

CALIFORNIA COWRIES (CYPRAEACEA): PAST AND PRESENT, WITH NOTES ON RECENT TROPICAL EASTERN PACIFIC SPECIES

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Over the past 100 million years at least 22 species of cowries have inhabited what is now known as California. Ten species are true cowries of the family Cypraeidae, eleven are allied cowries of the family Ovulidae, and one is a member of the family Pediculariidae, which together comprise the superfamily Cypraeacea of Ponder and Warén (1988). Of these, only one cypraeid, *Zonaria (Neobernaya) spadicea* (Swainson, 1823), four ovulids, *Neosimnia aequalis* (Sowerby, 1832), *N. bellamaris* Berry, 1946, *Spiculata barbarentis* (Dall in Williamson, 1892), *S. loebbeckeana* (Weinkauff, 1881), and the pediculariid *Pediculariella californica* (Newcomb, 1864) are extant. Table 1 lists all described fossil and Recent cypraeacean species known from California.

The earliest known cypraeaceans, *Palaeocypraea (Palaeocypraea) tithonica* (Stefano, 1882) and *Bernaya (Bernaya) gemmellaroi* (Stefano, 1882), are from Upper Jurassic (Tithonian) strata near Termini Imerese, Sicily, Italy (Groves, 1990) and are approximately 145 million years old. Cypraeaceans were distributed throughout Europe, North America, Africa, and the Middle East by the end of the Cretaceous. Subsequent major evolutionary radiations of cypraeaceans occurred in the Eocene and the Miocene.

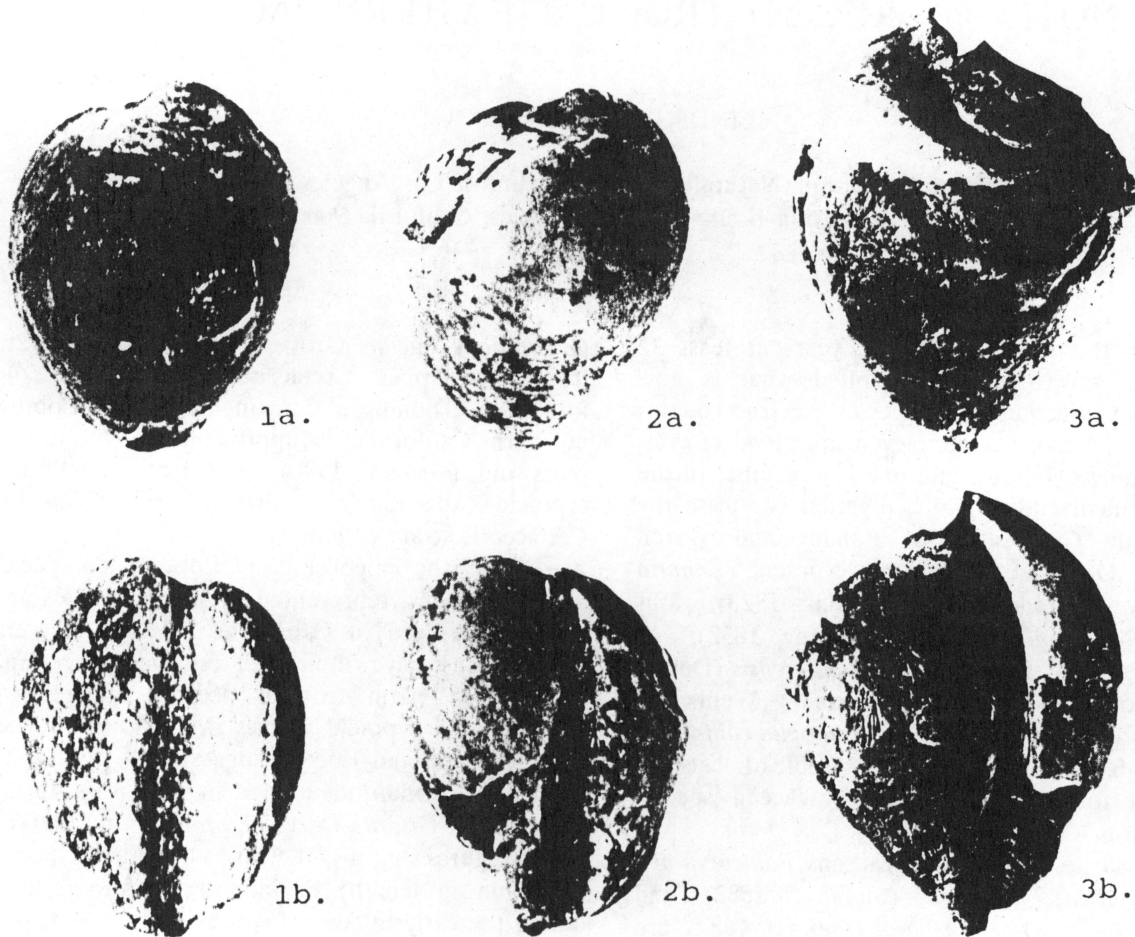
Palaeocypraea (Palaeocypraea) fontana (Anderson, 1958) (Figures 1a, 1b) from the Lower Cretaceous (uppermost lower Albian) Budden Canyon Formation, near Texas Springs, Shasta County, northern California is the earliest cypraeid known from California. It is approximately 100 million years old and is also the earliest cypraeid known from the Western Hemisphere (Groves, 1990). The earliest ovulid from the Western Hemisphere is also from California. *Eocypraea*

(*Eocypraea*) *louellae* Groves, 1990 (Figures 2a, 2b) from the Upper Cretaceous (Turonian) Yolo formation, Thompson Canyon area, Yolo County, northern California, is approximately 90 million years old (Groves, 1990). At least four other cypraeid species are present in California Cretaceous strata (Table 1).

During the Paleocene and Eocene, ten species of cypraeaceans, represented by four cypraeids and six ovulids, lived in California. Because Recent cypraeaceans have their greatest abundance and diversity in warm tropical oceans, the relative abundance of cypraeid species in California during the Paleocene and Eocene suggest that tropical to sub-tropical conditions existed in California during these times. *Gisortia (Megalocypraea) clarki* Ingram, 1940 (Figures 3a, 3b), the largest cypraeid species (126 mm in length) to inhabit California, lived during the early Eocene of south-central California.

Oligocene formations of California were not deposited in environments suitable for cypraeaceans. Loel and Corey (1932) listed *Cypraea*, n. sp. "A" and *Cypraea*, n. sp. "C" from the Miocene Vaqueros Formation of California. Because these specimens are poorly preserved, genus and species determination may not be possible. An undescribed Miocene cypraeid collected from the Topanga Canyon Formation in the Santa Monica Mountains of Los Angeles County is presently being described (Groves, in prep.).

Of the extant California cowries, only *Zonaria spadicea*, *Neosimnia aequalis*, *Spiculata barbarentis*, and *Pediculariella californica* have fossil records. The earliest record of *Z. spadicea* is from the Lower Pliocene part of the Towsley Formation in Elsmere Canyon, Los Angeles County, southern California (Kern, 1973). It has been cited as its junior



Figures 1-3. (1) *Palaeocypraea (Palaeocypraea) fontana* (Anderson, 1958), holotype CAS 1345.04, from Texas Springs, Shasta County, California [CAS loc. 13451], Lower Cretaceous, x1.8 [1a. dorsal, 1b. ventral]. (2) *Eocypraea (Eocypraea) louellae* Groves, 1990, holotype LACMIP 8281, from Thompson Canyon, Yolo County, California [LACMIP loc. 287571], Upper Cretaceous, x3.3 [2a. dorsal, 2b. ventral]. (3) *Gisortia (Megalocypraea) clarki* Ingram, 1940, holotype, UCMP 14844, from Las Lajas Canyon, Ventura County, California [UCMP loc. 4052], Lower Eocene, x0.46 [3a. dorsal, 3b. ventral].

synonym *Cypraea fernandoensis* Arnold, 1907 by numerous authors. Other Pliocene formational records for *Z. spadicea* include, the Pico Formation (Grant & Gale, 1931; Kew, 1924), the Fernando Formation (Soper & Grant, 1932; Zinsmeister, 1970 [1971]), the Niguel Formation (LACMIP locs. 5582 & 11928), and the San Diego Formation (LACMIP locs. 305, 305-A, and 305-C). Some Pleistocene

formational records for *Z. spadicea* include the Santa Barbara Formation (Ingram, 1947), the Lomita Marl (Woodring & others, 1946), the Nestor Terrace (Emerson & Addicott, 1953), and numerous other terrace deposits.

Neosimnia aequalis has been collected from the Pliocene San Diego Formation in southern San Diego County (LACMIP loc. 305), from the Upper

Pleistocene Palos Verdes Sand along John S. Gibson Boulevard near San Pedro, Los Angeles County (F.J. Peska, pers. commun., 1992), near Newport Beach, Orange County (Peska, 1976 [as *Simnia* cf. *vidleri*]; LACMIP loc. 487), and from the upper Pleistocene Bay Point Formation near Mission Bay, San Diego County (Y.C. Albi, pers. commun., 1991). The San Diego Formation specimens are the earliest representatives of the subfamily Ovulinae in the eastern Pacific region. *Spiculata barbarentis* has been reported from the Pleistocene Palos Verdes Sand at Playa del Rey (Willett, 1937 [as *Simnia* (*Neosimnia*) *catalinensis*]).

The only fossil occurrence of *Pediculariella californica* is from the Pleistocene 3rd, 125,000 yr. terrace at Punta Banda, Baja California, Mexico (G.L. Kennedy, pers. commun., 1991; LACMIP loc. 10130).

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APPENDIX

During the course of research on the eastern

Pacific fossil and Recent cypraceans and lamellariaceans, the following geographic and taxonomic refinements came to my attention. Because some of the following species are represented by a single specimen and may not be indicative of a breeding population or may indicate deliberate or accidental contamination, their presence in the eastern Pacific is listed "for the record." Most specimens have been examined by the author. Taxonomic classification follows that of Schilder and Schilder (1971).

Superfamily CYPRAEACEA Family CYPRAEIDAE

Macrocypraea cervinetta (Kiener, 1843)

A juvenile specimen of *M. cervinetta* collected by H.G. Kuck and R.W. Peck of the Los Angeles County Museum of Natural History, Invertebrate Zoology Section (LACM 88-8.3) extends the range of this Panamic species to Isla del Coco. LACM 88-8 is a *Porites* reef on the east side of Isla Manuelita, off the north side of Isla del Coco at a depth of 5-12 m (16-39 ft). Fragments of a sub-adult specimen also were collected by K.L. Kaiser at Punta Presidio, Isla del Coco on 12 February 1991 in rocks and muddy sand at a depth of 15-18 m (50-60 ft).

Mauritia maculifera Schilder, 1932

Hertlein and Allison (1960) reported this Indo-Pacific species from Clipperton Island. Two beachworn specimens (American Museum of Natural History, AMNH 204575) from Clipperton Island collected by the late Conrad Limbaugh are undoubtedly *M. maculifera*. Cate (1969:111, pl. 11, fig. 2) figured another specimen (AMNH 204575a) from Clipperton Island as *Mauritia* (*Arabica*) *maculifera*. This species was not included in the eastern Pacific records cited by Burgess (1985). Other eastern Pacific references to this species include: Sachet (1962), Salvat & Erhardt (1970), Keen (1971), Emerson (1978), Cantera (1991), and Emerson (1991).

Lyncina schilderoorum (Iredale, 1930)

Hertlein and Allison (1960) reported beachworn specimens (AMNH 204579) of the Indo-Pacific

species *Lyncina schilderorum* [=*L. arenosa* (Gray, 1824), not Dillwyn 1823] collected by Conrad Limbaugh from Clipperton Island. The figured specimen (AMNH 204579a) of Cate (1969:112, pl. 11, fig. 6) is also from Clipperton Island. Burgess (1985) did not cite *L. schilderorum* as an eastern Pacific species. Other eastern Pacific references to this species include: Sachet (1962) [as *Cypraea arenosa*], Salvat & Erhardt (1970) [as *C. arenosa*], Keen (1971), Emerson (1978) [as *C. arenosa*], Kay (1979), Cantera (1991), and Emerson (1991).

Lyncina vitellus (Linné, 1758)

A single beachworn specimen (AMNH 204578) of the Indo-Pacific species *L. vitellus* (Linné, 1758) was reported from Clipperton Island by Hertlein and Allison (1960). Cate (1969:112, pp. 11, fig. 5) figured the same specimen as *L. vitellus polynesiae* Schilder & Schilder, 1939. The Clipperton Island range of this species was excluded from the eastern Pacific by Burgess (1985). Other eastern Pacific references for this species include: Sachet (1962) [as cf. *C. vitellus*], Keen (1971), Emerson (1978), Kay (1979); Cantera (1991), and Emerson (1991).

Zonaria (Pseudozonaria) roberti (Hidalgo, 1906)

A fragment of outer lip of *Zonaria (Pseudozonaria) roberti* (Hidalgo, 1906) was collected by D. R. Shasky in 30 m (100 ft) off Bahía Chatham, Isla del Coco in May 1986. This is the first record of this Panamic species from Isla del Coco.

Erronea caurica (Linné, 1758)

A single beachworn specimen (AMNH 242834) of the Indo-Pacific species *Erronea caurica* (Linné, 1758) was collected by Helen DuShane at Rancho Eureka, Punta Arena, Baja California Sur, Mexico (ca. 23°36'N, 109°36'W). Cate (1969:104, pl. 14, fig. 23) figured this specimen as *Erronea c. caurica*. This is the only specimen of *E. caurica* thus far recorded from the eastern Pacific, and was not included by Burgess (1985) as an eastern Pacific species.

Blasicrura "teres" species complex

Blasicrura alisonae (Burgess, 1983) and *B. teres* (Gmelin, 1791), well documented from the eastern Pacific, and *B. rashleighana* (Melvill, 1888), doubtfully known from outside of the central Pacific, comprise the *B. "teres"* species complex in the eastern Pacific.

Blasicrura alisonae (Burgess, 1983)

A specimen labeled as *Cypraea rashleighana* in the California Academy of Sciences collection (CAS 23077.01) cited by Ingram (1945) from Isla del Coco is actually a beachworn *Blasicrura alisonae*. Most citations of *B. teres pellucens* (Melvill, 1888) and *B. rashleighana* from the eastern Pacific will probably prove to be *B. alisonae*. Two beachworn specimens (AMNH 80415) from Clipperton Island labeled as *Cypraea teres* are probably *Blasicrura alisonae*.

Blasicrura rashleighana (Melvill, 1888)

It is doubtful that breeding populations of *B. rashleighana* exist outside of the Hawaiian Islands (Burgess, 1985). Two specimens (AMNH 204595) from Clipperton Island figured by Cate (1969:116, pl. 13, fig. 17) as *Bistolida r. rashleighana* are most likely subadult specimens of *B. alisonae*.

Blasicrura teres (Gmelin, 1791)

Populations of true *B. teres* in the eastern Pacific are best known from Panama (e.g., AMNH 183217, 203809, 203810, 203812, 208751, 208752, 208753, 202836 [labeled *Cypraea alisonae*], 219982, and 242835 [labeled *C. alisonae*]; LACM 34-121.2 and LACM 35-88.3). Beachworn specimens are confirmed from Clipperton Island (AMNH 80415, 204595, and 204595a; and CAS 081109 and 081110, both figured by Hertlein & Emerson, 1953: pl. 27, figs. 8, 11, 14-15). *Blasicrura teres* is documented from Islas Galápagos (AMNH 110483 and 216763) and reported by Kay (1991).

Erosaria (Erosaria) helvola (Linné, 1758)

Hertlein and Allison (1960) reported *E. helvola* (Linné, 1758) from Clipperton Island. Ten beachworn specimens (AMNH 204597) collected by E. C. Allison are labeled *Cypraea helvola hawaiiensis*

Melville, 1888. A glossy specimen (AMNH 204597a) also from Clipperton Island was figured by Cate (1969:117, pl. 14, fig. 20) as *E. helvola hawaiiensis*. This Indo-Pacific species was not included in the eastern Pacific records cited by Burgess (1985). Other eastern Pacific references for this species include: Sachet (1962), Salvat & Erhardt (1970), Keen (1971), Emerson (1978) [as *C. helvola hawaiiensis*], Cantera (1991), and Emerson (1991).

Erosaria (Erosaria) spurca acicularis (Gmelin, 1791)

A single dead specimen of this Caribbean subspecies was collected on 6 April 1992 by James Novelly at Bahía Wafer, Isla del Coco on coarse sand at 15-18 m (50-60 ft). This specimen is in the collection of Kim C. Hutsell of San Diego, California.

Erosaria (Ravitrona) caputserpentis (Linné, 1758)

Tomlin (1927) and Lowe (1933) reported that this species had been dredged alive off Isla Coiba, Veraguas Prov., Panama during the 1924 St. George Expedition. Subsequent authors of the family Cypraeidae have obviously overlooked this important range extension.

Staphylaea staphylaea (Linné, 1758)

A single beachworn specimen (AMNH 242833) of the Indo-Pacific species *Staphylaea staphylaea* was collected by Helen DuShane at Los Chilenos, Baja California Sur, Mexico (ca. 22°58'N, 109°48'W). Cate (1969:104, pl. 14, fig. 24) figured this specimen as *Staphylaea s. staphylaea*, which is the only specimen of *S. staphylaea* thus far recorded from the eastern Pacific. This species was not included in the eastern Pacific records cited by Burgess (1985).

Family OVULIDAE

The following Californian and/or Panamic ovulid species are documented from Isla del Coco for the first time.

Cypropterina (Jenneria) pustulata ([Lightfoot, 1786]
ex Solander MS)

An outer lip fragment was collected by K. L. Kaiser on 26 April 1987, at Bajo Alcyone, Isla del Coco from barnacle shakings in 34 m (110 ft).

Neosimnia aequalis (Sowerby, 1832)

K. L. Kaiser collected seven specimens on 25 May 1985 at Roca Sucia, Isla del Coco attached to gorgonians in 34 m (110 ft), and four specimens on 11 February 1991 at Dos Amigos, Isla del Coco attached to gorgonians in 37 m (120 ft). Eight specimens were collected by D. R. Shasky on 27 May 1985 at Bahía Iglesias, Isla del Coco, attached to gorgonians in 24 m (80 ft).

Neosimnia avena (Sowerby, 1832)

Four specimens were collected by K. L. Kaiser on 24 April 1986 at Victorias Mount, Isla del Coco attached to gorgonians in 27 m (90 ft), and four additional specimens were collected by D. R. Shasky between 23 and 26 April 1986 at Roca Sucia, Isla del Coco attached to gorgonians in 18-24 m (60-80 ft).

Phenacovolva lenoreae Cardin & Walls, 1980

A single juvenile specimen was collected by D. R. Shasky in March 1984 at Roca Sucia, Isla del Coco in 18-34 m (60-110 ft). A specimen (AMNH 198612) figured by Bertsch and Bibbey (1982:44, figs. 7-8) as *Phenacovolva brevirostris* (Schumacher, 1817) from Los Zurroneles, Veraguas Prov., Panama was compared to the holotype of *P. lenoreae* Cardin & Walls, 1980 and has been reassigned to *P. lenoreae*.

Superfamily LAMELLARIACEA Family TRIVIIDAE

The following Panamic species in this section are documented from Isla del Coco for the first time.

Hespererato oligostata (Dall, 1902)

Four specimens were collected by D. R. Shasky on 5 March 1984 at Bahía Wafer, Isla del Coco in 61 m (200 ft).

Niveria atomaria (Dall, 1902)

A single dead specimen was collected by D. R. Shasky on 21 March 1989 at Isla Manuelita under dead coral in 21 m (69 ft).

TABLE 1. DESCRIBED FOSSIL AND RECENT CYPRAEACEANS OF CALIFORNIA

CRETACEOUS

Cypraeidae

- Palaeocypraea (Palaeocypraea) fontana* (Anderson, 1958)
Bernaya (Protocypraea) berryessae (Anderson, 1958)
Bernaya (Protocypraea) gualalaensis (Anderson, 1958)
Bernaya (Protocypraea) rineyi Groves, 1990
Bernaya (Bernaya) crawfordcatei Groves, 1990

Ovulidae

- Eocypraea (Eocypraea) louellae* Groves, 1990

PALEOCENE

Cypraeidae

- Propustularia kemperae* (Nelson, 1925)
Propustularia simiensis (Nelson, 1925)

Ovulidae

- Eocypraea (Eocypraea) novasumma* (Nelson, 1925)
Sphaerocypraea martini (Dickerson, 1914)

EOCENE

Cypraeidae

- Bernaya (Bernaya) fresnoensis* (Anderson, 1905)
Gisortia (Megalocypraea) clarki Ingram, 1940

Ovulidae

- Eocypraea (Eocypraea) bayerquei* (Gabb, 1864)
Eocypraea (Eocypraea) castacensis (Stewart, 1927)
Eocypraea (Eocypraea) maniobraensis Squires & Advocate, 1987
Sulcocypraea mathewsonii (Gabb, 1869)

OLIGOCENE and MIOCENE

No species yet described

PLIOCENE

Cypraeidae

- Zonaria (Neobernaya) spadicea* (Swainson, 1823)

Ovulidae

- Neosimnia aequalis* (Sowerby, 1832)

PLEISTOCENE+ and RECENT*

Cypraeidae

- Zonaria (Neobernaya) spadicea* (Swainson, 1823)+*

Ovulidae

- Neosimnia aequalis* (Sowerby, 1832)+*
Neosimnia bellamaris Berry, 1946*
Spiculata barbarensis (Dall in Williamson, 1892)+*
Spiculata loebbeckeana (Weinkauff, 1881)*

Pediculariidae

- Pediculariella californica* (Newcomb, 1864)+*

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