New Species of Late Cretaceous Cypraeacea (Mollusca: Gastropoda) from California and Mississippi, and a Review of Cretaceous Cypraeaceans of North America

by

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Abstract. Cypraeacean mollusks are rare in Cretaceous deposits of North America. Only 15 species are recognized, of which four are new and are described herein. Six species of *Palaeocypraea* s.s. have been previously described, and *Palaeocypraea (P.) fontana* (Anderson, 1958) from the Lower Cretaceous (uppermost Lower Albian), Budden Canyon Formation, Shasta County, California, is the earliest known cypraeacean from the Western Hemisphere. *Bernaya* s.s. is represented by two species and *Bernaya (Protoocypraea)* comprises five species. *Eocypraea* s.s. is represented by two species. New species described herein are as follows: *Bernaya (B.) crawfordcatei* from the Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation, San Diego County, California; *Bernaya (Protoocypraea) mississippiensis* from the Upper Cretaceous (Campanian), Coffee Formation, Lee County, Mississippi; *B. (P.) rineyi* from the Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation, San Diego County, California; and *Eocypraea (E.) louellae* from the Upper Cretaceous (Turonian), Yolo Formation, Yolo County, California. *Eocypraea (E.) louellae* is the earliest known ovulid from the Western Hemisphere.

INTRODUCTION

Four new species of cypraeacean gastropods, rare in Cretaceous deposits of North America, are described from localities in San Diego and Yolo counties, California, and Lee County, Mississippi (Figure 1). Two of the new species are from the Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation (Rosario Group), near Carlsbad, northern San Diego County, southern California; the third is from the Upper Cretaceous (Turonian), Yolo Formation of the Great Valley Series, Yolo County, northern California. A fourth new species is from the Upper Cretaceous (Campanian), Coffee Formation (Selma Group), Lee County, northeastern Mississippi. This paper describes and illustrates these new species as well as illustrating and providing a brief synopsis of the previously described North American cypraeacean species.

Historical Review

The first cypraeacean species described from the Cretaceous of North America was *Cypraea mortoni* Gabb, 1860. *Cypraea squyeri* Campbell, 1893, from Montana and a similar species, *Cypraea suciensis* Whiteaves, 1895, from SuisC Island, Washington, were subsequently described. Schilder (1932) separated species from Alabama and New Jersey, both previously considered to be *Cypraea mortoni*, and proposed *Palaeocypraea burlingtonensis* for the New Jersey species. In a survey of the Navarro Group of Texas, Stephenson (1941) described two new species: *Cypraea nuciformis* and *Cypraea gracilis* (Cypraea gracilis Stephenson, preoccupied, was subsequently renamed *Cypraea corsicanana* Stephenson, 1948). Ingram (1942, 1947a, b) included Cretaceous species in his reviews of North American fossil and living cypraeaceans. Anderson (1958)
described *Cypraea gualalaensis*, *Cypraea berryessae*, and *Cypraea fontana* from northern California. Anderson also introduced the name *Cypraea argonautica* for a specimen from Oregon he had previously identified as *Erato veraghoorensis* Stoliczka, 1867. Most recently, *Cypraea grooti* Richards & Shapiro, 1963, was described from northern Delaware.

**Cypraeacean Biogeography**

Recent cypraeaceans have their greatest diversity and abundance in warm tropical oceans; warm temperate seas seldom support more than a single species. Cretaceous species ranged as far north as San Juan County, Washington (49°45'N) in North America and Valkenburg, The Netherlands (50°52'N) in Europe. The Cretaceous distribution of cypraeaceans supports the concept of both broad tropical and subtropical to warm-temperate climatic belts (Schil-der & Schil-der, 1971).

**Mesozoic Cypraeacean Paleontology**

The earliest known cypraeaceans, *Palaeocypraea* (P.) *tithonica* (Stefano, 1882) and *Bernaya* (B.) *gemmaellaroi* (Stefano, 1882), are from Upper Jurassic (Tithonian) strata near Termini Imerese, Sicily, Italy. Cretaceous cypraeaceans have been found in Europe, India, South Africa, Iran, North America, and Brazil (Schil-der & Schil-der, 1971). Schil-der & Schil-der (1971) recognize 69 species of Cretaceous cypraeaceans, 43 of which are from uppermost Cretaceous (Campanian through Maastrichtian) strata, the cypraeacean Mesozoic peak in terms of both numbers of species and geographic distribution.

Genera and subgenera found in North America are *Palaeocypraea* s.s., *Bernaya* s.s., *Bernaya* (Protocypraea), and *Eocypraea* s.s. (Figure 2). *Palaeocypraea* is known from Upper Jurassic (Tithonian) through Upper Paleocene (Thanetian) strata in Europe, South Africa, North America, and Brazil (Schil-der & Schil-der, 1971). Two species, one of them new, are found in the North American Cretaceous. *Bernaya* (Protocypraea) is known from Lower Cretaceous (Barremian) to Recent and is found in Europe, India, Iran, and western North America. *Protocypraea* is represented by a single living species, *Bernaya* (Protocypraea) *teulerei* Cazenavette, 1846 (=*Cypraea leucostoma* Gaskoin, 1843, *non* Gmelin, 1791; =*B.* (P.) *hidalgoi* (Shaw, 1909)) from the Gulf of Oman. *Bernaya* (P.) is represented by five species in the Cretaceous of North America, two of which are new. *Eocypraea* s.s. is known from Upper Cretaceous (Cenomanian) through Lower Oligocene (Lattorfan) strata in Europe, India, Iran, New Zealand, South Africa, Indonesia, North America, and South America (Schil-der & Schil-der, 1971). Two species of *Eocypraea* s.s., one of them new, are from the Cretaceous of North America.

Abbreviations used for institutional catalogue and lo-
Figure 2

cality numbers are as follows: ANSP, Academy of Natural Sciences of Philadelphia; CAS, California Academy of Sciences, San Francisco; GIT, California Institute of Technology (collection now at LACMIP); GSC, Geological Survey of Canada, Ottawa; LACMIP, Los Angeles County Museum of Natural History; MGS, Mississippi Geological Survey, Jackson; SDSNH, San Diego Society of Natural History; USGS, United States Geological Survey, Washington; and USNM, National Museum of Natural History, Smithsonian Institution, Washington.

Measurement parameters are defined as follows: length = greatest distance between anterior and posterior ends; width = greatest distance between lateral margins; and height = greatest distance between base and dorsum.

STRATIGRAPHY
Point Loma Formation
The type section for the Point Loma Formation (KENNEDY & MOORE, 1971:711–713) is at Point Loma, San Diego County, California. Its stratigraphic position is near the Campanian/Maastrichtian boundary based upon benthic foraminifera (SLITER, 1968) and mollusks (BANNON et al., 1989). A magnetic reversal in the Point Loma Formation at La Jolla, California, suggests that the formation is mainly early Maastrichtian in age (BANNON et al., 1989). Strata at Carlsbad, California, have been correlated with the Point Loma and La Jolla sections (SLITER, 1968). The mollusks at Carlsbad suggest a more near-shore environment for the Carlsbad strata than for much of the Point Loma and La Jolla strata. Diagnostic molluscan species common to all three areas—e.g., Baculites lomaensis Anderson, 1958, Pachydiscus (Neodesmoconia) catarinae (Anderson & Hanna, 1935), and Perissitys colorata Popenoe & Saul, 1987—suggest that these sections are of equivalent age. Calcareous nanofossils, benthic foraminifera, and palynomorphs from Carlsbad also suggest a Campanian to Maastrichtian age (M. V. FILEWICZ et al., 1989, personal communication). A 17-m thick section of the Point Loma Formation near Carlsbad consists of shale and interbedded sandstones that contain a diverse and locally rich molluscan fauna (LOCH, 1989). Fossils in the deposit represent a distinct inner shelf assemblage in water less than 140 m deep (SLITER, 1968).

Yolo Formation
The Upper Cretaceous (Turonian), Yolo Formation of KIRBY (1943:285–287) was named for extensive exposures along the west side of the Sacramento Valley in Yolo County, northern California. Petrologic evidence suggests that the randomly interbedded mudstones, shales, and sandstones of the Yolo Formation were deposited as basinplain turbidite deposits within the Great Valley forearc basin sequence (INGERSON et al., 1977).

Coffee Formation
The Coffee Formation of the Selma Group was named by SAFFORD (1864:361–363) for exposures at Coffee Landing, Hardin County, Tennessee. Sandstone units in the Tupelo Tongue of the Coffee Formation demonstrate a cyclical sedimentation pattern related to four periods of delta progradation and abandonment (DOCKERY & JENNINGS, 1988). Excavations within the last 15 yr in northeastern Lee County, Mississippi, have exposed very fossiliferous sections of the Upper Cretaceous (Campanian), Coffee Formation (DOCKERY, 1988).

MATERIALS AND METHODS
Thirty-one cypraeacean specimens from the San Diego Society of Natural History, Invertebrate Paleontology collection were borrowed for this project. Two undescribed and one previously described species were determined. A subsequent search of the Los Angeles County Museum of
Natural History, Invertebrate Paleontology collection yielded an additional undescribed species, two specimens of *Bernaya (Protocypraea) argonautica*, and two cypraeaceous fragments of undetermined generic affinity. A fourth undescribed species was borrowed from the Mississippi Geologic Survey. Undescribed specimens were compared to the holotypes of all previously described North American species, which are figured herein for comparison. Comparisons were also made with published illustrations of species from regions other than North America. Matrix from the apertures of several specimens was carefully removed with permission of the lending institutions.

**SYSTEMATICS**

The classification herein follows that of Schilder & Schilder (1971) with the exception of the Recent southwestern Australian species *Bernaya catei* Schilder, 1963. Burgess (1970, 1985) and Walls (1979) correctly placed *B. catei* in synonymy with *Zoila (Zoila) venusta* (Sowerby, 1846) based upon similar anatomical and radular characteristics. The genus *Zoila of Jousseaume* (1884), which ranges from the Lower Miocene to the Recent of Australia, India, Indonesia, and Tasmania, may be a descendant of *Bernaya* (Wenz, 1941).

**SYSTEMATIC PALEONTOLOGY**

Superfamily CYPRACEAEA Rafinesque, 1815

Family CYPRAEIDAE Rafinesque, 1815

Subfamily BERNAYINAE Schilder, 1927

Genus *Palaeocypraea* Schilder, 1928

**Type species:** *Cypraeasites spiratus* Schlotheim, 1820, by original designation. Lower Paleocene (Danian), Faxe, Denmark.

**Diagnosis:** Shell small to medium in size, elongated, spire broad and partially covered, aperture wide with deep terminal canals and fine dentition, fossula broad, concave, and smooth.

Subgenus *Palaeocypraea s.s.*

*Palaeocypraea (Palaeocypraea) corsicanana* (Stephenson, 1948)

(Figures 3, 4)


*Cypraea corsicanana* Stephenson, 1948:642 [new name for *Cypraea graciilis* Stephenson, 1941].


**Type material:** Holotype, USNM 20894. The holotype measures 14.2 mm in length, 10 mm in width, and 7.8 mm in height.

**Type locality:** USGS loc. 518, near Postoak Creek, north edge of Corsicana, Navarro County, Texas. Upper Cretaceous (Maastrichtian), Nacatoch Sand, Navarro Group.

**Remarks:** *Palaeocypraea squyeri* (Campbell, 1893) has deeper terminal canals and is more elongate than *Palaeocypraea corsicanana*, and should be considered a separate species.

*Palaeocypraea (Palaeocypraea) fontana* (Anderson, 1958)

(Figures 5, 6)

*Cypraea fontana* Anderson, 1958:177, pl. 21, figs. 15, 16.


**Type material:** Holotype, CAS 1345.04. The holotype measures 27.8 mm in length, 16.8 mm in width, and 11.1 mm in height.

**Type locality:** CAS loc. 1345, Texas Springs, 3.2 km east of Horsetown, on road leading to Centerville, Shasta County, California. Lower Cretaceous (uppermost lower Albian) (L. R. Saul, 1989, personal communication), Budden Canyon Formation.

**Remarks:** *Palaeocypraea korycanensis* (Weinzel, 1910) from Korycany, Czechoslovakia, is more elongate and less globose than *Palaeocypraea fontana* (Anderson, 1958) and is considered a separate species. *Palaeocypraea fontana* is the earliest cypraeaceous found in the Western Hemisphere.

*Palaeocypraea (Palaeocypraea) grooti* (Richards & Shapiro, 1963)

(Figures 7, 8)

*Cypraea grooti* Richards & Shapiro, 1963:12, pl. 4, fig. 3a-c; Richards, 1968:140; Owens et al., 1970:45.


**Type material:** Holotype, ANSP 30838. The holotype measures 17.5 mm in length, 10.1 mm in width, and 7.9 mm in height.

**Type locality:** Station 6 of Groot et al. (1954), Biggs Farm, south bank Chesapeake and Delaware Canal, 2.41 km east of crossing of U.S. Highway 13 and the canal at St. Georges, New Castle County, Delaware. Upper Cretaceous (lower Maastrichtian), Mt. Laurel-Navesink Formation.

**Remarks:** Represented by a single poorly preserved internal mold that does not resemble *Palaeocypraea squyeri* (Campbell, 1893). *Palaeocypraea grooti* is more globose and less elongate than *P. squyeri* and, although treated as a subspecies of the latter by Schilder & Schilder (1971:25), they are considered separate species.
Palaeocypraea (Palaeocypraea) nuciformis (Stephenson, 1941)

(Figures 9, 10)

Cypraea nuciformis STEPHENSON, 1941:314, pl. 59, figs. 8 (holotype), 10-11 (paratypes).

Type material: Holotype, USNM 76988, and two paratypes, USNM 21007. The holotype measures 20.1 mm in length, 11.9 mm in width, and 9.5 mm in height.

Type locality: USGS loc. 761, in the vicinity of Kaufman, Kaufman County, Texas. Upper Cretaceous (Maastrichtian), Cedar District Formation, Nanaimo Group.

Remarks: The holotype and two paratypes are from the same locality. Palaeocypraea nuciformis has a wider aperture and is more globose than P. suciaensis Schilder, 1928, from Denmark and they are considered separate species.

Palaeocypraea (Palaeocypraea) squyeri (Campbell, 1893)

(Figures 11, 12)

Cypraea squyeri CAMPBELL, 1892:50-51, nomen nudum.
Cypraea squyeri CAMPBELL, 1893:52, pl. 2, figs. 1, 2; INGRAM, 1942:16; pl. 3, figs. 3, 4; INGRAM 1947a:59-60, pl. 2, figs. 11, 12; INGRAM, 1947b:13; RICHARDS, 1968:190.
Palaeocypraea squyeri (Campbell, 1893): SCHILDER, 1932: 110.

Type material: Holotype, ANSP 13536. The holotype measures 20.1 mm in length, 11 mm in width, and 8.9 mm in height.

Type locality: Near Mingusville (now Wibaux), Dawson County (now in Wibaux County), Montana. Upper Cretaceous (Maastrichtian), Fox Hills Formation.

Remarks: This species is represented only by the well preserved holotype. Palaeocypraea squyeri is similar to P. suciensis (Whiteaves, 1895), but is more elongate and has a shallower posterior terminal canal than the latter, and should be considered a separate species.

Examination of Figures 3 to 18

**Bernaya (Bernaya) burlingtonensis**
*(Schilder, 1932)*

**Figures (15, 16)**

*Cypraea (Aracia) mortoni* Gabb, 1860: *GABB, 1861:104 [in part]; *WHITFIELD, 1892a:120, 291, pl. 15, figs. 1–3; *WHITFIELD, 1892b:120, 291, pl. 15, figs. 1–3; *WHITNEY, 1928:154. Not *Cypraea mortoni* Gabb, 1860 [= *Eocypraea (E.) mortoni* (Gabb, q.v.)].


**Type material:** Holotype, ANSP 13537. The holotype measures 16.5 mm in length, 12.9 mm in width, and 9.6 mm in height.

**Type locality:** Burlington County, New Jersey. Upper Cretaceous (upper Campanian), Mt. Laurel-Navesink Formation.

**Remarks:** _Bernaya (B.) burlingtonensis_ is represented by at least three specimens. An internal mold was figured by WHITFIELD (1892a, b) as *Cypraea (Aracia) mortoni* Gabb, 1860. Based upon a comparison to the ANSP specimen, this is the holotype. A second specimen was illustrated by WELLER (1907) as _Cypraea mortoni_ Gabb from Atlantic Highlands, Monmouth County, New Jersey. A third specimen was collected from the Upper Cretaceous (Campanian) Marshalltown Formation (USGS loc. 17702) by C. W. Carter (OWENS et al., 1970) near the Chesapeake and Delaware Canal, New Castle County, Delaware. SCHILDER (1932) separated these Campanian specimens—previously identified with _Cypraea mortoni_, the Maastrichtian species—based on a similar, but less globose, internal mold from Prairie Bluff, Alabama.

_Bernaya (Bernaya) craufordcacei_ Groves, sp. nov.

(Figures 17, 18)

**Diagnosis:** _A Bernaya_ of large size, anterior and posterior canals deep, spire of medium height, fossula smooth concave, anterior and posterior terminal ridges prominent extending to margins.

**Description:** Shell large, somewhat constricted anteriorly; maximum height and width posterior to center; spire of medium height, partially covered; dorsum somewhat flattened; aperture wide, slightly S-shaped; denticle coarse, with smooth interstices, outer lip with 16 teeth that become stronger posteriorly; outer lip with prominent anterior and posterior terminal ridges extending to anterior and posterior margins; posterior terminal ridge extending to base of spire; anterior terminal ridge forming slight marginal callus.

**Comparison:** The new species most similar to _Bernaya (Protocypraea) gualalaensis_ (ANDERSON, 1958:176, pl. 63, fig. 2–2b) from the Upper Cretaceous (lower Maastrichtian), Gualala Group, Mendocino County, California. _Bernaya (B.) craufordcacei_ differs from _B. (P.) gualalaensis_ by its larger size, coarser denticulation, wider base, terminal ridges that do not extend onto the spire, slight anterior marginal callus, deeper anterior and posterior canals, and a gently sloping anterior profile.

**Discussion:** Post-depositional crushing has damaged the fossula and inner lip denticulation. Generic and subgeneric assignment are based on its large size, wide aperture, deep anterior and posterior terminal canals, and spire of medium height. _Bernaya (B.) craufordcacei_ is much larger than other North American Cretaceous cypraeaceans and exceeds the next largest species, _B. (Protocypraea) gualalaensis_ (Anderson, 1958), by 22 mm in length.

**Material:** The new species is represented by two specimens. The holotype is slightly crushed, but otherwise well preserved. A second specimen is a poorly preserved internal mold with minor amounts of original shell material.

**Type material:** Holotype, SDSNH 33998. The holotype measures 72.9 mm in length, 45.8 mm in width, and 30.2 mm in height.

**Type locality:** SDSNH loc. 3392, near Carlsbad, northern San Diego County, southern California. Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation.

**Etymology:** The species is named in honor of the late Crawford N. Cate, in recognition of his valuable contributions to cypraeacean studies.

**Subgenus Protocypraea** Schilder, 1927

**Type species:** *Eocypraea orbignyana* Vredenburg, 1920, by original designation. Upper Cretaceous (Turonian through Santonian), Trichinopoly Group, Kullygoody, southern India.

**Diagnosis:** Shell small to medium in size, shape moderately pyriform, somewhat constricted anteriorly, fossula smooth, concave, wide.

_Bernaya (Protocypraea) argonautica_ (Anderson, 1958)

(Figures 19, 20)

 Erinna vergahooraensis [sic] (?) Stoliczka, 1867: *ANDERSON, 1902:75–76, pl. 9, figs. 181, 182. Not Erato vergahoor- ensis Stoliczka, 1867 [= _Bernaya (B.) vergahoroenis_].


**Type material:** Holotype, CAS 61856.05 [ex CAS 42]. The holotype is a partially pyritized specimen that mea-
Type material: Terebratulites (lower Maastrichtian), Gualala Group. The holotype measures 50.2 mm in length, 32.4 mm in width, and 13.6 in height. But was recovered and preserved in the CAS. The specimens are excellently preserved and display original shell material. Bernaya (Protocypraea) kayei (Forbes, 1846) from southern India, is similar to B. (P.) gualalaensis but is more globule and less elongate, and is treated here as a separate species.

Bernaya (Protocypraea) mississippiensis Groves, sp. nov. (Figures 27, 28)

Bernaya (s.l.) new species: Dockery, 1988:19, fig. 3.

Diagnosis: Pyriform Protocypraea, anterior and posterior basal terminal ridges prominent, fossula, concave, smooth.

Description: Shell moderately inflated, slightly elongate, of small size, constricted anteriorly; spire covered, dorsum moderately arched; maximum height near midpoint of shell; maximum width slightly posterior of center; aperture slightly S-shaped, denticulation fine with smooth intercubes, outer lip with 20 teeth, inner lip with 17 teeth; fossula smooth and concave; all surfaces smooth and glossy; anterior and posterior basal terminal ridges prominent; anterior and posterior terminal canals deep.

Comparison: The new species is most similar to Bernaya (Protocypraea) rineyi sp. nov. from the Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation, San Diego County, southern California, and to Eocypraea newboldi (Forbes, 1846:134, pl. 12, fig. 121) from the Upper Cretaceous (Turonian through Santonian) Trinicipoly Group of southern India. Bernaya (P.) mississippiensis differs from both in having more numerous apertural teeth, deeper anterior and posterior terminal canals, a less inflated dorsum, and prominent anterior and posterior basal terminal ridges.

Discussion: The excellent preservation allows for unequivocal generic and subgeneric assignment. Bernaya (P.) mississippiensis is quite different from other Cretaceous cypraeids from the Gulf Coast region of the United States and is the first cypraeacean species reported from the upper reaches of the Mississippi Embayment (Dockery, 1988).

Material: Represented by the well preserved holotype and a sub-adult paratype, both of which display original shell material.

Type material: Holotype USNM 446797, paratype USNM 446798. The holotype measures 21.5 mm in length, 13.7 mm in width, and 9.8 mm in height. The paratype measures 15.9 mm in length, 10.5 mm in width, and 8.4 mm in height.

Type locality: MGS loc. 129, northern Lee County, Mississippi. The holotype and paratype were collected from the Upper Cretaceous (Campanian), "Chapelville fossiliferous horizon" within the Tupelo Tongue sequence of the Coffee Formation near Chapelville, Mississippi.
Etymology: This species is named after the state of Mississippi.

Bernaya (Protocypraea) rineyi Groves, sp. nov.  
(Figures 29, 30)

Diagnosis: Pyriform Protocypraea, anterior and posterior canals shallow, aperture slightly S-shaped, fossula, smooth, concave.

Description: Shell inflated-pyriform, of small size, constricted anteriorly; spire nearly covered; dorsum highly arched; maximum height near midpoint of shell; maximum width posterior of center; aperture slightly S-shaped, narrowing near midpoint and widening toward anterior end; denticulation coarse with smooth interstices, outer lip with 13 teeth that increase in strength posteriorly, inner lip with 12 teeth; fossula concave, smooth, wide; anterior and posterior terminal canals shallow; all surfaces smooth and glossy.

Comparison: The new species is most similar to Bernaya (Protocypraea) berryessae (Anderson, 1958:176, pi. 65, fig. 2–2b) from the lower Upper Cretaceous (Turonian) of Yolo County, California, but differs from the latter by its smaller size, wider, slightly S-shaped aperture, shallower anterior and posterior canals, and fewer teeth on the outer and inner lips.

Discussion: The excellent preservation displayed in the holotype allows for unequivocal generic and subgeneric assignments. Not only is Bernaya (Protocypraea) rineyi different from all other Cretaceous cypraeaceans from North America, but it is much younger than any similar species.

Material: Six specimens include the excellently preserved complete holotype, four poorly preserved crushed, incomplete specimens, and a single posterior fragment. All specimens appear to display original shell material.

Type material: Holotype, SDSNH 34008. The holotype measures 12.3 mm in length, 9.1 mm in width, and 7.1 mm in height.

Type locality: The holotype is from SDSNH loc. 3392 and the other specimens are from SDSNH locs. 3162-B and 3392. All of the specimens were collected from the Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation, near Carlsbad, northern San Diego County, California.

Etymology: This species is named after Bradford O. Riney (SDSNH) who collected not only the holotype, but numerous important fossils from southern California and northern Baja California, Mexico.

Family Ovulidae Fleming, 1828

Subfamily Eocypraeinae Schilder, 1924

Genus Eocypraea Cossmann, 1903

Type species: Cypraea inflata Lamarck, 1802, by original designation. Middle Eocene (Lutetian–Bartonian Stages), Paris Basin, France.

Diagnosis: Inflated-pyrim form shell of small to medium size; spire involute; narrow elongate aperture; fossula broad, smooth, concave.

Subgenus Eocypraea s.s.

Eocypraea (Eocypraea) louellae Groves, sp. nov.  
(Figures 31, 32)

Diagnosis: An Eocypraea with highly inflated shell, coarse denticulation, and slightly S-shaped aperture.

Description: Shell highly inflated, of small size, constricted anteriorly; spire partially covered; dorsum highly arched; maximum height slightly posterior of center; maximum width posterior of center; aperture slightly S-shaped; denticulation coarse with smooth interstices; outer lip with two teeth; fossula smooth, concave; all surfaces smooth, glossy; posterior columella highly inflated; anterior and posterior terminal canals shallow.

Comparison: The new species is most similar to Eocypraea newboldi (Forbes, 1846:134, pl. 12, fig. 21) from Upper Cretaceous (Turonian through Santonian), Trichinopoly

Explanation of Figures 19 to 34

Group, southern India, but differs from the latter by its highly inflated posterior columella, coarser denticulation, less sinuous aperture, and larger size.

Discussion: Good preservation of the holotype permits unequivocal generic and subgeneric assignments. *Eocypraea louellae* differs from all other Cretaceous cypraeaceans of North America, and is the earliest known ovulid from the Western Hemisphere.

Material: This species is represented by the well preserved holotype that displays original shell material. A second specimen from the Upper Cretaceous (Cenomanian to Turonian) Hornbrook Formation of Jackson County, Oregon, UCLA loc. 7288, is an internal mold with minor amounts of original shell material.

Type material: Holotype LACMIP 8281. The holotype measures 15.5 mm in length, 12.3 mm in width, and 9.7 mm in height.

Type locality: LACMIP loc. 28757, Putah Creek area of Thompson Canyon, Yolo County, northern California. Upper Cretaceous (Turonian), Yolo Formation.

Etymology: This species is named for LouElla R. Saul (LACMIP) in recognition of her numerous important contributions to Cretaceous and Tertiary molluscan paleontology.

*Eocypraea* (Eocypraea) mortoni (Gabb, 1860)
(Figures 33, 34)

*Cypraea* mortoni GABB, 1860:91, pl. 68, fig. 9 [not fig. 8].


Type material: Holotype, ANSP 13535. The holotype measures 17.4 mm in length, 13.9 mm in width, and 11.9 mm in height.

Type locality: Prairie Bluff, Wilcox County, Alabama. Upper Cretaceous (Maastrichtian), Prairie Bluff Formation.

Remarks: *Eocypraea mortoni* is represented by a single poorly preserved internal mold that displays few identifiable shell characters. Schilder (1932) separated material from Prairie Bluff, Alabama, and Burlington County, New Jersey, assigning those from New Jersey to *Palaeocypraea burlingtonensis*. *Eocypraea mortoni* is more globose than *Berneya* (Protocypraea) burlingtonensis.

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APPENDIX

Localities Cited

CAS loc. 1345, Texas Springs, 3.2 km E of Horsetown on road leading to Centerville, SW side of road, SW ¼ sec. 28, T31N, R5W, MDBM, Redding Quad, Shasta Co., Calif. Coll.: F. M. Anderson. Lower Cretaceous (Albian), Belden Canyon Formation.

CAS loc. 31918, Thompson Creek, 182.9 m W and 365.8 m N of SE ¼ sec. 20, T8N, R2W, MDBM, Monticello Dam Quad, Yolo Co., Calif. Coll.: W. E. Kennett, 1943. Just above base of Upper Cretaceous (Turonian), Yolo Formation.

CAS loc. 61856 (ex CAS loc. 445-A), Fitch Ranch, 3.2 km W of Phoenix, 0.8 km S of Fitch's house, Medford Quad, Jackson Co., Oregon. Upper Cretaceous (Genomanian/Turonian), Blue Gulch Member, Hornbrook Formation.


LACMIP loc. 28757, Thompson Creek, 640.5 m E of Napa-Yolo Co. line, 823.5 m N of Putah Creek, near mouth of small E flowing ravine, SE ¼ SE ¼ sec. 20, T8N, R2W, MDBM, Monticello Dam Quad, Yolo Co., Calif. Coll.: P. W. Reinhart. Upper Cretaceous (Turonian), Yolo Formation, 3425 m below top of exposed Chico Formation.

LACMIP loc. 10903 (ex CIT loc. 1622), near Ashland, along irrigation ditch 45.7–61 m above and to the SW of the Southern Pacific RR tracks at a point 6.43 km SE of U.S. Highway 99 bridge over Ashland Creek, Ashland, Jackson Co., Oregon, near midpoint of W boundary sec. 24, T39S, R1E, WBM, Medford Quad, Oregon. Coll.: W. P. Popeno and W. A. Findlay, September 1933. Upper Cretaceous (Turonian), Hornbrook Formation.


SDSNH loc. 3162, Carlsbad area, locality (now covered by Faraday Avenue) was exposed during development of Carlsbad Research Center, SW of El Camino Real, S of Letterbox Canyon and N of Palomar Airport, 33°08'02"N, 117°16'41"W, San Luis Rey Quad, San Diego Co., Calif. Coll.: B. O. Riney, T. A. Deméré, and M. A. Roeder, March–May 1982. Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation.

SDSNH loc. 3162-A, Carlsbad area, at the base of stratigraphic section measured at SDSNH loc. 3162, approximately 6.1 m below a calcareous marker bed. Coll.: B. O. Riney, T. A. Deméré, and M. A. Roeder, March–May 1982. Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation.

SDSNH loc. 3162-B, Carlsbad area, 2.1–3.9 m below a calcareous marker bed in measured stratigraphic section at SDSNH loc. 3162. Coll.: B. O. Riney, T. A. Deméré, and M. A. Roeder, March–May 1982. Upper Creta-
ceous (Campanian/Maastrichtian), Point Loma Formation.

SDSNH loc. 3162-M, Carlsbad area, near top of exposed stratigraphic section measured at SDSNH loc. 3162. Coll.: B. O. Riney, T. A. Deméré, and M. A. Roeder. Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation.

SDSNH loc. 3392, Carlsbad area, N of Palomar Airport, roadcut along W side of College Blvd., approximately 424 m S of intersection with El Camino Real, 33°08'21"N, 117°17'02"W, San Luis Rey Quad, San Diego Co., Calif. Coll.: SDSNH field party May 1987. Upper Cretaceous (Campanian/Maastrichtian), Point Loma Formation.


UCLA loc. 7288, Bellinger Hill area, large block displaced to S side of Bellinger Lane and about 0.19 km E of crest of Bellinger Hill by road improvement, approximately 793 m N and 884 m E of NE corner sec. 5, T38S, R2W, in parcel 92, T37S, R2W, WBM, Medford Quad, Jackson Co., Oregon. Coll.: W. P. Popenoe, R. B. Saul, L. R. Saul, R. B. Saul, and R. L. Saul, 17 June and 23 August 1975. Upper Cretaceous (Cenomanian), Osburger Gulch Sandstone Member, Hornbrook Formation.


USGS loc. 761, near Kaufman on W facing slope of Kings Creek valley, 0.8 km from courthouse where wagon road goes down to Kings Creek, and along E side of creek for 4.8 km S of Kaufman, Kaufman Co., Texas; approximately same as USGS loc. 7545. Coll.: T. W. Stanton, 1890; L. W. Stephenson, 1911. Upper Cretaceous (Maastrichtian), Nacatoch Sand, Navarro Group.

USGS loc. 17702, S side of Chesapeake and Delaware Canal, 91.5 m W of Conrail’s Chesapeake and Delaware Canal bridge, northern Delaware. Coll.: C. W. Carter, 1935–37. Upper Cretaceous (Campanian), Marshalltown Formation.