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First described species of *Costacopluma* (Crustacea: Brachyura: Retroplumidae) from the Pacific slope, Paleocene of California, USA

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Abstract

A new species of the brachyuran crab *Costacopluma* Collins and Morris, 1975, *Costacopluma squiresi*, is described from lower Paleocene strata of the San Francisquito Formation and upper Paleocene strata of the Santa Susana Formation of southern California. *Costacopluma squiresi* represents the first described species of *Costacopluma* from the Pacific Coast of North America.

Keywords: Crustacea, *Costacopluma*, Paleocene, California.

Resumen

Una especie nueva de cangrejo braquiuro *Costacopluma* Collins y Morris, *Costacopluma squiresi*, es descrita de estratos del Paleoceno Inferior de la Formación San Francisquito y de estratos del Paleoceno Superior de la Formación Santa Susana del sur de California. Esta especie representa la primera especie descrita de *Costacopluma* en la costa del Pacífico de Norteamérica.

Palabras clave: Crustacea, *Costacopluma*, Paleoceno, California.

1. Introduction

Two specimens of *Costacopluma* have been discovered in outcrops of Paleocene strata of the San Francisquito and Santa Susana formations of southern California. One of these specimens was reported earlier, but the species was not described or named (Nyborg *et al.*, 2003). One of the specimens was collected from an outcrop of the lower Paleocene (Danian) portion of the lower San Francisquito Formation northwest of Warm Springs Mountain, Los Angeles County, California (Figure 1, LACMIP locality 21580), which is part of a small area of outcrop in the central Transverse Ranges (Kirby and Saul, 1995; Prothero and Vacca, 2001). The San Francisquito Formation ranges in age from latest Cretaceous to late Paleocene (Dibblee, 1967; Sage, 1973; Kooser, 1980, 1982; Kirby and Saul, 1995; Squires, 1997; Prothero and Vacca, 2001) and consists of 100 m of shallow-marine deposits overlain by and interfingering with deep marine sediments (Sage, 1973; Kirby, 1991). In the vicinity of Warm Springs Mountain, the San Francisquito Formation is part of a shallow-marine phase of a transgressive sequence that continued across the Cretaceous/Tertiary boundary and into the Paleocene (Kooser, 1980; Kirby, 1991; Kirby and Saul, 1995). The horizon containing the Cretaceous/Tertiary boundary near Warm Springs Mountain is within an 8 m-thick interval composed of shoreface, transition zone and offshore deposits (Kirby, 1991). Deposition of the basal portion of the San Francisquito Formation was probably nearly

continuous across the Cretaceous/Tertiary boundary based on sedimentology (Kirby, 1991), as well as on biostratigraphic age constraints primarily recognized by the *Turritella* zonation of Saul (1983b). Abundant specimens of the gastropod *Turritella peninsularis quaylei* Saul, 1983, a taxon which indicates the horizon is within the Danian Stage of the Paleocene Series, and the specimen of *Costacopluma squiresi* were collected from beds approximately 75 m above the Cretaceous/Tertiary boundary (Kirby, 1991; Kirby and Saul, 1995).

The second specimen was collected from shallow-marine beds in the upper portion of the Santa Susana Formation in Quarry Canyon, in the east-central Santa Monica Mountains, Los Angeles County, California (Figure 1, LACMIP locality 11688; see Squires and Saul, 1998 and 2007, for details of the stratigraphy in this area). A recent geologic map of the region (Dibblee, 1992) and subsequent stratigraphic and paleontologic investigations (Colburn, 1996; Colburn *et al.*, 1988; Squires and Kennedy, 1998; Squires and Saul, 1998) have demonstrated that the rocks in Quarry Canyon are part of the Santa Susana Formation. The lithology of the outcrop from which the specimen was collected consists of coralline-algal-rich muddy siltstone that is related to adjacent beds of coralline-algal limestone and interpreted to have been deposited in nearshore, tropical to subtropical conditions (Squires and Saul, 2007). Squires and Saul (1998) assigned the strata of Quarry Canyon and the surrounding area to the provincial "Martinez Stage" of late Paleocene age. Colburn *et al.* (1988) and Colburn

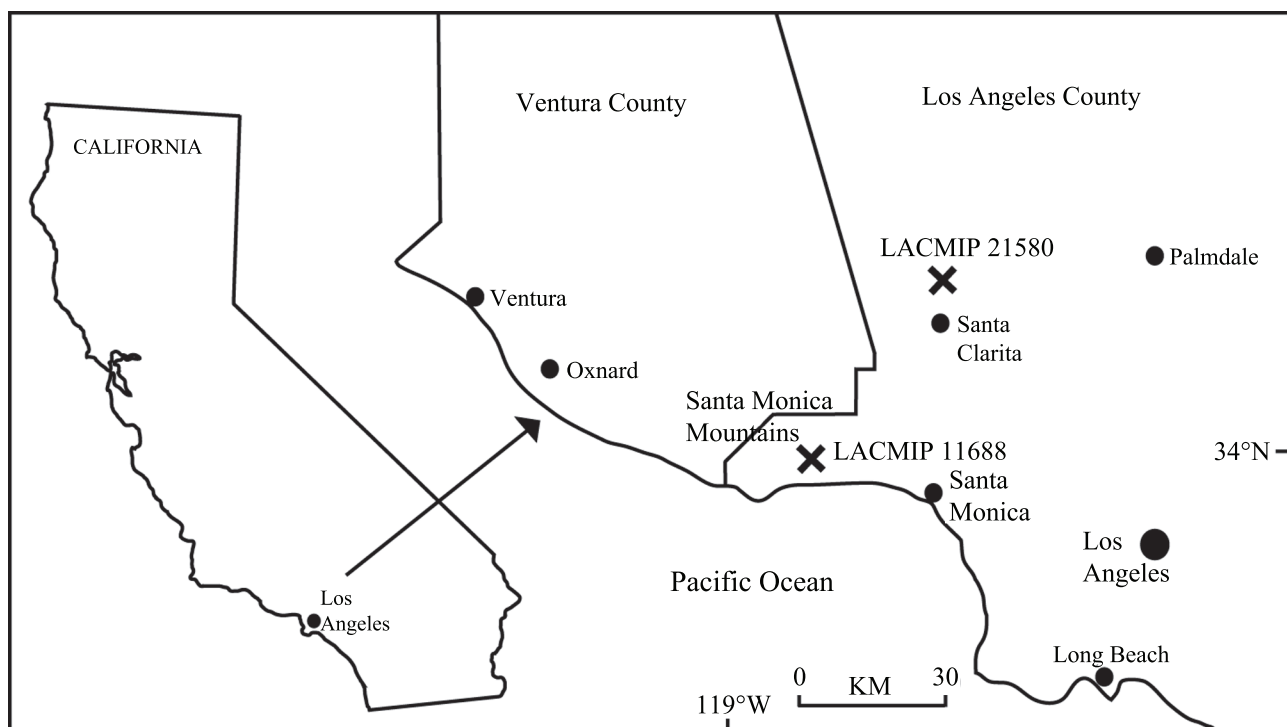


Figure 1. Generalized location map showing position of the two localities where *Costacopluma squiresi* new species, was collected.

(1996) concluded that the upper portion of the Santa Susana Formation was deposited in a low-energy protected bay that was not more than 40 m in depth. Macrofossils and microfossils collected from outcrops of the Santa Susana Formation in the Santa Monica Mountains (Squires, 1997; Squires and Saul, 1998; Squires and Kennedy, 1998) and in the Simi Hills (Zinsmeister, 1983a, 1983b; Saul, 1983a, 1983b; Heitman, 1983; Frederickson, 1983; Filewicz and Hill, 1983; Squires, 1999) are indicative of a late Paleocene age. Two other fossil crabs have been reported previously from the Santa Susana Formation: *Cyclocorystes alderstoni* Squires, 1980, and *Zanthopsis* sp. aff. *Z. hendersoni* Rathbun, 1926 (Squires, 1999).

2. Systematic Paleontology

Infraorder Brachyura Latreille, 1802
 Section Eubrachyura Saint-Laurent, 1980
 Subsection Heterotremata Guinot, 1977
 Superfamily Retroplumoidea Gill, 1894
 Family Retroplumidae Gill, 1894
 Genus *Costacopluma* Collins and Morris, 1975

Type species. *Costacopluma concava* Collins and Morris, 1975, p. 823, pl. 97, figs. 1-9, by original designation.

Costacopluma squiresi new species

Figure 2.1-2.4

Costacopluma n. sp. Nyborg, Vega, and Filkorn, 2003, p. 166.

Diagnosis. Carapace small, subtrapezoidal to subhexagonal elongated, widest at posterior fourth of carapace; marginal notch separates anterolateral from lateral margins; transverse ridges moderately strong, with sharp, granulated crests; areas between ridges ornamented with very fine granules; sternum wide; male abdomen triangular; right cheliped massive.

Description. Carapace small, subtrapezoidal to subhexagonal elongated, maximum length equal to maximum width, widest at posterior fourth of carapace, three moderately strong transverse ridges with fine granulated crests mark carapace regions; regions between ridges ornamented with fine granules; anterior margin sinuous, four-fifths maximum carapace width; strong outer orbital spine; anterolateral margin slightly concave, one-fourth maximum carapace length, marginal notch at level of epibranchial region; posterolateral margin slightly inclined outward, about three-fourths maximum carapace length; posterolateral margin inclined posteriorly, slightly curved, one-fourth maximum carapace width; posterior margin straight, two-thirds maximum carapace width; anterior ridge arched, uniform in width, with sharp crest covered with fine granules; mesogastric lobe rhomboid;

mid-ridge subparallel to anterior ridge, uniform in width, inclined 45 degrees with respect to posterior margin, includes epibranchial and mesobranchial lobes; posterior ridge subparallel to posterior margin, wider at junction with posterolateral margin, includes metabranchial lobes; cardiac lobe subtrapezoidal, one-third carapace width, with fused posterior lobe; intestinal region depressed; cervical groove deeply impressed around cardiac lobe.

Sternum wide, abdominal cavity deep; sternites 1 and 2 unknown; sternite 3 transversely elongated with two lateral, elongated bosses with crests covered by granules, separated from sternite 4 by deep transverse groove; sternite 4 trapezoidal, lateral margins rimmed with numerous tubercles, lateral process triangular, sharp; sternite 5 rectangular, with median ridge with coarse granules on crest, extending to triangular, sharp lateral process; sternite 6 similar to sternite 5; sternite 7 two-thirds width of sternite 6, but with median, granulated crest; male abdomen triangular, elongated, all abdominal segments with a median granulated transverse crest; telson not preserved, but inferred to be triangular based on shape of sternal cavity; segment 4 subtrapezoidal; segment 3 subrectangular, one-third wider than segment 4, but equal in length; segment 2 rectangular, one-third wider than segment 3 and slightly shorter.

Right cheliped robust; merus rectangular, length equal to one-third carapace length, height approximately half its own length, cuticle not preserved, carpus as high as merus and half its length; palm subtrapezoidal, as long as merus, wider at distal portion; dactyl not preserved, but inferred to be unciform based on impression (external mold) in concretion.

Etymology. The species name honors Richard L. Squires, prominent paleontologist and prolific publisher on the stratigraphy and paleontology of the Pacific slope of North America.

Material examined. Two specimens deposited in the collections of the Department of Invertebrate Paleontology, Natural History Museum of Los Angeles County (LACMIP). Holotype, LACMIP specimen 13560, from LACMIP locality 11688, preserves the dorsal carapace and right cheliped. Paratype, LACMIP specimen 13561, from LACMIP locality 21580, preserves the dorsal carapace and portions of the sternum.

Measurements (in mm). Holotype, carapace length = 11.2, width = 11.5; paratype, carapace length = about 13.0, width = 15.8.

Occurrence. The paratype, LACMIP specimen 13561, is from LACMIP locality 21580, lower Paleocene (Danian), San Francisquito Formation, about 3.5 km northwest of Warm Springs Mountain, south side of the East Fork of Fish Canyon, in the canyon wall about 30 feet above the stream bed, Los Angeles County, California. USGS Warm Springs

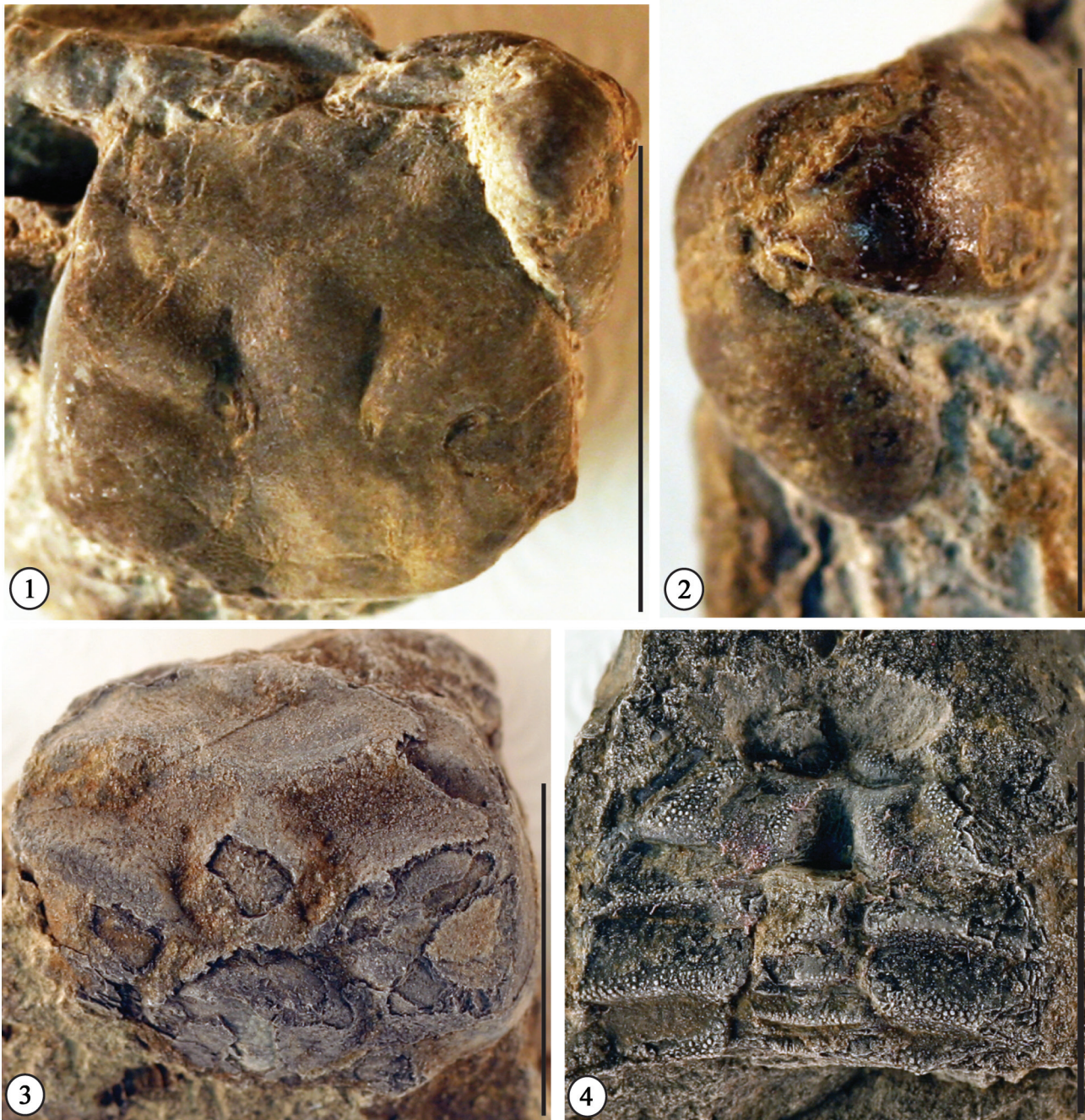


Figure 2. 1 - 4. *Costacopluma squiresi*, new species. 1. Dorsal view of carapace, holotype LACMIP specimen 13560, Paleocene, LACMIP locality 11688. 2. Dorsal view of carapace, paratype LACMIP specimen 13561, Paleocene, LACMIP locality 21580. 3. Lateral view of right cheliped, holotype LACMIP specimen 13560. 4. Ventral view of carapace, paratype LACMIP specimen 13561. Scale bars = 1 cm

Mountain 7.5' Quadrangle, latitude N 34° 36' 39", longitude W 118° 36' 44". Collected by R.W. Webb and E.H. Quayle, June 5, 1941. The holotype, LACMIP specimen 13560, is from LACMIP locality 11688, upper Paleocene provincial "Martinez Stage", in the upper portion of the Santa Susana Formation, Quarry Canyon, near the head of Quarry Canyon and in the canyon bottom at about 1400 feet elevation, in a siltstone about 50 feet above a conglomerate, east-central Santa Monica Mountains, Los Angeles County, California.

USGS Topanga 7.5' Quadrangle, latitude N 34° 5' 20", longitude W 118° 33' 16". Collected by J. M. Alderson, January, 1980.

3. Discussion

Costacopluma squiresi, new species, differs from all other species of the genus in having a nearly square

carapace, weaker transverse ridges, and a dorsal surface covered by very fine granules. All the Paleogene species that have been described previously have a similar small size, but the shapes of their carapaces are distinctly different. *Costacopluma senegalensis* (Gorodiski and Rémy, 1959); *C. binodosa* Collins and Rasmussen, 1992; *C. bifida* Collins, Higgs and Cortitula, 1994; *C. australis* Feldmann, Casadio, Chirino-Gálvez and Aguirre-Urreta, 1995; *C. nordestiana* Feldmann and Martins-Neto, 1995; *C. salamanca* Feldmann, Rodríguez, Martínez and Aguirre-Urreta, 1997, and *C. grayi* Feldmann and Portell, 2007, all possess a subhexagonal to ovate carapace, stronger transverse ridges of unequal width, and relatively stronger granules on the ridge crests. A new species from the Paleocene of Texas (Armstrong *et al.*, in press) is different from *C. squiresi* in having a carapace wider on the posterior third of the carapace, a notch on the anterolateral margin, shorter outer orbital spines, transverse ridges with more rounded crests ornamented with stronger tubercles, and a more swollen mesobranchial ridge.

The oldest known *Costacopluma* species is *C. bishopi* Vega and Feldmann, 1992, from the Coniacian of Guerrero, southern Mexico (Vega and Feldmann, 1992; Fraaije *et al.*, 2006). The youngest representative is *C. grayi* from the Eocene of Alabama (Feldmann and Portell, 2007). During the Late Cretaceous (Campanian-Maastrichtian), *Costacopluma* was distributed in western Africa and north of India (Collins and Morris, 1974; Gaetani *et al.*, 1983), northern Mexico (Vega and Perrilliat, 1989; Vega *et al.*, 1995), southeastern United States (A. Armstrong, pers. comm.) and Colombia (J. Luque, pers. comm.). By Paleocene time, the genus showed a wider distribution, including east Africa (Gorodiski and Rémy, 1959), Greenland (Collins and Rasmussen, 1992), Texas (Armstrong *et al.*, in press), Venezuela (Collins *et al.*, 1994), Brazil (Feldmann and Martins-Neto, 1995; Araujo-Távora and Cruz-Miranda, 2004) and Argentina (Feldmann *et al.*, 1995; 1997). The youngest occurrence for the genus is in Eocene sediments of Alabama (Feldmann and Portell, 2007). The presence of *Costacopluma squiresi* new species in the Paleocene of California is especially interesting because all previously known Cretaceous and Paleogene species of this genus occur in the Atlantic, along the ancient east coast of the Americas (from Greenland to Argentina) and the west coast of Africa. McLay (2006) suggested that *C. mexicana*, *C. bishopi*, *C. binodosa* and *C. australis* should be removed from the Retroplumidae and reassigned to the Palicidae Bouvier, 1898, based on the lack of diagnostic features for that family established by Saint-Laurent (1989), such as size proportions of the carapace (width greater than length) and the presence of transverse sternal carinae, among others. *Costacopluma bishopi* and *C. mexicana* have an ovate carapace with width greater than length and, in particular, *C. mexicana* also has strong transverse sternal carinae (Vega and Perrilliat, 1989, p. 85, figs. 2h and 2j). Detailed review of the Palicidae by Castro (2000) indicated that palicids have a rough dorsal carapace surface, very small chelae, anterolateral spines and

a spiny anterior. None of the species suggested by McLay (2006) to be removed from the Retroplumidae include these features. It is true that knowledge of morphological details of every species of *Costacopluma* is incomplete, but they all share common features that indicate they are closely related and therefore belong to the same family. Based on the general shape of the carapace, it is possible to subdivide the species of *Costacopluma* into two main groups: 1) the ovate carapace group, represented by the Cretaceous American and African species and the Eocene *C. grayi*, and 2) the subhexagonal carapace group, represented by Paleocene species from Greenland, Texas and South America. The quadrate carapace shape of *Costacopluma squiresi* suggests it belongs to group 2), and its presence in the Paleocene of California can be explained by two possible migration routes: 1) from southeastern North America, westward through the southern edge of North America (see Vega *et al.*, 2007; 2008), or 2) from South America, northward along the east coast and then to the northwest through the southern portion of Mexico. Dispersal routes proposed for the Paleocene by Feldmann and Schweitzer (2006, fig. 2.2) support route option number 2. However, some decapod genera typically from the Paleogene West Coast have been found, along with genera from Texas and Alabama, in lower Eocene deposits of Chiapas (Vega *et al.*, 2008), as well as some typical Tethyan genera such as *Lophoranina*, that dispersed westward to inhabit the Eocene seas of Baja California (Squires and Demetrian, 1992). There is also the possibility that both routes affected the composition of Paleocene decapods assemblages along the West Coast of North America. Gardner and Bowles (1934) and Maldonado-Koerdell (1950) suggested the existence of a portal of communication between the Atlantic and Pacific oceans during early Eocene time, located in the Isthmus of Tehuantepec region. The occurrences of common decapod crustacean species in Eocene deposits of central Chiapas and Baja California (Vega *et al.*, 2008) suggest that this oceanographic connection was probably situated near that isthmus.

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