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# Specific Status of the North American Fence Lizards, *Sceloporus undulatus* and *Sceloporus occidentalis,* With Comments on Chromosome Variation

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## ABSTRACT

The eastern fence lizard (*S. undulatus*) and western fence lizard (*S. occidentalis*) are shown to be sympatric in a woodland community in the Pine Valley Mountains, Washington County, Utah. Observations on external morphology and chromosomes, involving 49 specimens from the area of sympatry, produced no evidence of interbreeding. These forms are properly regarded as different species.

The 16 *S. occidentalis* karyotyped from the Pine Valley Mountains included a triploid female that was sterile but otherwise appeared normal.

Specimens of *S. occidentalis* have been karyotyped from many localities throughout its range (Utah to California, Washington to Baja California Norte), and, normally, all individuals are alike in chromosome morphology. However, four specimens out of 12 from northwestern California (Del Norte, Trinity, and Shasta counties) had a heteromorphic pair of chromosomes that were not sex-correlated.

Following a generally overlooked paper by Harper, the authorship of the name *Stellio undulatus* (=*Sceloporus undulatus*) should be credited to Bosc and Daudin (in Sonnini and Latreille, 1801).

## INTRODUCTION

The eastern fence lizard, *Sceloporus undulatus,* occurs throughout the eastern United States from New York southward to Florida and westward to Utah and Arizona. Within this area and northern Mexico, but particularly in the topographically and ecologically diverse Southwest, *Sceloporus undulatus* displays such striking geographically correlated

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diversity in obvious characters as size, coloration, scutellation, and preferred habitat, that various distinctly recognizable subspecies have been described. Because of its diversity and abundance, several workers have selected *S. undulatus* as an ideal animal for analyzing intraspecific variation and local adaptation. Recent publications have dealt with several aspects of population dynamics (Tinkle and Ballinger, 1972; Vinegar, 1975; Derickson, 1976; Ferguson et al., 1980; Pounds and Jackson, 1981; Vitt and Price, 1982), chromosomes (Cole, 1972, 1975), and electrophoretic patterns of tissue proteins (Guttman, 1970; Spohn and Guttman, 1976). The conclusions and significance of these studies, however, and of others in progress, would be drastically altered if future evidence should indicate that the populations involved represent more than one species.

Considering particularly the geographically correlated chromosomal variation within *Sceloporus undulatus,* and considering that one of the less distinct "subspecies" recognized previously has been elevated to specific rank (Cole, 1963), one of the basic questions underlying my recent work is the following: Does *Sceloporus undulatus,* as we understand it today (Stebbins, 1966; Conant, 1975), actually include more than one species? For investigations of *S. undulatus* that are in progress, I have sampled populations throughout most of its range in the United States; I have prepared karyotypes of about 700 individuals; and I have directed field efforts toward locating and studying zones of contact between the most distinctly different and adjacent subspecies, to determine whether they interbreed. Details of these investigations will be published elsewhere, but it is pertinent to state now that the evidence strongly indicates that *Sceloporus undulatus* does comprise a single polytypic species.

Another problem concerns the specific status of populations considered closely related to, but specifically distinct from, *S. undulatus,* although occurring on the periphery of its range. The status of *Sceloporus virgatus* Smith has already been addressed (Cole, 1963). The status of the southeastern *Sceloporus woodi* Stejneger is not so firm, as several narrow ecotones are known in Florida, where it interbreeds with *S. undulatus,* and the hybrids appear to be fertile (Jackson, 1973). Two additional species that warrant investigation to determine their specific status relative to that of *S. undulatus* are *Sceloporus occidentalis* Baird and Girard and *Sceloporus cautus* Smith.

The present report addresses the question of whether *S. occidentalis* and *S. undulatus* are conspecific, considering the following: (1) these two forms are morphologically very similar, in some cases appearing more similar to each other than are subspecies within *S. undulatus*; (2) *S. occidentalis* and *S. undulatus* generally appear parapatric in distribution (Stebbins, 1966), similar to many subspecies; and (3) early reports of sympatry in southwestern Utah (V. M. Tanner, 1927; Bell, 1954) have not previously produced a single confirmed locality where the two forms coexist. Smith (1946, pp. 221, 222, 244) and Stebbins (1954, p. 318) pointed out the need for further work in this area, and more recently W. W. Tanner and Banta (1966, p. 106) stated, "we would suppose that *S. undulatus elongatus* is actually closer to *S. occidentalis* than to the more eastern North American populations of *S. undulatus.*" Sympatry between *S. occidentalis* and *S. undulatus* in southwestern Utah is documented below.

## ACKNOWLEDGMENTS

The sympatric populations of *S. occidentalis* and *S. undulatus* in Utah discussed here were first reported in a talk by Mr. Gene C. Olson (1971), who provided me with locality data and live specimens for photography and initial karyotypic studies. In addition, for providing live specimens and/or for assistance in the field or laboratory, I thank Dr. Robert L. Bezy, Dr. Stephen R. Goldberg, Dr. W. Ronald Heyer, Mr. Stephen Minter, Dr. Michael D. Robinson, Mr. Philip C. Rosen, Ms. Carol R. Townsend, Dr. John W. Wright, and Dr. Richard G. Zweifel.

## METHODS

Characters of external morphology were determined as described by Smith (1946). Color notes and photographs of the lizards were taken in life. Statistical data are presented as the mean ± one standard error of the mean. Chromosomes were studied as described elsewhere (Cole, 1978); this report is based on 190 cells from 47 lizards (26 males, 21 females), in addition to the *S. occidentalis* and *S. undulatus* on which I reported previously (Cole, 1972, 1975).

## SPECIMENS EXAMINED

The specimens are individually catalogued in the herpetological collections of the American Museum of Natural History (AMNH; catalogue numbers are in parentheses).

*Sceloporus occidentalis occidentalis:* UNITED STATES: *California:* Del Norte Co.: Patrick Creek (on the Smith River) (108027–108032; nos. 108029 and 108032 with dimorphic chromosome no. 8). Sacramento Co.: Sacramento, American River Bike Trails nr. Calif. Exposition (108880–108881, 108884–108885, 108888–108889). Shasta Co.: east side of Redding (108020–108022; no. 108021 with dimorphic chromosome no. 8); Madrone Camp, Squaw Creek, 6 mi. N, 9 mi. W Montgomery Creek (108019). Trinity Co.: Gray Falls Forest Camp, 3 mi. N, 1 mi. W Burnt Ranch Post Office (108024–108025; 108025 with dimorphic chromosome no. 8). *Washington:* Kittitas Co.: *ca.* 11 mi. W Ellensburg on Hwy. 90 (125506).

*Sceloporus occidentalis biseriatus:* MEXICO: *Baja California Norte:* vic. Rancho San Jose (Meling Ranch), *ca.* 26 mi. (by rd. to Observatorio) E San Telmo (125510). UNITED STATES: *California:* Inyo Co.: 9 mi. (Hwy. 168) NE Big Pine, *ca.* 6000 ft. elev. (108045–108048, 108050–108052); 17 mi. (Hwy. 168 + White Mtns. road) NNE Big Pine, *ca.* 7600 ft. elev. (108044). Kern Co.: 8.1 mi. (rd.) E Glennville, *ca.* 4700 ft. elev. (108042–108043); 14.3 mi. (Hwy. 178) WSW Miracle Hot Springs, *ca.* 1700 ft. elev. (108034–108035, 108037–108039). Los Angeles Co.: jct. Calif. Hwy. 39 and road to Crystal Lake Campground, 5200 ft. elev. (125507–125509); Whittier Hills (=Puente Hills), *ca.* 400 ft. elev., jct. Youngwood Drive and Las Cumbres Drive, Whittier (107497–107506). Tulare Co.: 7 mi. (rd.) NW Roads End, *ca.* 4300 ft. elev. (108040). Ventura Co.: Rancho dos Rios, nr. jct. San Antonio and Lion Creeks (11 mi. by rd. N Ventura) (113402). *Utah:* Washington Co.: Pine Valley Mountains: 4.9 mi. (by rd. to Oak Grove Camp) NNW Leeds (112472); 5 mi. (by rd. to Oak Grove Camp) NW Leeds (107494–107496); 5.2 mi. (by rd. to Oak Grove Camp) NNW Leeds, 4800 ft. elev. (112458–112471); 5.6 mi. (by rd. to Oak Grove Camp) NNW Leeds (109128).

*Sceloporus undulatus elongatus:* UNITED STATES: *Arizona:* Mohave Co.: Virgin Mtns., 6100 ft. elev., 9.5 mi. (airline) S and 3.3 mi. (airline) E Littlefield (=1.8 mi. by rd. SW Cougar Spring) (112534–112549). *Utah:* Washington Co.: Pine Valley Mountains: 5 mi. (by rd. to Oak Grove Camp) NW Leeds (107507–107514); 5.2 mi. (by rd. to Oak Grove Camp) NNW Leeds, 4800 ft. elev. (112559–112569); from 4.4 mi. to 9.2 mi. (by rd. to Oak Grove Camp) NNW Leeds, 4700 to 6250 ft. elev. (109205–109215).

## RESULTS AND DISCUSSION

### SYMPATRY OF *Sceloporus occidentalis* AND *Sceloporus undulatus*

Since early reports of sympatry of these species in Utah (V. M. Tanner, 1927; Bell, 1954) remain unconfirmed, Olson's (1971) report warrants close attention. Following up on information (and initial specimens) generously provided by him, I have documented that two species of fence lizards (with the characters of the *undulatus* species group of *Sceloporus*) occur in the Pine Valley Mountains, Washington County, Utah. Both are found together along a stretch of road through woodland from at least 4.9 to 5.6 miles (by road to Oak Grove Camp) north-northwest of Leeds. The correlation of coloration and karyotypes of these lizards indicate that the species are *S. occidentalis* and *S. undulatus*, and no evidence of interbreeding has been found.

COLORATION: I handled 49 living fence lizards from the Pine Valley Mountains and had no difficulty in assigning a specific identity to any of them (19 *S. occidentalis*, 30 *S. undulatus*), even though the most conspicuous traits were developed best on large adults. Distinguishing features of these species are given below.

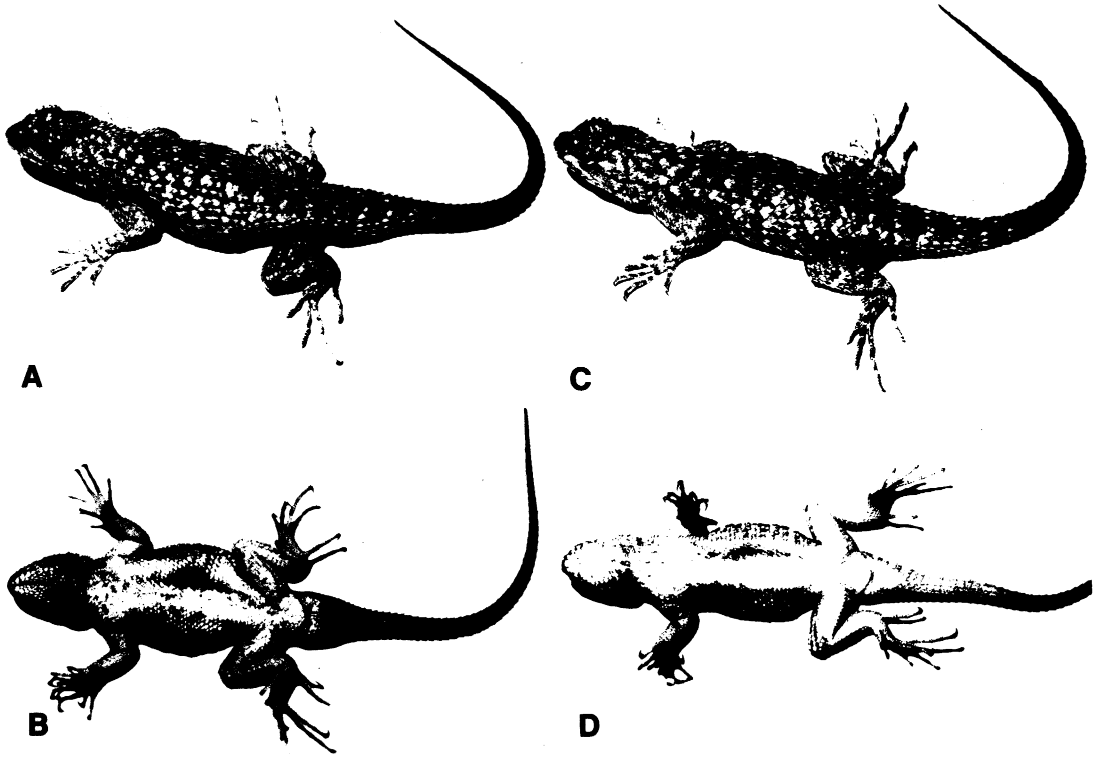


FIG. 1. Western fence lizards, *Sceloporus occidentalis,* from the zone of sympatry, Pine Valley Mountains, Washington Co., Utah. A and B. Dorsolateral and ventral views, respectively, of adult male, AMNH 112468, 71 mm. snout–vent length. C and D. Dorsolateral and ventral views, respectively, of adult female, AMNH 112471, 73 mm. snout–vent length.

*Sceloporus occidentalis* (fig. 1): dorsal body of adults usually with conspicuous blue flecks or spots; dorsolateral and lateral light stripes indistinct or absent; adult males (some females) with conspicuous blue on tail (lateral base, some crossbands); small light gray or light greenish blue spots on head, as well as small dark brown spots; one conspicuous, broad blue patch across throat; gray ventral smudges on body and hind legs; axilla of adults bright orangish yellow; underside of arms, legs, hands, feet yellow or yellowish orange, being brightest on thigh and anterior edge of vent; ventral base of tail with conspicuous orange; orange flecks usually on nape, side of neck, and superciliaries.

*Sceloporus undulatus* (fig. 2): dorsal body without blue; dorsolateral and lateral light stripes (cream, beige, yellow) present, if indistinct, uppermost often represented as light spots posterior to dark brown dorsal crossbars; tail without blue, some adult males having pale green spots on lateral base; top of head without light spots; two blue throat patches, medium in size, widely separated; no gray ventral smudges; axilla cream, gray, tan, or yellow, without bright orange; underside of arms, legs, hands, feet, vent area without yellow or orange; ventral base of tail without conspicuous orange; nape, side of neck, and superciliaries (beige) without orange flecks.

SIZE AND PROPORTIONS: With data from 14 males and 16 females from the Pine Valley Mountains, Student's *t*-test indicated no sexual dimorphism in snout–vent (body) length in *S. undulatus* ($P > 0.05$). Only about half of these lizards apparently had the original tail complete (seven males, nine females), and sexual dimorphism was not readily apparent

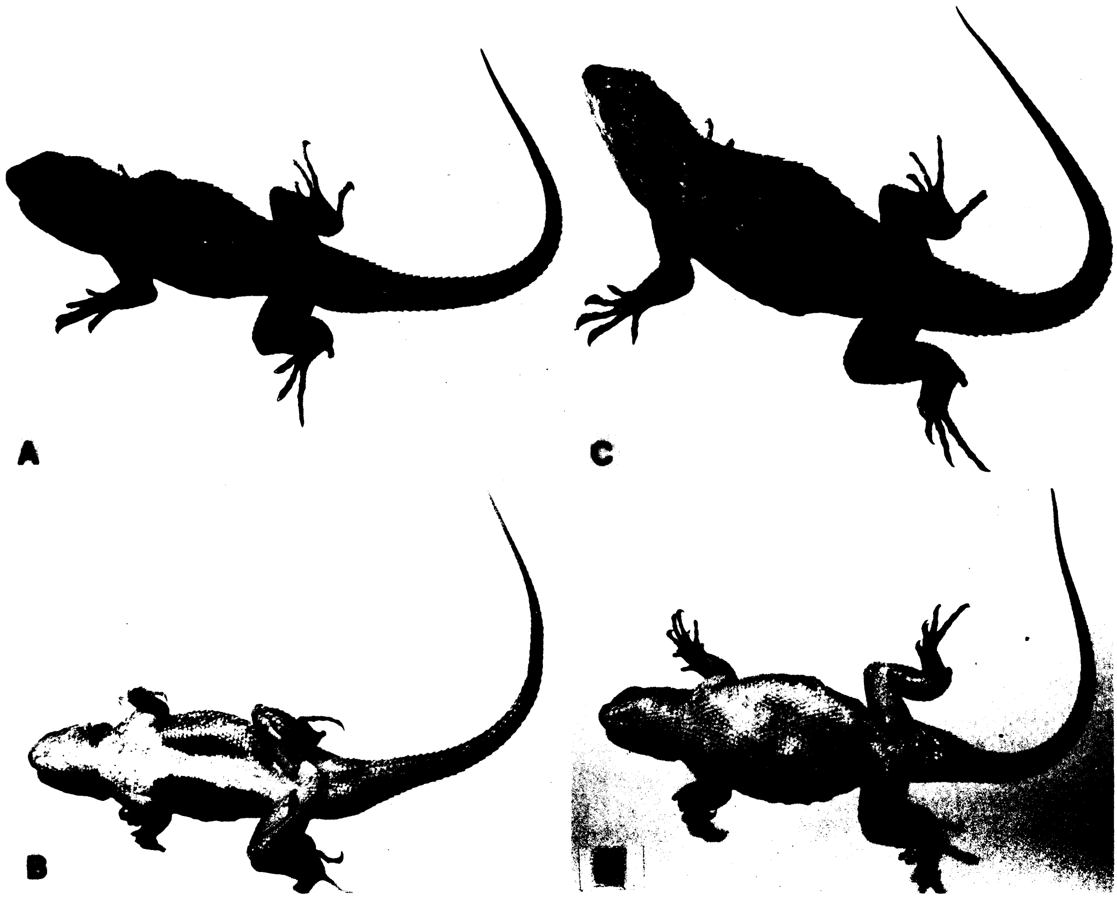

FIG. 2. Eastern fence lizards, *Sceloporus undulatus,* from the zone of sympatry, Pine Valley Mountains, Washington Co., Utah. A and B. Dorsolateral and ventral views, respectively, of adult male, AMNH 112567, 68 mm. snout–vent length. C and D. Dorsolateral and ventral views, respectively, of adult female, AMNH 112562, 75 mm. snout–vent length.

in the ratio of tail length to total length. Sexual dimorphism was not apparent in these characters in the smaller sample of *S. occidentalis,* either (in fact, the nine males and 10 females each had a mean body length of 74.4 mm.), so sexes were pooled for interspecific comparisons.

Body length of the 19 *S. occidentalis* (mean, 74.4 ± 1.10 mm.) was longer than and significantly different from that of the 30 *S. undulatus* (mean, 66.0 ± 1.00 mm.). However, the tail length proportional to total length (%) was shorter in the 11 complete *S. occidentalis* (mean, 57.7 ± 0.34) than in the 16 *S. undulatus* (mean, 59.1 ± 0.31); $t = 2.974$, $P < 0.05$. Because the ratio of tail length to total length may vary ontogenetically and may have very small differences between the sexes, I examined this character also in the size-group best represented in the samples: lizards of 65–75 mm. snout–vent length. For these, the three females of *S. occidentalis* had a mean of 57.8 (range, 57.2–58.5); the six males of *S. occidentalis* had a mean of 58.3 (range, 58.0–58.7); the six females of *S. undulatus* had a mean of 58.8 (range, 57.1–60.1); and the five males of *S. undulatus* had a mean of 59.4 (range, 58.1–60.7). Better samples would be needed to compare these populations well in this character.

SCUTELLATION: With data from 14 males and 16 females from the Pine Valley Moun-

TABLE 1
**Scutellation[a] of Two Samples Each of *Sceloporus occidentalis* and *Sceloporus undulatus***

| Sample | Dorsals, occiput–rump | Scales around midbody | Femoral pores (total) | Scales between pore series | Fourth toe lamellae |
|---|---|---|---|---|---|
| *S. o.* (CA)[b] | 38.6 ± 0.45 | 41.0 ± 0.49 | 29.0 ± 0.79 | 9.2 ± 0.47 | 45.6 ± 0.79 |
| | (36–41) 10 | (39–43) 10 | (24–32) 10 | (7–11) 10 | (41–49) 10 |
| *S. o.* (UT)[c] | 42.5 ± 0.41 | 44.9 ± 0.37 | 31.2 ± 0.65 | 9.2 ± 0.29 | 46.4 ± 0.62 |
| | (39–46) 19 | (42–49) 19 | (25–36) 19 | (8–13) 19 | (40–51) 19 |
| *S. u.* (UT)[c] | 44.4 ± 0.35 | 47.2 ± 0.34 | 36.0 ± 0.33 | 6.8 ± 0.19 | 46.9 ± 0.34 |
| | (41–48) 30 | (42–51) 30 | (32–40) 30 | (5–9) 30 | (44–50) 29 |
| *S. u.* (AZ)[d] | 43.1 ± 0.41 | 45.8 ± 0.50 | 34.6 ± 0.59 | 6.4 ± 0.20 | 47.2[e] ± 0.50 |
| | (40–46) 16 | (43–49) 16 | (30–39) 16 | (5–8) 16 | (42–56) 15 |

[a] Number of scales; mean ± one std. error of the mean (range) N.
[b] *Sceloporus occidentalis* from Whittier, Los Angeles Co., California.
[c] *Sceloporus occidentalis* (*S. o.*) and *Sceloporus undulatus* (*S. u.*) from Pine Valley Mountains, Washington Co., Utah.
[d] *Sceloporus undulatus* from Virgin Mountains, Mohave Co., Arizona.
[e] Mean of left toe doubled, as all these lizards were marked RR-4.

tains, Student's *t*-tests indicated no sexual dimorphism in the number of middorsal scales (occiput to rump), number of scales around midbody, total number of femoral pores, and total number of lamellae under the fourth toe in *S. undulatus* ($P > 0.05$). The only scale character in which sexual dimorphism was indicated in these lizards was the number of ventral scales between the series of femoral pores (mean in males, 6.3 ± 0.24; mean in females, 7.2 ± 0.24; $t = 2.587$; $0.01 < P < 0.05$). However, the 10 males and nine females of *S. occidentalis* from the Pine Valley Mountains had an identical mean (9.2) in this character, and similar means were found in the two sexes of *S. undulatus* from the Virgin Mountains, Mohave County, Arizona (males, 6.2; females, 6.6). Consequently, I pooled data from both sexes for the following comparisons.

In addition to comparing them with each other, the *S. occidentalis* and *S. undulatus* from Utah were compared with a second sample of each species obtained from the nearest locality for which a sufficiently large sample was readily available. These samples represent the same subspecies to which the samples from the Pine Valley Mountains are assigned (*Sceloporus occidentalis biseriatus* and *Sceloporus undulatus elongatus*; see Stebbins, 1966). The nearest sample of *S. o. biseriatus* was from Whittier, Los Angeles County, California (about 340 miles away), and the sample of *S. u. elongatus* was from the Virgin Mountains, Mohave County, Arizona (about 45 miles away, where no *S. occidentalis* were found while making this collection to the SSW of the Pine Valley Mountains, across the Virgin River).

The scutellation data are summarized in table 1 and variation is illustrated in figure 3. The samples of *S. occidentalis* and *S. undulatus* from the Pine Valley Mountains apparently differ from each other in all of these characters except in the number of fourth toe lamellae, which is similar in all four samples compared. The most conspicuous interspecific differences are in the number of ventral scales between the femoral pore series and the number of femoral pores. The intraspecific variation observed in number of dorsals and number of scales around midbody within *S. occidentalis* may reflect the relatively large distance separating the localities involved.

KARYOTYPES: *Sceloporus occidentalis* and *S. undulatus* normally have a diploid number of 22 chromosomes, with six pairs of larger chromosomes and five pairs of smaller ones; none of the latter is sufficiently small to be referred to as a microchromosome (Cole, 1972). Considering the six larger pairs in order of decreasing length (fig. 4), in both species numbers 1, 3, 4, and 5 are metacentric or nearly so, and numbers 2 and 6 are submetacentric; a small satellite is at the tip of the long arm of number 2. Of the smaller pairs, numbers 8 through 11 typically are metacentric or submetacentric in both species. Thus, the major difference between these species is in the shape (centromere position) of chromosome number 7 (largest of the smaller pairs).

In *S. undulatus,* chromosome 7 exhibits considerable geographic variation in shape (Cole, 1972), but in *S. u. elongatus* from southwestern Utah, it is metacentric (fig. 4A). In *S. occidentalis,* chromosome 7 is telocentric (fig. 4B). If individuals bearing such differently shaped number 7 chromosomes were to interbreed, $F_1$ hybrids would have a heteromorphic seventh pair, with one telocentric chromosome and one metacentric. No such heteromorphic pair was found in any of the 37 fence lizards from the area of sympatry whose chromosomes were examined. In all of the 21 *S. undulatus* (10 males, 11 females), all number 7 chromosomes were metacentric, and in all of the 16 *S. occidentalis* (nine males, seven females), all number 7 chromosomes were telocentric. Each animal had the homozygous condition of chromosome pair number 7 that was predicted based on the colors and pattern of the living lizard.

Two surprises were encountered in examining chromosomes of the fence lizards from the Pine Valley Mountains. For one *S. undulatus* (AMNH 112566, male), 10 cells examined at mitotic metaphase had normal karyotypes but one cell did not (fig. 5A). This aberrant condition may have resulted from a translocation between one chromosome number 1 and a number 6. Otherwise, this lizard appeared normal and had the following characters of external morphology, all of which are normal, although the number of scales around midbody is the lowest count for the entire sample from this locality: body length, 65 mm.; tail incomplete; dorsal scales, 41; scales around midbody, 42; total femoral pores, 33; scales between femoral pore series, 6; total fourth toe lamellae, 48.

Far more surprising was the karyotype of an *S. occidentalis* (AMNH 112463, female), of which 12 somatic cells were examined at mitotic metaphase from bone marrow preparations and all were triploid ($3n = 33$, with

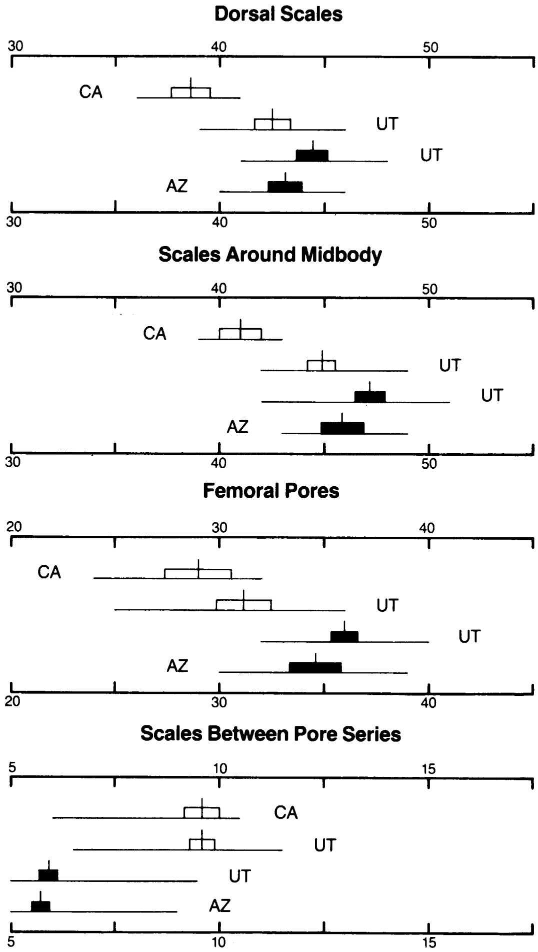


FIG. 3. Variation in four scale characters in four samples of fence lizards, *Sceloporus.* Open rectangles represent *S. occidentalis* from Whittier, Los Angeles Co., California (CA) and from the Pine Valley Mountains, Utah (UT). Solid rectangles represent *S. undulatus* from the Pine Valley Mountains (UT) and from the Virgin Mountains, Mohave Co., Arizona (AZ). Horizontal line indicates range, vertical line indicates mean, rectangle indicates 95 percent confidence interval (table 1).

three of each chromosome; fig. 5B). Externally, this lizard appeared normal and had the following characters, all of which are normal: body length, 71 mm.; tail length, 100 mm.; ratio of tail length to total length $\times$ 100, 58.5; dorsal scales, 43; scales around midbody, 45; total femoral pores, 31; scales be-

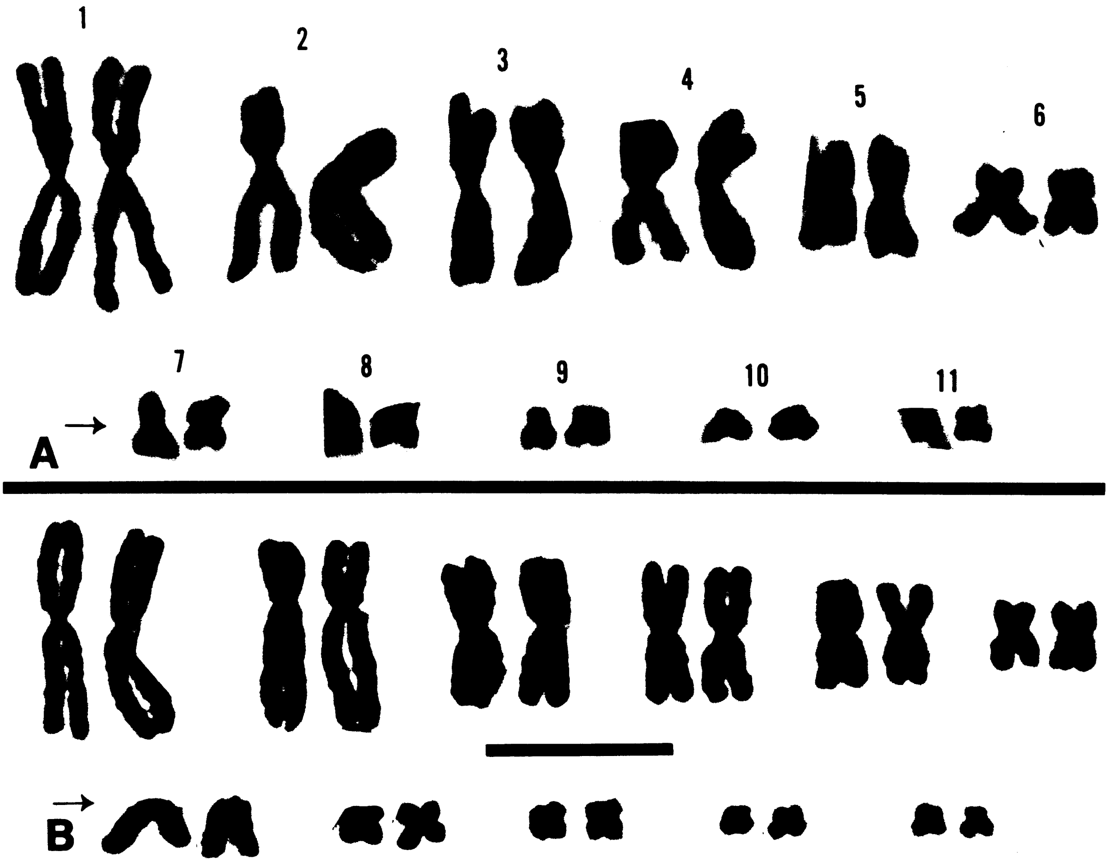


FIG. 4. Karyotypes of two species of fence lizards, *Sceloporus*, from the zone of sympatry, Pine Valley Mountains, Washington Co., Utah. A. *S. undulatus*, $2n = 22$, AMNH 107514, female. B. *S. occidentalis*, $2n = 22$, AMNH 112470, female. Note that chromosome number 7 is metacentric in *undulatus*, telocentric in *occidentalis* (arrows). Line represents 10 microns.

tween femoral pore series, 9; total fourth toe lamellae, 48.

Judged from the lack of enlarged postanal scales and the small, inconspicuous appearance of the femoral pores, the triploid *S. occidentalis* was considered a female. Upon dissection, no gonads were evident, and if I identified the oviducts properly, they were small and unplaited (i.e., undeveloped in this lizard of 71 mm. snout–vent length). Internal examination of the five other females collected on the same day (18 May 1975), all measuring from 73 to 77 mm. in snout–vent length, revealed that each had clearly recognizable, broadly plaited oviducts and adult ovaries, with yolking follicles as large as 4.5 to 8 mm. in diameter. Apparently the triploid was sterile.

Triploidy occurs as a normal condition in a few reptiles, all of which are unisexual species that may reproduce by parthenogenetic cloning (Cole, 1979; Hardy and Cole, 1981; Dessauer and Cole, 1980). Triploid species apparently stemmed from fertilization of diploid ova produced by diploid parthenogenetic females of hybrid origin (Lowe and Wright, 1966). There is no indication that interspecific hybridization was involved in the production of this triploid *S. occidentalis*, which is one karyotypically aberrant in-

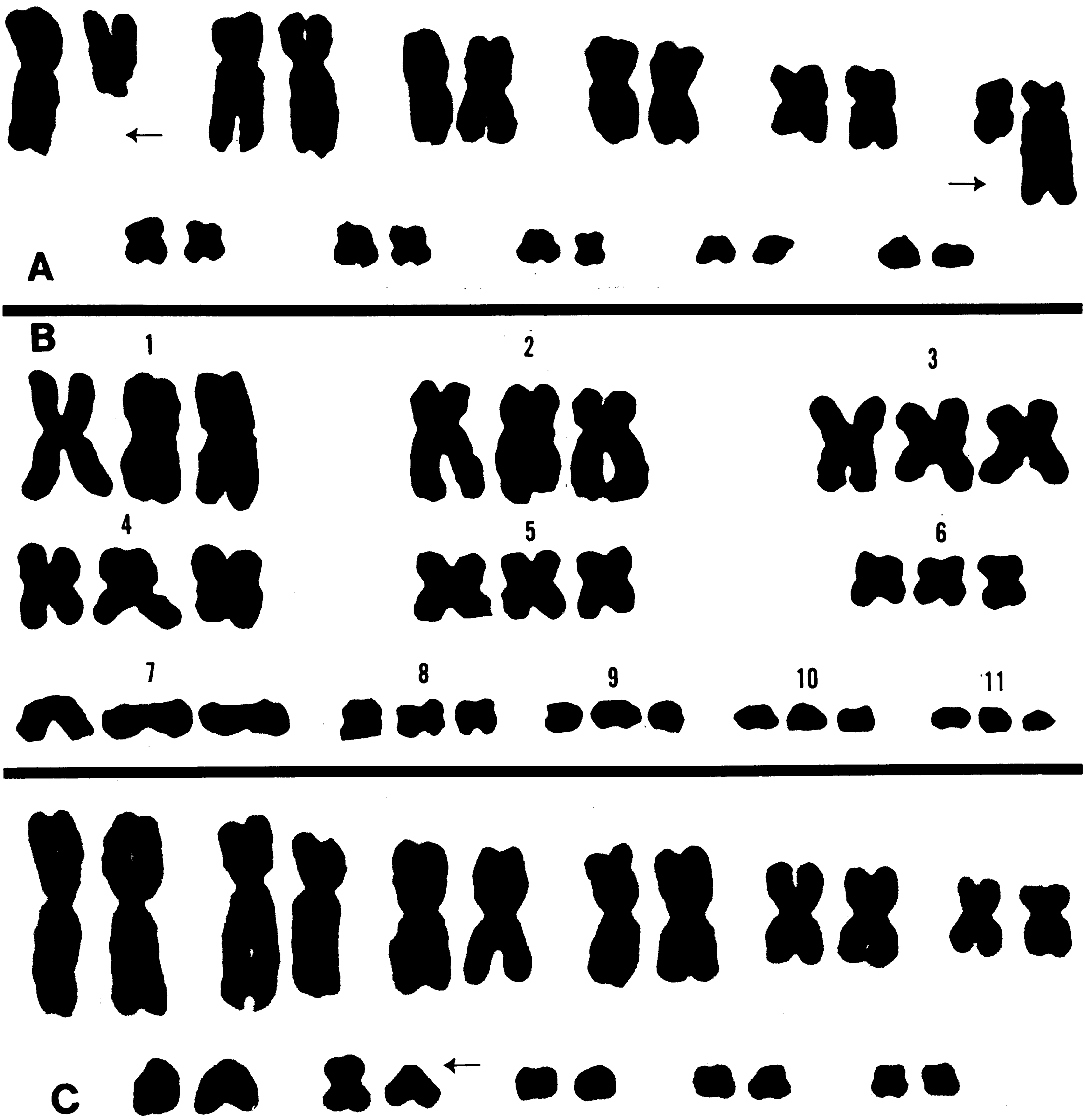


FIG. 5. Karyotypes of two species of fence lizards, *Sceloporus*. A. Aberrant *S. undulatus,* apparently heterozygous for a translocation involving chromosomes 1 and 6; AMNH 112566, male. B. Triploid *S. occidentalis,* $3n = 33$, AMNH 112463, sterile female. Note that the larger chromosomes (nos. 1 through 6) are arranged on two rows, reading left to right, upper to lower. C. *Sceloporus occidentalis* from northwestern California, with chromosome number 8 heteromorphic (one metacentric, one subtelocentric; arrow), AMNH 108025, female.

dividual out of 16 karyotyped from the local population, although an unreduced gamete may have been involved.

Witten (1978) reported an aberrant triploid individual of an Australian agamid lizard, *Amphibolurus nobbi.* The triploid apparently was an otherwise normal male, except that spermatogenesis was atypical and produced triploid secondary spermatocytes. In addition, Hall (1980) mentioned finding four triploids among more than 1200 diploid *Sceloporus grammicus* karyotyped; one of those triploids was from a hybrid zone.

ECOLOGY: I have had access to three collections of fence lizards from the zone of sympatry: (1) three *S. occidentalis* and eight *S. undulatus* collected by Gene C. Olson on 1 August 1971 (I do not know whether he collected additional specimens at the time); (2) one *S. occidentalis* (the only one seen) and 11 *S. undulatus* collected 26–27 July 1972 by Matthew Zweifel and me; and (3) 15 *S. occidentalis* and 11 *S. undulatus* (many others were seen) collected on 18 May 1975 by Michael D. Robinson, Carol R. Townsend, and me. Hybrids were not evident on any of these occasions.

The following description is largely paraphrased from my field notes of 18 May 1975, taken at 5.2 miles (by road to Oak Grove Camp) north-northwest of Leeds, at 4800 feet elevation in the Pine Valley Mountains, Washington County, Utah, with Dr. Michael D. Robinson assisting in plant identification. Heading up the road into the mountains, we were essentially at the intersection with a road merging from the right (to Horse Valley, 4 mi.; and Wet Sandy, 6 mi.).

The habitat is piñon-juniper woodland (fig. 6) with chaparral species of plants in the understory, including *Arctostaphylos, Garrya, Quercus turbinella, Coenothus gregii,* a platyopuntia in addition to a beavertail-like *Opuntia, Vitis arizonica, Yucca* (presumably *Y. bocata*), and *Agave.* Rocks, including granite boulders with caprocks, are numerous and Dr. Robinson found one each of *S. occidentalis* and *S. undulatus* (both collected) concurrently on one rock (fig. 6). *Sceloporus undulatus* was generally conspicuous except in small areas with an intimate association between granite boulders and *Quercus turbinella,* where, on several occasions, we found *S. occidentalis* in local "pockets." We also found "pockets" of *S. occidentalis* on piled boulders edging Leeds Creek or an adjacent small creekbed. In general, we saw twice as many *undulatus* as we saw *occidentalis,* although we did not need to collect as many. By 11:30 A.M. we had extensive cloud cover and a light rain fell. *Sceloporus undulatus* became less evident at this time, whereas *S. occidentalis* did not. Later we noted that there was still snow on the ground in sheltered patches higher than Oak Grove Camp, at 6500 feet elevation, 9.5 miles north-northwest of Leeds. This delightful, scenic canyon with a nice campground would be quite suitable for a local ecological and behavioral study of congeners, for in addition to the two species of fence lizards, we found *Sceloporus magister* and *Sceloporus graciosus* in abundance, the latter mostly at higher elevations.

## GEOGRAPHIC VARIATION IN CHROMOSOMES OF *Sceloporus occidentalis*

To date, I have karyotyped 59 *S. occidentalis* (32 males, 27 females) from many localities representing much of its range (Utah to California, Washington to Baja California Norte). Normally, the karyotype at all localities is the same as the one shown in figure 4B. However, a karyotype differing in one centromere position (and most readily explained by a single unequal pericentric inversion or a centric shift) was found in northwestern California. Here, four of the 12 lizards examined from Del Norte, Trinity, and Shasta Counties had chromosome number 8 heteromorphic, with one being the typical metacentric element and one being subtelocentric (fig. 5C). The four lizards with this heteromorphism included both sexes (two males, two females), as did the eight other lizards from this area that had the homomorphic (metacentric) pair 8 (two males, six females), so sex chromosomes are not involved; chromosome number 8 in *S. occidentalis* can be regarded as an autosome.

Unless a deleterious recessive allele is on the subtelocentric chromosome 8, it is likely that individuals homozygous for the subtelocentric 8 also occur in the area. In fact, if the two forms of chromosome 8 occur at Hardy-Weinberg equilibrium, we can predict the frequency of individuals homozygous for the subtelocentrics as follows (although the sample is small): Let p = the frequency of metacentric chromosome 8 and q = the frequency of subtelocentric 8 (= 1 − p). Since 12 lizards were examined, the sample includes 24 num-

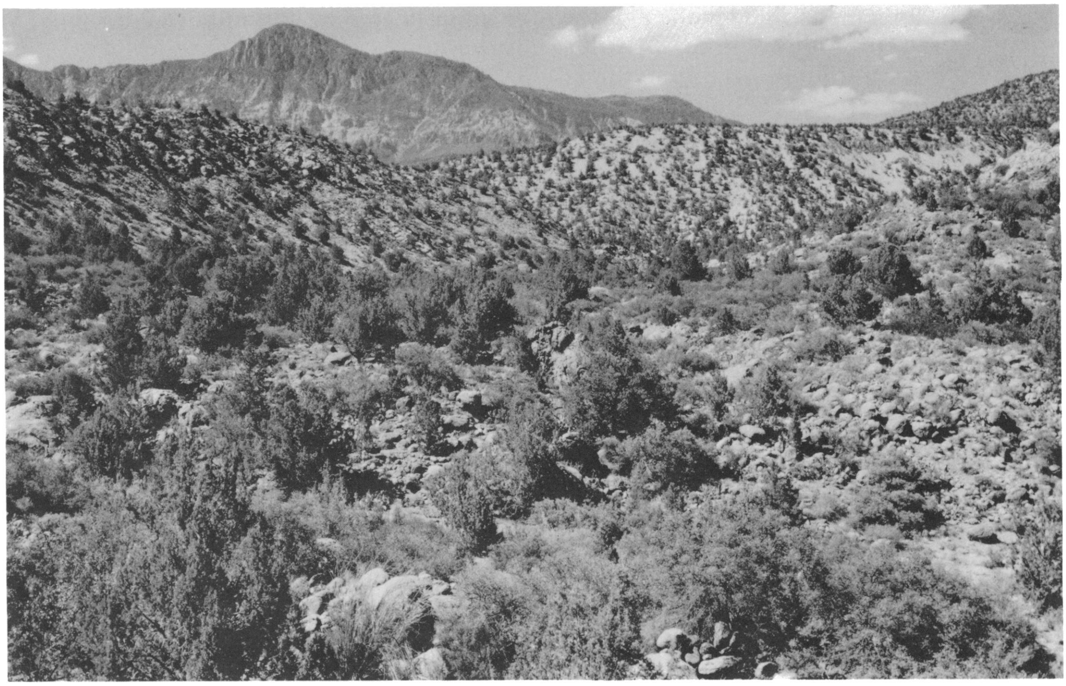

FIG. 6. Habitat at area of sympatry between *S. occidentalis* and *S. undulatus,* Pine Valley Mountains, Washington Co., Utah. Individuals of both species were basking concurrently on the large rock in the foreground of the bottom photograph.

ber 8 chromosomes (as counted in the zygotes from which the 12 lizards developed). Of these 24, 20 were metacentric ($p = 0.83$) and four were subtelocentric ($q = 0.17$). Consequently, the frequency of lizards homozygous for subtelocentric number 8, $q^2$, would be on the order of 0.03, or about one lizard out of 35.

The figures discussed above are crude estimates, not only because of the small sample but also because the figures involve pooling samples from three localities in three counties. It is possible that the frequencies of the dimorphic chromosomes differ at different localities, and it is even possible that the subtelocentric number 8 is fixed in some populations and the heterozygotes are intergrades. Present samples are inadequate for exploring these questions further, but it may be useful for future efforts to specify the localities where specimens heterozygous for chromosome 8 were collected (see Specimens Examined).

### AUTHORSHIP OF *Sceloporus undulatus*

Several recent herpetologists, myself included, have considered Latreille as the author of the name *Stellio undulatus* (=*Sceloporus undulatus*), with the year of publication of 1802. Banta (1961) briefly discussed the indication that Bosc had an important role in the original naming and describing of this species, but Banta and others overlooked a scholarly report by Harper (1940), which was brought to my attention by Richard G. Zweifel. Harper (p. 712) carefully discussed problems of authorship and dates of publication, and, following his conclusions, it seems appropriate to cite the name as *Sceloporus undulatus* (Bosc and Daudin, in Sonnini and Latreille, 1801).

## CONCLUSIONS

1. *Sceloporus undulatus* and *Sceloporus occidentalis* are properly treated as different species, as they are sympatric in the Pine Valley Mountains, Washington County, Utah, without evidence of interbreeding.
2. The most reliable characters for identifying individuals of these two species from the area of sympatry are in coloration and karyotypes.
3. Triploidy is a rare abnormality that occurs in lizards of normally diploid, bisexual species.
4. The unusual triploid *S. occidentalis* reported here was a sterile female that appeared normal in nonreproductive characters.
5. Chromosome number 8 is a dimorphic autosome in *S. occidentalis* from northwestern California, one chromosome being metacentric (typical) and one being subtelocentric.
6. The scientific name of the eastern fence lizard should be referred to as *Sceloporus undulatus* (Bosc and Daudin, in Sonnini and Latreille, 1801), following the study by Harper (1940).

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