) are known from single populations (Fig. 11). Karyotype (k_6) was found in Fresno Co. growing in a damp spot on a dry sunny slope above the Kings River at an elevation of 4,900 ft and is interesting in that it consists entirely of long metacentric chromosomes. Karyotype (k_7) differs from (k_6) in that it possesses 22 long metacentric chromosomes and two long submetacentrics. It was discovered in Tulare Co. north of Elderwood (el. 490 ft) where it was growing on grassy hills with scattered oaks. It is not common in the area.

Plants with $2n = 16$ chromosomes, karyotype (k_5) are found in two plant communities in Tulare Co. (Fig. 12). They are common in openings in the foothill woodland community along the Tule River at elevations of from about 1,700 ft to about 2,000 ft. In that area plants with $2n = 24$ chromosomes (k_8) are found at considerably lower elevations as at Lake Success (el. 650 ft). Plants of (k_5) are also found below Camp Wishon at 2,800 ft and extend up to 3,000 ft at Camp Wishon. Plants are not found in the chaparral that separates these two areas. In general plants of (k_5) are probably most abundant, but scattered, in partially shaded openings in the yellow pine forest as at Long Meadow campground, Redwood Meadow and near Pierpoint Springs, often within the general vicinity of groves of *Sequoia-dendron giganteum* (Lindl.) Buchh. Plants of ssp. *scabra* with $2n = 16$ chromosomes are restricted to Tulare Co.

Plants with $2n = 32$ chromosomes (Fig. 12), karyotype (k_9) are known from only a small area in the vicinity of Lake Kaweah (el. 690 ft) in Tulare Co. where they are common in sunny or lightly shaded areas in the foothill woodland community. Karyotype (k_9) is characterized by having all long metacentric chromosomes. Plants with $2n = 24$, karyotype (k_8) have also been found in the vicinity of Lake Kaweah and plants of (k_2) with $2n = 10$ chromosomes are found only a few miles farther up the Kaweah River where they are common at Three Rivers (el. 820 ft) and extend to about 4,000 ft in Sequoia Nat'l. Park. They are also common along the road to Mineral King.

Plants with $2n = 20$ chromosomes, karyotypes (k_3) and (k_4) are known from single collections (Fig. 13). Plants with karyotype (k_3) were dis-

Fig. 14. *Triteleia ixioides* ssp. *unifolia*.—24882, open square, (k_1).—12210, open circle, (k_2).—13035, solid square, (k_3).

covered at an elevation of 5,000 ft in the Greenhorn Mts. growing in an area of grassland with scattered oaks. Karyotype (k_4) was collected in Fresno Co. along the Kings River just below Pine Flat Dam at an elevation of 900 ft. Although the chromosome numbers are the same the karyotypes of the two collections are distinct.

TRITELEIA IXIOIDES (Ait. f.) Greene ssp. *UNIFOLIA* Lenz

Triteleia ixioides ssp. *unifolia* is found from Mariposa Co. north to Tehama Co., usually in lower montane coniferous forests mostly at elevations of about 3,500 ft. It favors shaded to lightly shaded areas that are in general more mesic than those occupied by ssp. *scabra*. At present two chromosome races are known with three distinct karyotypes (Fig. 14). The karyotypes may be characterized as follows:

$$24882: 6M_{st} + 4S_{st}^{sat} + 2S_m + 2S_t = 14 (k_1)$$

$$12210: 6M_{st} + 4S_{st}^{sat} + 2S_{sm} + 2S_t = 14 (k_2)$$

$$13035: 4L_{sm} + 4M_{st}^{sat} + 2M_{st} + 2S_{sm} + 4S_{st} = 16 (k_3)$$

Karyotypes (k_1) and (k_2) are unique in the section in that they are the only ones with nearly terminal centromeres ($r = > 7.1$). The two differ in that (k_1) possesses two short metacentrics and no submetacentric whereas (k_2) has two short submetacentric chromosomes and no metacentrics.

Karyotype (k_3) is entirely distinct from (k_1) and (k_2) and in addition has 16 chromosomes rather than 14. Karyotype (k_3) was collected on Table Mt. in Butte Co. and the plants occupy entirely different habitats from those of other collections of the subspecies. However, morphologically the collections are indistinguishable.

LITERATURE CITED

- Battaglia, E. 1955. Chromosome morphology and terminology. *Caryologia* 8: 179-187.
 Burbank, M. P. 1941. Cytological and taxonomic studies in the genus *Brodiaea*. *Bot. Gaz. (Crawfordsville)* 103: 247-265.
 Lenz, L. W. 1966. Chromosome numbers in the Allieae (Liliaceae). *Aliso* 6(2): 81-82.
 ———. 1975. A biosystematic study of *Triteleia* (Liliaceae). I. Revision of the species of section *Calliprora*. *Aliso* 8: 221-258.
 Levan, A. K., A. Fredga, and A. Sandberg. 1964. Nomenclature for centromeric position on chromosomes. *Hereditas* 52: 201-220.
 Niehaus, T. 1965. In Documented chromosome numbers of plants. *Madroño* 18: 123.
 Rieger, R., A. Michaelis, and M. M. Green. 1968. A glossary of genetics and cytogenetics. 3rd ed. Springer-Verlag, New York. 507 pp.