

Fossil Lizards from the Elsinore Fault Zone, Riverside County, California

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INTRODUCTION

Recent salvage and mitigation efforts conducted by the San Bernardino County Museum Paleontologic Resource Assessment Program near Murrieta, Riverside County, California produced a significant number of fossil vertebrate remains from sediments mapped by Kennedy (1977) as an unnamed sandstone and conglomerate unit. Kennedy (1977) indicates that this unit unconformably underlies the Pauba Formation and may overlie the Temecula Arkose in the Elsinore Fault Zone. A Pliocene age is assigned to the Temecula Arkose based on the presence of mammalian taxa indicative of the Blancan North American Land Mammal Age (Golz et al., 1977; Reynolds and Reynolds, 1993). Fossil vertebrates have been reported from the Pauba Formation (Mann, 1955; Reynolds and Reynolds, 1990b; Bowden and Scott, 1992) and the unnamed sandstone (Reynolds and Reynolds, 1990a; Reynolds et al., 1990, 1991; Scott and Cox, 1993).

Reynolds and Reynolds (1990a) and Reynolds et al. (1991) tentatively proposed that an ash layer present in the unnamed sandstone is contemporaneous with the Bishop tuff dated at 700,000 yr BP (Dalrymple et al., 1965; Merriam and Bischoff, 1975). Suggestions of a late Irvingtonian age for the unnamed sandstone (Reynolds et al., 1990, 1991) were based on this presumed ash correlation and on the supposed presence of the rodent *Clethrionomys*. The ash from the unnamed sandstone, however, remains undated and has not conclusively been shown to correlate with the Bishop tuff. In addition, specimens originally identified as *Clethrionomys* were recently reexamined and determined to belong to the species *Mimomys (Ophiomys) parvus* (C. A. Repenning, pers. comm., 1993) of Blancan V age (Repenning et al., 1990). A detailed review of the biostratigraphy of the unnamed sandstone indicates a late Blancan and/or early Irvingtonian age for the sediments as a whole, however individual vertebrate fossil collection localities sampled from the unit appear to contain faunas of one age or the other (Scott and Cox, 1993).

The lizard fossils reported here are from the Morrison Homes parcel in the unnamed sandstone (County of Riverside Tract 23110, accessioned

under San Bernardino County Museum # A2535). A single tooth of the Pliocene rabbit *Hypolagus* was recovered from this parcel, but appears to be reworked (Scott and Cox, 1993). Apart from this, no Blancan indicator taxa are known from the unnamed sandstone at Morrison Homes.

A better understanding of the stratigraphic relationships within and among the geologic units along the Elsinore Fault Zone is necessary to clarify the relationships of the recovered faunas, and this report is a preliminary step towards building an understanding of the herpetofaunas from the region.

SYSTEMATIC PALEONTOLOGY

Class Reptilia Laurenti, 1768
Order Squamata Oppel, 1811
Suborder Sauria McCartney, 1802
Family Phrynosomatidae Fitzinger, 1843
Genus *Phrynosoma* Wiegmann, 1828
Phrynosoma coronatum (Blainville, 1835)

Referred Specimens: A2535-0257, left squamosal.

Description: This single specimen is assigned to species based upon the diagnostic features of the squamosal. There are two primary horns present, the posterior larger than the anterior. The two horns are connected at their base. Two accessory horns are also present, one positioned posterior and dorsal to the base of the posterior primary horn, the second positioned dorsal to the junction of the bases of the two primary horns. Although the squamosal was not discussed as a diagnostic element by Presch (1969) or Montanucci (1987), Norell (1989) demonstrated that the horn morphology of this bone may be used to distinguish fossil and living species of the genus. The number of squamosal horns varies in the 12 living species recognized by Montanucci (1987) and among fossil species preserving squamosals. *P. solare* and *P. josecitensis* have 4; *P. ditmarsii* and *P. modestum* have 3 or 4; *P. anzaense*, *P. braconnieri*, *P. cornutum*, *P. mcallii*, *P. orbiculare*, and *P. platyrhinus* have 3; *P. coronatum* and *P. douglassii* have 2 or 3; *P. asio* has 2; *P. taurus* has 1 enlarged horn (Brattstrom, 1955; Presch, 1969; Montanucci, 1987;

Norell, 1989). The squamosal horn patterns of the extinct species *P. adinognathus* (Rickart, 1976) and *P. holmani* (Eshelman, 1975; Van Devender and Eshelman, 1979) are unknown. Two forms, *P. cerroense* and *P. boucardii*, not included in Montanucci's (1987) treatment were recognized by Presch (1969). The former is an endemic species (closely related to *P. coronatum*) on Cedros Island off the west coast of Baja California, and has 3 squamosal horns, the latter has been synonymized under *P. orbiculare* (Montanucci, 1979). *P. cerroense* was not included in Norell's (1989) analysis of squamosal horn morphology, and specimens were not available for comparisons with the Morrison Homes fossil. In *P. asio*, the two squamosal horn bases are separate and an accessory horn, when present, is located at the anterior base of the anterior horn. The horns of *P. douglassii* are not as large as the horns in the Morrison Homes specimen.

The presence of 2 primary squamosal horns and the relative position of these and the accessory horns on the fossil are the characters used to identify the specimen to *P. coronatum*. This species lives in the Murrieta area today (Stebbins, 1985). The phylogenetic reconstructions of *Phrynosoma* by Presch (1969) and Montanucci (1987) both place *P. orbiculare* as the most primitive living member of the genus, with *P. coronatum* or its sister species being an early derivative form which gave rise in the Pliocene and Pleistocene to the more xeric adapted species *P. cornutum*, *P. mcallii*, *P. modestum*, *P. platyrhinos*, and *P. solare*. Although *P. coronatum* is considered to be an early derivation within the genus, the fossil record for this species is extremely limited. *P. coronatum* is known from late Pleistocene/early Holocene deposits at Rancho La Brea and Maricopa, and from ?Irvingtonian to late Pleistocene sediments in the Emery Borrow Pit in Orange County, California (Brattstrom, 1953; Jefferson, 1991). This specimen from Morrison Homes represents the earliest known fossil of this species.

Phrynosoma sp.

Referred Specimens: A2535-0254, A2535-0838c, right maxillae; A2535-0255, right maxilla fragment; A2535-0253, left maxilla fragment; A2535-0256, left squamosal fragment.

Description: The dorsal portion of the maxillae of *Phrynosoma* species typically show a narrow, dorsally projecting, anteriorly directed ramus. The

crowns of the posterior teeth of *Phrynosoma* are typically simple, blunt, and peglike, but may be tricuspid with very small secondary cusps (Etheridge and de Queiroz, 1988). The fossil maxillae above show the typical morphological characters for the genus.

Robinson and Van Devender (1973) provide a brief discussion of the morphology of the maxillae of seven species of *Phrynosoma*. They use a combination of total maxillary tooth space counts and general morphology to distinguish some species. They note a prominent ridge on the labial surface of the maxilla of *P. coronatum*, but do not comment on the presence or absence of this feature in other species. In order to determine whether this character remains valid with a larger sample size and across taxa, I examined 9 additional specimens of *P. coronatum* and available specimens of other species (Figure 1, Table 1). The ridge is strongly developed to moderately well developed in specimens of *P. coronatum*, *P. platyrhinos*, and *P. solare*, and is weakly developed in some specimens of *P. cornutum*, *P. coronatum*, and *P. solare*. No ridge was found on available specimens of *P. douglassii*.

Table 1 also provides total tooth space counts of examined specimens and the range for tooth spaces is expanded for 3 species: *P. cornutum*, *P. coronatum*, and *P. platyrhinos* (Table 2). I found no consistently reliable means of distinguishing isolated maxillae of all species of *Phrynosoma*, although the extremely reduced dentition of *P. solare* noted by Robinson and Van Devender (1973)

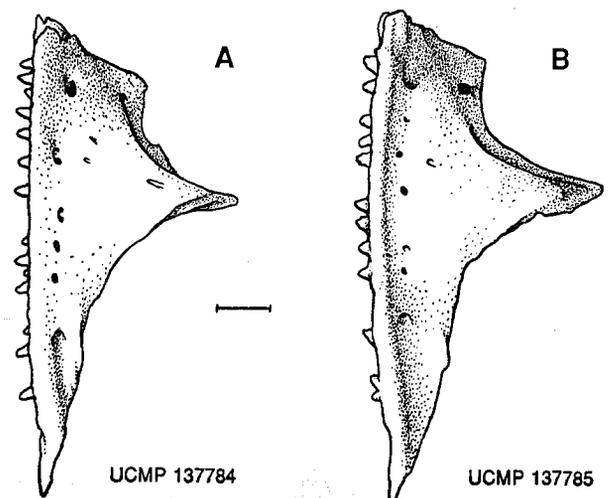


Figure 1. Left maxilla of two modern *Phrynosoma solare* showing the weak (A) and strong (B) development of a ridge on the labial surface. Scale bar = 1 mm.

Table 1. Total maxillary tooth space counts for specimens of five species of *Phrynosoma* housed in the UCMP collections. The relative development of a ridge on the labial surface of the maxilla is noted. rt. = right; lt. = left; n.a. = not observed.

Species	Specimen #	Total tooth spaces	Development of labial ridge
<i>P. cornutum</i>	118979	12	weak
	118980	14	weak
	137775	14	n.a.
	137776	14	weak
	137779	16	weak
	137782	19 rt., 16 lt.	absent
<i>P. coronatum</i>	117136	14	weak
	117165	14	weak
	117164	15	weak
	118982	16	weak
	118981	17	weak
	137781	17	moderate
	123059	19	moderate
<i>P. douglassii</i>	118983	17	absent
	137791	19	absent
<i>P. platyrhinos</i>	117137	13	strong
	113138	16	strong
	85186	17	n.a.
	118978	17	moderate
<i>P. solare</i>	137783	15	strong
	137777	16	strong
	137785	16	strong
	137784	17	weak

is present in all specimens of this species I examined, and is probably a taxonomically useful character.

Only the anterior two thirds or so of A2535-0256 is preserved and does not display any characters which may be used to definitively place it within any species of *Phrynosoma*. There are two horns preserved, the anterior horn being the smaller and very reduced in size. The posterior preserved horn is also quite small and the bases of the two horns do not connect.

There are three species of horned lizards living in California, *P. coronatum*, *P. mcallii*, and *P. platyrhinos*, but only *P. coronatum* lives in the Murrieta area today (Stebbins, 1985). The extinct species *P. anzaense* is known only from the Palm Springs Formation in the Anza Borrego Desert (Norell, 1989). *Phrynosoma* fossils are relatively common in fossil lizard faunas in the southwestern United States (Mead and Bell, in press; Jefferson, 1991).

Table 2. Summary table of total maxillary tooth space counts for seven species of *Phrynosoma*. Mean number and observed range of total tooth spaces, and number of specimens examined (N) are provided. n.a. = no specimens observed; R&VD = data from Robinson and Van Devender (1973); Bell = data summarized from Table 1.

Species	Mean total tooth spaces	Observed range	N
<i>P. cornutum</i>			
R&VD	14	12-18	15
Bell	15	12-19	6
<i>P. coronatum</i>			
R&VD	17	17	2
Bell	16	14-19	7
<i>P. douglassii</i>			
R&VD	17.3	13-23	47
Bell	18	17-19	2
<i>P. mcallii</i>			
R&VD	14	14	2
Bell	n.a.	n.a.	n.a.
<i>P. modestum</i>			
R&VD	17	16-18	6
Bell	n.a.	n.a.	n.a.
<i>P. platyrhinos</i>			
R&VD	14	12-16	28
Bell	15.75	13-17	4
<i>P. solare</i>			
R&VD	14.3	12-17	22
Bell	16	15-17	4

Sceloporine, sp. indet.
(*sensu* Etheridge and de Queiroz, 1988)

Referred Specimens: A2535-0287, A2535-0838b, right maxillae; A2535-0245, A2535-0248, left maxilla fragments; A2535-0250, right dentary; A2535-0246, left dentary; A2535-0247, 2 left dentary fragments; A2535-0249, left dentary fragment; A2535-0430b, 2 left dentary fragments.

Description: The extant Phrynosomatids (*sensu* Frost and Etheridge, 1989) can be divided into four generic groups: 1) *Pertrosaurus* group, 2) *Sator* - *Sceloporus* - *Urosaurus* - *Uta* group (the "*Sceloporus* group"), 3) sand lizard group including *Callisaurus*, *Cophosaurus*, *Holbrookia*, and *Uma*, and 4) *Phrynosoma* group (Etheridge and de Queiroz, 1988). The problems of distinguishing isolated skeletal elements from taxa within a group are

discussed elsewhere (see Etheridge, 1964; Larsen and Tanner, 1974; Gauthier, 1982; Wellstead, 1982; Norell, 1989). The general dental characteristics of each group are presented by Norell (1989), and the specimens recovered from the Morrison Homes parcel most closely resemble the "*Sceloporus* group" in general morphology. The teeth are tricuspid and high-crowned with expanded bases. The teeth of some specimens have well defined cusps, in others the lateral cusps are merely weakly developed shoulders on the edges of the crown. All the specimens here are of small sized lizards within the size range of *Urosaurus*, *Uta* and the smaller species of *Sceloporus*. Representatives of all three of these genera live in the Murrieta area today (Stebbins, 1985). Sceloporines are an important component of Pleistocene herpetofaunas throughout the southwestern U.S. (Mead and Bell, in press; Jefferson, 1991).

Family Teiidae Gray, 1827

Genus *Cnemidophorus* Wagler, 1830

cf. *Cnemidophorus* sp.

Referred Specimens: A2535-0267a, A2535-0267b, A2535-0268, right maxillae; A2535-0270, right maxilla fragment; A2535-0269, 2 right maxilla fragments; A2535-0261, A2535-0262, A2535-0263, left maxillae; A2535-0265, A2535-0266, left maxilla fragments; A2535-0264, 2 left maxilla fragments; A2535-0156b, 2 right dentaries; A2535-0280, 5 right dentaries; A2535-0279, 2 right dentaries; A2535-0278, right dentary; A2535-0281, 2 right dentary fragments; A2535-0271, A2535-0272, A2535-0273, A2535-0274, A2535-0275, A2535-0276, left dentaries; A2535-0277, 3 left dentaries; A2535-0156c, left dentary fragment; A2535-0282, A2535-0283, frontal; A2535-0284, frontal fragment; A2535-0285, left quadrate.

Description: Teeth of *Cnemidophorus* are asymmetrically bicusperate, with an anteriorly directed smaller cusp. The dorsal portion of the maxilla forms an anteroposteriorly broad-based triangle which displays no distinct dorsal ramus. The Meckelian canal of the dentary is open ventrally for its entire length. The frontal has a rugose dorsal surface and three anterior processes, the longest in the middle for insertion between the nasals. There is no pineal foramen. The frontal narrows posterior to the mid point, but widens to reach its greatest width at the posterior margin where it contacts the parietal. Mead (1988) demonstrates the potential for using quadrates to

distinguish lizard taxa and the quadrate of teiids is unlike that of any other North American lizards I examined. The lateral border is slightly expanded and strongly recurved, forming an anterior tympanic recess (Fisher and Tanner, 1970). There are several extant species of *Cnemidophorus* in western North America (Stebbins, 1985) and individual skeletal elements cannot be reliably identified to the specific level. In addition, Presch (1974) found that there were no significant osteological differences between *Cnemidophorus* and *Ameiva*. These two genera can be distinguished from *Kentropyx* by their concave parietal-frontal roof (Presch, 1974). Because these specimens could potentially represent *Ameiva*, they are only tentatively referred to *Cnemidophorus*, and are not assigned with certainty. Although the specimens are most likely from the more northern genus *Cnemidophorus*, it is possible that the southern *Ameiva* may have ranged further North during Irvingtonian time. There are two extant species of *Cnemidophorus* in California, *C. hyperythrus* and *C. tigris*, and both occur in the Murrieta area (Stebbins, 1985). Fossil specimens of *Cnemidophorus* have been recovered from numerous Pleistocene localities in the southwestern United States (Mead and Bell, in press; Jefferson, 1991).

Family Scincidae Gray, 1825

Genus *Eumeces* Wiegmann, 1834

Eumeces sp.

Referred Specimens: A2535-0259, A2535-0260, left dentaries; A2535-0709b, left dentary fragment.

Description: Posteriorly, the Meckelian groove in the dentary of *Eumeces* is broadly open and directed lingually. The groove narrows and becomes ventrally directed as it nears the symphysis. The teeth are unicusperate, generally closely and regularly spaced, with lingually concave, striated crowns, of a uniform height above the dentary parapet (Estes, 1963; Norell, 1989). Individual skeletal elements of *Eumeces* can be extremely difficult to distinguish at the species level (Estes, 1963; Nash and Tanner, 1970; Norell, 1989) and no characters have been found to identify these specimens beyond generic rank. There are two species extant in California, *E. gilberti* and *E. skiltonianus*, and both occur in the general region of the Morrison Homes deposits (Stebbins, 1985). The fossil specimens are relatively small and are within the size range of a young *E.*

gilberti or of an adult *E. skiltonianus*. *Eumeces* is a fairly common component of fossil lizard faunas in California (Jefferson, 1991; Norell, 1989).

Family Anguinae Gray, 1825
Subfamily Gerrhonotinae Tihen, 1949
gen. et sp. indet.

Referred Specimens: A2535-0838d, A2535-0838e, right dentaries; A2535-0838f, left dentary; A2535-0838g, frontal.

Description: The difficulties in assigning gerrhonotine fossil elements to genus or species are discussed at length by Gauthier (1982) and Good (1987, 1988). The dental characteristics listed by Gauthier (1982) as diagnostic for Anguinae are present in these dentary specimens. These include chisel-shaped teeth which form an inwardly pointing V in occlusal view, with striae on the medial face of the crown. The Gerrhonotinae is diagnosed by only two character states: elongate supratemporals and fused, hourglass shaped frontals (Good, 1988). The dentaries above are assigned to this subfamily based on their association with the frontal. Identification beyond the subfamily is not possible based on the material preserved. The only extant gerrhonotine in the Murrieta area is *Elgaria multicarinata* (Stebbins, 1985). Fossil gerrhonotines are fairly common in California (Jefferson, 1991; Good, 1988).

Subfamily Anniellinae Nopsca, 1928
Genus *Anniella* Gray, 1852
Anniella sp.

Referred Specimens: A2535-0430c, 2 dorsal vertebrae; A2535-0430d, 3 dorsal vertebrae; A2535-0709c, 2 anterior dorsal vertebrae; A2535-0840b, 1 dorsal vertebra; A2535-0840c, 1 dorsal vertebra.

Description: The anguimorph affinities of the osteology of *Anniella* are discussed by Gauthier (1980, 1982). There are two extant species of *Anniella*, but there are no characteristics of isolated vertebrae which may serve to distinguish them (Gauthier, 1980). Members of the genus *Anniella* are small, fossorial lizards whose modern distribution includes coastal and near-coastal California and Baja California del Norte, Mexico (Stebbins, 1985). *Anniella* fossils were recovered from Clarendonian (Miocene) sediments in Contra Costa County, California (Gauthier, 1980) and Reynolds et al. (1990, 1991) include *Anniella* in

faunal lists from other localities within the unnamed sandstone. The larger, extinct *Apodosauriscus* from the Early Eocene of Sweetwater County, Wyoming (Gauthier, 1982) is the only other member of the Anniellinae, and is known only from the type locality.

COMPARISON OF FAUNA

The Plio-Pleistocene Palm Springs Formation in the Anza Borrego Desert (Norell, 1989) produced the nearest roughly contemporaneous fossil lizard fauna. Taken as a whole, the Morrison Homes and Anza Borrego lizard faunas are similar in some respects, yet differ in a few significant ways. Both include *Phrynosoma* (though different species), *Eumeces*, a teiid (*Ameiva* or *Cnemidophorus*) and indeterminate sceloporine and gerrhonotine taxa. Although no extinct taxa are recognizable among the Morrison Homes lizards, the Anza Borrego Fauna includes several extinct taxa, including the iguanid *Pumilia novaceki**, the crotophytid *Gambelia corona*, and the xantusiid *Xantusia downsi** (the asterisk denotes a metasppecies, *sensu* Norell, 1989).

There is some faunal evidence suggesting that the Morrison Homes lizards were living in relatively more mesic conditions than found at Anza Borrego. Two taxa are particularly suggestive. The desert iguana, *Dipsosaurus dorsalis*, from Anza Borrego is today a desert dwelling lizard with a high thermal tolerance and a preferred body temperature (38.5°C) near the maximum level tolerated by *Anniella* (Miller, 1944; DeWitt, 1967). The two taxa are currently almost entirely allopatric, although Klauber (1932) reports *Anniella* from the base of the desert foothills in eastern San Diego County, in possible association with *Dipsosaurus dorsalis*. The two taxa are not found in association in the fossil record. Both genera favor sandy substrates, but the distribution of *Anniella* is at least in part controlled by soil moisture content (Stebbins, 1985; Norris, 1953; Miller, 1944).

The other lizard taxa from the two faunas do not provide much information regarding paleoenvironments at the two localities because they are extinct, are relatively cosmopolitan taxa (eg: *Cnemidophorus*), or cannot be identified to a level at which ecological information can be inferred.

Comparisons of the faunas are hindered by the lack of tight chronological control in the unnamed sandstone deposits. An examination of the stratigraphic distributions of the lizard taxa in the

Palm Springs Formation (Norell, 1989:27) indicates that some taxonomic changes took place through the depositional sequence. Norell (1989) does not provide stratigraphic data for *Gambelia corona*, *Phrynosoma*, or the gerrhonotine, but an increase in sceloporine taxa concurrent with the disappearance of *Dipsosaurus* and *Pumilia* just before the Plio-Pleistocene boundary is evident. *Xantusia* is present in both the Blancan and Irvingtonian components of the Palm Springs Formation, but is found in greater abundance in the Irvingtonian. The teiid and *Eumeces* are present fairly consistently throughout the section. If an Irvingtonian age for the Morrison Homes parcel is correct, then this fauna postdates the disappearance of *Dipsosaurus* from the Anza Borrego locality and indicates a greater taxonomic similarity between the two faunas. This may suggest that during the late Pliocene and early Pleistocene the two regions were not as significantly segregated environmentally as they are today.

The Soboba fossil flora from near San Jacinto, California (North and East of the Morrison Homes project area) is roughly contemporaneous with the Morrison Homes deposits. Analysis of this fossil flora suggests an increased effective precipitation in the region at the time, with a slightly lower mean annual temperature, but a seasonality similar to that of today (Axelrod, 1966).

The two faunas suggest a modernization of the lizard fauna of southern California (at the generic and subfamilial level) by the beginning of the Pleistocene, and support the hypothesis that the squamate faunas in this region have a long history essentially in place as they are today (Savage, 1960; Norell, 1989).

ACKNOWLEDGEMENTS

I thank Robert E. Reynolds, Richard L. Reynolds, Alois Pajak, Charles Repenning and especially Eric Scott for many enlightening discussions regarding the faunas from the Murrieta area and the geology and chronology of the unnamed sandstone. Kathleen Springer and Robert E. Reynolds provided access to the specimens in their care. Scott Springer provided help in synthesizing locality information and Marnie Crook curated the lizard fossils. Special thanks to J. Howard Hutchison for preparing the illustrations. Many helpful comments on an early version of this paper were provided by Drs. J. Howard Hutchison and Jim I. Mead. This is contribution #1601 from the University of California Museum of Paleontology.

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