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Chromosome Numbers of Spermatophytes, Mostly Californian

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Studies of chromosomes are normally confined to limited taxonomic groups, for very good reasons. Studies thus restricted are not only apt to yield more accurate results than those concerned with a wide variety of plants, but the patterns within these groups may become obvious with relatively little effort. One unfortunate effect of this kind of orientation, however, has been that many groups of plants have never or very rarely been examined cytologically, and many interesting facts thus remain unknown.

The superb living collections of California plants at the Rancho Santa Ana Botanic Garden have provided the nucleus of this study. Each is associated with a voucher collected in the field at the time of the original collection. These have been supplemented by selected collections of wild plants, mostly from California and adjacent areas. In general, meiotic material has been fixed in one of the variants of Carnoy’s solution and squashed in acetocarmine. Observations of meiosis in pollen mother cells have provided the bulk of the information on chromosome numbers presented here. Occasionally, we have obtained chromosome numbers from mitotic divisions, either in floral material or in root-tips.

The present study reports chromosome numbers for 144 collections of 121 taxa. Included are what we believe to be the first reports for Pectocarya, Oxystylis, Idahoa, Acanthomintha, Pogogyne, Salazaria, Pickeringia, Adenostoma, Cneoridium, Anemopsis, Galvesia, Mohavea and Plectritis. Also included are first counts for 79 species and 8 additional subspecies and varieties, including such prominent members of the California flora as Epipactis gigantea, Toxiodendron diversilobum, Sambucus mexicana, Cercidium flordium, Salix lasiolepis, Platanus racemosa, Staphylea bolanderi, and Styrax officinalis. Our counts for Cleome lutea, C. serrulata, Fouquieria splendens, Lyonothamnus, Simmondsia and Psoralea macrostachya differ from previous reports, which in all except perhaps the second and fifth cases we believe to have been approximations only or in error. Our earlier report for Erysimum capitatum subsp. bealianum is shown to have been in error. We believe that the present article includes the first accurate report of a chromosome number in the family Fouquieriaceae. Additional comments are found under the species concerned.
with apparently new counts being indicated by an asterisk. The voucher specimens are deposited in various herbaria, as indicated by the standard abbreviations.

We would like at this time to express our appreciation to David M. Bates, for his count of *Mohavea* and the fixed material of *Eriogonum thomasii*; to Henry J. Thompson, for fixed material of his collection of *Dalea*; to Lauramay Dempster, for fixed material of *Quercus*; to Theodore L. Hanes, for his material of *Adenostoma sparsifolium*; to Reid Moran, for fixed material of *Penstemon*; and to Percy C. Everett, of the Rancho Santa Ana Botanic Garden, for his very kind cooperation in this project. This work has been supported in part by Grant 2G–365–R1 from the U. S. Public Health Service—National Institutes of Health.

**GYMNOSPERMAE**

**Ephedraceae**


**MONOCOTYLEDONAE**

**Cyperaceae**


**Gramineae**


**Liliaceae**


**Orchidaceae**


**DICOTYLEDONAE**

**Acanthaceae**

CHROMOSOME NUMBERS

ANACARDIACEAE


BERTERIDACEAE

Berberis amplexcens (Eastw.) Wheeler. 2n = 14n*. Cuyamaca Mountains 3 miles from Julian on the road to Cuyamaca Lake, San Diego Co., Calif., Wolf 9892 (RSA), progeny.

BORAGINACEAE

Cynoglossum grande Dougl. 2n = 12n*. Just south of Lake San Andreas, San Mateo Co., Calif., Black 607 RSA), progeny. Stebbins and Major (Ecol. Monogr. 35: 12. 1965 reported 2n = ca. 100 for this species, based on observations of numerous dividing pollen mother cells from an individual cultivated at the Santa Barbara Botanic Garden (Stebbins, pers. comm.). The origin of this individual is not known (R. Philbrick, pers. comm.), but plants or populations with n = 52 should be sought in the field.

BUXACEAE

Simmondsia chinensis (Link) C. K. Schneid. 2n = 26n. Potrero Grade, San Diego Co., Calif., Stark 607 RSA), progeny. Presumably the plant of this species from Mesa Co., Colo., reported by Rollins (Lloydia 2: 111. 1939) as having a chromosome number of n = ca. 16, actually had the same number as the plants reported here.

CALYCERACEAE

Acicarpa tribuloides Juss. 2n = 8n. Cultivated, University of California, Los Angeles, Calif., Hill in 1963 (DS).

CAPPARIACEAE

Cleome isomeris (Nutt.) Greene (Isomeris arborea Nutt.). 2n = 20n, 8 miles west of Essox, San Bernardino Co., Calif., Raven 18755 (DS).

Cleome lutea Hook. 2n = 17n. Winnemucca, Humboldt Co., Nev., Raven 18538 (DS); near Big Pine, Inyo Co., Calif., Raven 17557 (RSA). From a collection of this species from Uinta Co., Wyoming, Rollins (loc. cit.) reported n = 16.}


CAPIPOLIACEAE

Sambucus mexicana Presl. 2n = ca. 36n. 8 miles southeast of Livermore on the Mines Road, Alameda Co., Calif., Raven 18762 (DS).

COBRETACEAE


CONVOLVULACEAE

Cuscuta denticulata Engelm. 2n = 15n*. Along Highway 78, 0.5 miles inside of boundary of Anza-Borrego State Park, San Diego Co., Calif., Kyhos 62-23 (DS).

CRUCIFERAE

ARABIS SPARSIFLORA Nutt. var. CALIFORNICA Rollins. 2n = 22*. 4 miles north of Claremont, Los Angeles Co., Calif., Everett & Balls 22955 (RSA), progeny. At meiotic metaphase I, this plant formed 7 bivalents and 8 univalents, suggesting the presence of apomixis.

CAULANTHUS COOPERI (S. Wats.) Pays. 2n = 14n*. About 2 miles west of junction of Highway 78 with road to Yaqui Pass, San Diego Co., Calif., Kyhos 62-7 (DS).

CAULANTHUS COULTERI S. Wats. 2n = 14n*. 3 miles south of Ozena Guard Station on U.S. Highway 399, Ventura Co., Calif., Hill x-32 (DS).


DITHYREA WISLIZENII Engelm. n = 9*. 10.4 miles northeast of Peñasco, Sonora, Raven 11684 (DS).

ERYSIMUM CAPITATUM (Dougl.) Greene. 2n = 18n. Moist north slope in Gaviota Pass, 150 ft., Santa Barbara Co., Calif., Breedlove 1775 (DS); 4 miles north of Claremont, 1800 ft., Los Angeles Co., Calif., Everett & Balls 22864 (RSA), progeny. The second collection had a fragment in addition to its 18 bivalents. Erysimum capitatum var. bealianum (Jeps.) Rossbach was reported by Raven (Madroño 15: 49. 1959) as having n = 16; a re-examination of the original slide has shown that this report was erroneous, and the plant examined had n = 18.

IDAHOA SCAPIGERA (Hook.) Nels. & Macbr. 2n = 16n. Oregon State line on U.S. Highway 97, Siakjyou Co., Calif., Raven 18763 (DS). This collection was grown at Stanford and was entirely cleistogamous, the styles being exposed only by the expanding fruit.

LEPIDIUM DENSIFLORUM Schrad. var. PUBICARPUM (A. Nels.) Theil. 2n = 16n. Along Highway 78, 0.7 miles inside the east entrance to Anza-Borrego State Park, San Diego Co., Calif., Kyhos 62-24 (DS).

ERICACEAE

CHIMAPHILA UMBELLATA (L.) Barton var. OCCIDENTALIS (Rydb.) Blake. 2n = 26*. 2 miles west of McCall, Valley Co., Ida., Raven 18514 (DS). The same number as recorded for var. umbellata in the Old World.

VACCINIUM OVATUM Pursh. 2n = 12n. 2.5 miles east of Fort Bragg on road to Willits, Mendocino Co., Calif., Everett & Balls 18610 (RSA), progeny.

EUPHORBIACEAE

ACALYPHA CALIFORNICA Benth. 2n = 10n*. Harbison Canyon, San Diego Co., Calif., Wolf 9490 (RSA), progeny. All previously reported species of this large genus have had chromosome numbers based on x = 7.

FAGACEAE

QUERCUS AGRIFOLIA Née. 2n = 12n. Claremont, Los Angeles Co., Calif., Balls 18263 (RSA). This plant was apparently heterozygous for the nucleolar organizer.


FOUQUIERIACEAE

FOUQUIERIA SPLENdens Engelm. 2n = 12n. Road to Borrego Springs about 3 miles from Highway 78, San Diego Co., Calif., Kyhos 62-62 (no voucher). The only previous report of chromosome numbers in this small family has been that of Johansen (Am. Jour. Botan. 23: 95-99. 1938), who reported n = 8 in this species, 2n = 16 in F. peninsularis, and 2n = 16 in F. burracei. In view of the known unreliability of chromosome counts by Johansen (cf. Lewis et al., Aliso 4: 81. 1958) and the fact that he mentioned that his material of Fouquieria was "not in the most satisfactory condition" (Johansen, op. cit., p. 99), we believe that it would be wise to disregard his counts. It is extremely interesting to note that n = 12 is the only chromosome number known in Tamaricaceae, with which Fouquieriaceae have often been grouped.
MARCH 22, 1965

CHROMOSOME NUMBERS

HYDROPHYLLACEAE

Phacelia egena Greene. \( n = 22 \). Triunfo Canyon, Santa Monica Mountains, Los Angeles Co., Calif., Raven 15404 (LA).

Hypericaceae

Hypericum concinnum Benth. \( 2n = 8n^* \). 6.3 miles south of Lower Lake, Lake Co., Calif., Raven 17913 (DS).

Labiate


Acanthomintha undulata Benth. \( 2n = 17n^* \). Near San Marcos Pass, Santa Barbara Co., Calif., Raven 15513 (DS).

Poogynne serpylloides (Torr.) A. Gray. \( 2n = 19n^* \). Near Buena Vista, Amador Co., Calif., Raven 18357 (DS).

Salarzaria mexicana Torr. \( 2n = 50n^* \). 7 miles southeast of the crossing of Burro Creek, Mohave Co., Ariz., Raven 17365 (DS).

Leguminosae

Astragalus breweri A. Gray. \( n = 12n^* \). Lakeport, Lake Co., Calif., Raven 18167 (DS).

Astragalus didymocarpus H. & A. var. didymocarpus. \( 2n = 12n^* \). Kettleman Hills, Kings Co., Calif., Raven 16981 (RSA).

Astragalus didymocarpus H. & A. var. obspoensis (Ryd.) Jeps. \( 2n = 13n^* \). 7.5 miles north of Santo Tomás, Baja California, Raven 17051 (DS).


Astragalus formosa Torr. \( 2n = 7n^* \). 1 mile north of Camp Verde on Highway 69, Ariz., Kyhos 62-106 (DS).
Dalea fremontii Torr. var. fremontii. 2n = 10u*. Marble Canyon, Inyo Mountains, Inyo Co., Calif., Raven 17549 (DS); 1.8 miles east of Darwin on road to Wash and Darwin Falls, 4300 ft., Inyo Co., Calif., Thompson 3271 (DS).


Dalea schottii Torr. var. puberula (Parish) Munz. 2n =10u*. 0.7 miles east on Ocotillo Wells, San Diego Co., Calif., Kyhos 62-78 (DS); 2.2 miles east of Ocotillo Wells, San Diego Co., Calif., Kyhos 62-77 (DS).

Kennedya prostrata Ait. 2n = 11u*. Cultivated, botanic garden, University of California, Los Angeles, Calif., Hill in 1964 (DS).

Lathyrus laetiflorus Greene var. laetiflorus. 2n = 7u*. Mulholland Drive 0.9 miles west of Beverly Glen Boulevard, Los Angeles, Calif., Kyhos 62-12 (DS). The plant investigated exhibited a bridge and fragment at meiotic anaphase I, suggesting the presence of a paracentric inversion.

Lotus argophyllus (A. Gray) Greene var. argophyllus. 2n = 7u*. 3 miles south of Ensenada, Baja California, Raven 17010 (DS); about 2 miles east of Alpine Cafe on Palms Pine Highway, San Jacinto Mountains, Riverside Co., Calif., Kyhos 62-79 (DS).

Lotus argophyllus (A. Gray) Greene subsp. ornithopus (Greene) Raven. 2n = 7u. West side of Isthmus Harbor, Santa Catalina Island, Los Angeles Co., Calif., Wolf 10888 (RSA), progeny; San Clemente Island, Los Angeles Co., Calif., Raven 17149 (RSA), 17281 (RSA).

Lotus benthamii Greene. 2n = 7u*. State Highway 1, 11.8 miles northwest of San Luis Obispo-Montery Co. line, Monterey Co., Calif., Balls 23550 (RSA), progeny.

Lotus grandiflorus (Benth.) Greene. 2n = 7u*. Stunt Road, 2.2 miles from junction with Mulholland Highway, Santa Monica Mountains, Los Angeles Co., Calif., Kyhos 62-81 (DS), 62-26 (RSA).


Lotus salsuginosus Greene var. salsuginous. 2n = 7u*. Mulholland Highway 1.4 miles north of junction with Las Virgenes Road, Los Angeles Co., Calif., Kyhos 62-74 (DS); Backus Road 8 miles from junction with U. S. Highway 101, Los Angeles Co., Calif., Kyhos 62-48 (DS).

Lotus salsuginosus Greene var. brevivexillus Ottley. 2n = 7u*. San Felipe Wash, San Diego Co., Calif., Kyhos 62-60 (DS).

Lotus scoparius (Nutt.) Ottley var. brevialatus Ottley. 2n = 7u*. Cabazon, Riverside Co., Calif., Kyhos 62-38 (DS); Highway 74 at Lower San Juan Campground, Santa Ana Mountains, Orange Co., Calif., Kyhos 62-113 (DS); 1.1 miles east of Banner on Highway 78, San Diego Co., Calif., Kyhos 62-112 (DS, RSA).


Lupinus albifrons Benth. 2n = 24u*. Santa Cruz Island, Santa Barbara Co., Calif., Balls & Blakley 32869 (RSA), progeny.

Medicago arborea L. 2n = 16u. Cultivated, University of California, Los Angeles, Calif., Hill in 1964 (DS).

Meliotus indica (L.) All. 2n = 8u. West Los Angeles, Calif., Kyhos 62-85 (DS).

Pickeringia montana Nutt. 2n = 14u*. 12.6 miles south of Lower Lake, Lake Co., Calif., Raven 17917 (DS). Although this species rarely sets fruit, no meiotic irregularities were observed.

Psoralea californica S. Wats. 2n = 11u*. San Benito River 5.2 miles south of junction with Clear Creek Road, San Benito Co., Calif., Raven 18979 (DS, TEX). Two of the pairs were distinctly heteromorphic.

Psoralea macrostachya DC. 2n = 11. Guadalupe Creek, Santa Clara Co., Calif., Raven 19646 (DS, TEX); along Alamitos Creek near New Almaden, Santa Clara Co., Calif., Raven 19645 (DS, TEX). The chromosome number of this species was reported as 2n = 20 by Kreuter (Planta 11: 11. 1930), but his observations may have been in error. All north American species appear to have n = 11 (cf. also Turner, Legumes of Texas, p. 133-142. 1959), and it would be remarkable if aneuploidy occurred in this species alone.

Psoralea physodes Dougl. n = 11*. 2 miles west of Aetna Springs, Napa Co., Calif., Raven 19042 (DS, TEX).


Vicia angustifolia Reich. 2n = 6n. Stokes Canyon, Santa Monica Mountains, Los Angeles Co., Calif., Kyhos 62-53 (DS).

MALVACEAE


Oleaceae

Fraxinus dipetala H. & A. 2n = 23n*. Silverado Canyon, Santa Ana Mountains, Orange Co., Calif., Wolf 6139 (RSA), progeny.

Orobanchaceae

Orobanche cooperi (A. Gray) Heller. 2n = 24n*. 1.5 miles northeast of Daggett, San Bernardino Co., Calif., Raven 18976 (DS).

Orobanche fasciculata Nutt. 2n = 24n*. 2.5 miles west of junction of U. S. Highways 395 and 50, Washoe Co., Nev., Raven 17868 (DS).

Papaveraceae

Dendromecon rigida Benth. subsp. rigida. 2n = 28n*. Backus Road 10.2 miles west of junction with Mulholland Highway, Santa Monica Mountains, Los Angeles Co., Calif., Kyhos 62-17 (DS). Stebbins and Major (Ecol. Monogr. 35: 11. 1965) reported 2n = ca. 54 for an individual of this species from Moraga Ridge, Contra Costa Co., Calif. (Stebbins, pers. comm.). Doubtless this plant also had n = 28.


Eschscholzia parishii Greene. 2n = 6n. Whitewater Canyon, Riverside Co., Calif., Kyhos 62-43 (DS). The plant investigated had a bridge and fragment at meiotic anaphase I, suggesting the presence of a paracentric inversion.

Plantaginaceae


Plantago subnuda Pilger. 2n = 48*. Surf, Santa Barbara Co., Calif., Raven 15507 (RSA), progeny.

Platanaceae

Platanus racemosa Nutt. 2n = 21n*. Claremont, Los Angeles Co., Calif., Raven 18739 (DS).

Polygalaceae

Polygala fishiae Parry. 2n = 9n*. Triunfo Canyon, Santa Monica Mountains, Ventura Co., Calif., Raven 15403 (LA).

Polygala subsinosa S. Wats. var. heterorhyncha Barneby. 2n = 38*. Frenchman Flat, Clark Co., Nev., Raven 18902 (DS). At meiotic metaphase I, this plant formed 18 pairs plus two small chromosomes that separated precociously.
**Polygonaceae**

*Eriogonum thomasi* Torr. \(2n = 20n^*\). Box Canyon, Riverside Co., Calif., *Bates 2300* (DS).

*Polygonum paronychia* Cham. & Schlecht. \(2n = 28^*\). Presidio, San Francisco, Calif., *Mertens 8* (DS), progeny. Although morphologically similar to some species of sect. *Avicularia*, this species was shown by Hedberg (*Svensk Bot. Tidskr.* 40: 371-404, 1946) to have entirely different pollen and to be referred better to sect. *Duravia* S. Wats. All species of sect. *Avicularia* that have been investigated have had chromosome numbers based on \(x = 10\).

**Ranunculaceae**

*Thalictrum polycarpum* (Torr.) S. Wats. \(2n = 14n^*\). Headwaters of Rocky Creek, Santa Lucia Mountains, Monterey Co., Calif., *Wolf 9555* (RSA), progeny.

**Rhamnaceae**

*Rhamnus ilicifolia* Kell. \(2n = 12n^*\). 1 mile southeast of Bootjack, Mariposa Co., Calif., *Wolf 11038* (RSA), progeny.

**Rosaceae**

*Adenostoma fasciculatum* Hook & Arn. \(2n = 9n^*\). Topanga Canyon, Santa Monica Mountains, Los Angeles Co., Calif., *Hill in 1963* (DS).


*Lyonothamnus floribundus* A. Gray subsp. *asplenifolius* (Greene) Roven. \(2n = 27n^*\). Santa Cruz Island, Santa Barbara Co., Calif., *Wolf 4129* (RSA), progeny. The report of \(2n = 48\) in this species (Stebbins & Major, *Ecol. Monogr.* 35: 12, 1965) was based on a very approximate count of a tree of this variety cultivated in Berkeley (Stebbins, pers. comm.), and it is presumably in error. Judging from the ease with which the strain we are reporting on here hybridizes with Santa Catalina Island material of subsp. *floribundus* when they are cultivated side-by-side at Rancho Santa Ana, and the apparent full fertility of these hybrids, we consider it likely that there is only one chromosome number represented in the genus.

**Rutaceae**


**Salicaceae**

*Salix gooddingii* Ball. \(2n = 19n^*\). Cane Springs, Nye Co., Nev., *Raven 18944* (DS).

*Salix lasiolepis* Benth. \(2n = 38n^*\). Just south of Lake San Andreas, San Mateo Co., Calif., *Raven 18742* (DS).

**Saururaceae**

*Anemopsis californica* Hook. \(2n = 22n^*\). Little Lake, Inyo Co., Calif., *Raven 17539* (RSA); Point Mugu, Ventura Co., Calif., *Raven 14008* (DS). Both American and Asiatic species of the related genus *Saururus* have \(n = 11\).

**Saxifragaceae**

*Carpenteria californica* Tott. \(2n = 20.\) 5 miles from Auberry on road to Pineridge, 4000 ft., Fresno Co., Calif., *Everett 7268* (RSA), progeny. This number underscores the distinctiveness of this attractive Californian endemic genus, as other genera of the "Hydrangeaceae" that have been counted have had \(x = 13, 14, 16, 17, \) and 18.
CHROMOSOME NUMBERS

Scrophulariaceae

**Antirrhinum multiflorum** Penn. *n* = 16*. Saddle Peak, Santa Monica Mountains, Los Angeles Co., Calif., *Raven* 15392 (LA).


**Galia juncea** (Benth.) Ball. *2n* = 15*. 14 miles south of San Quintín, Baja California, *Raven* 17026 (RSA).


**Mohavea confertiflora** (Benth.) Heller. *2n* = 15*. Box Canyon, Riverside Co., Calif., *Bates* 2297A (DS).


**Penstemon clevelandii** A. Gray var. **angelicus** I. M. Johnst. *n* = 8*. Arroyo Estatón, Isla Angel de la Guarda, Baja California, *Moran* 8580 (SD).

**Scrophularia californica** Cham. & Schlecht. subsp. **californica**. *2n* = 48*. West Los Angeles, Los Angeles Co., Calif., *Raven* 15412 (LA). This plant provided excellent metaphase I figures when fixed in 3 parts absolute ethanol : 1 part glacial acetic acid. Taking into account the approximate chromosome numbers published by Shaw (Aliso 5: 156–158, 1962), we consider it likely that all North American species except *S. montana* Wooten and possibly *S. marilandica* L. will prove to have *n* = 48.

Solanaceae


Staphyleaceae

**Staphylea bolanderi** A. Gray. *2n* = 13*. Near summit of Tollhouse Grade, Fresno Co., Calif., *Frampton in 1956*, progeny (RSA). Apparently the first diploid in this small family to be reported from North America.

Styracaceae

**Styrax officinalis** L. var. **fulvescens** (Eastw.) Munz & Johnst. *2n* = 8*. Main Divide Road, Santa Ana Mountains, Orange Co., Calif., *Wolf & Stark* 4441 (RSA), progeny.

Valerianaceae

**Plectritis macrocera** Torr. & Gray, *n* = 15*. 14.5 miles southeast of Livermore on the Mines Road, Alameda Co., Calif., *Raven* 18761 (DS). A new basic number for the Valerianaceae, which underscores the distinctiveness of *Plectritis* from *Valerionella* and other genera. The preparations were excellent.

Verbenaceae