

Protoconch of the Rare Ovoid Gastropod  
*Cypraeogemmula warnerae* Effinger, 1938, from the  
Eocene of Western Washington

by

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**Abstract.** The protoconch of the small, rare gastropod *Cypraeogemmula warnerae* Effinger, 1938, is illustrated for the first time; the pattern of rhombs indicates that this genus belongs to family Oculididae. Only well-preserved specimens of this species show the protoconch. This new information is based on recently collected specimens from lower Eocene rocks of western Washington.

The genus *Cypraeogemmula* is only known from two species, *C. warnerae* from the lower to upper Eocene of western Washington and *C. liliputana* (Schilder, 1922) from the lowermost Oligocene of northern Germany. Previously, *C. warnerae* was known only from the upper Eocene of western Washington.

#### INTRODUCTION

The small ovoid gastropod *Cypraeogemmula warnerae* Effinger, 1938, is a rare species from Eocene rocks in western Washington (Effinger, 1938; Durham, 1944; Squires & Goedert, 1995) (Figure 1). Recent collecting in western Washington has yielded a few additional specimens of this species. Some of these specimens are well preserved and show the protoconch, which has not been previously illustrated for the genus.

Only two species-level taxa are known for the genus

*Cypraeogemmula*. Other than *C. warnerae* from Washington, the remaining taxon is *C. liliputana* (Schilder, 1922), from Lattorf, northern Germany. The Lattorf area is the stratotype of the Lattorfian Stage, and, based on studies of calcareous nannofossils, Berggren et al. (1985) assigned this stratotype to the lowermost Oligocene.

The molluscan stages for the Pacific coast of North America used in this report stem mainly from Clark & Vokes (1936), who proposed five mollusk-based Eocene stages, namely, "Meganos" (lowermost Eocene), "Capay" (middle lower Eocene), "Domengine" (upper lower to lower

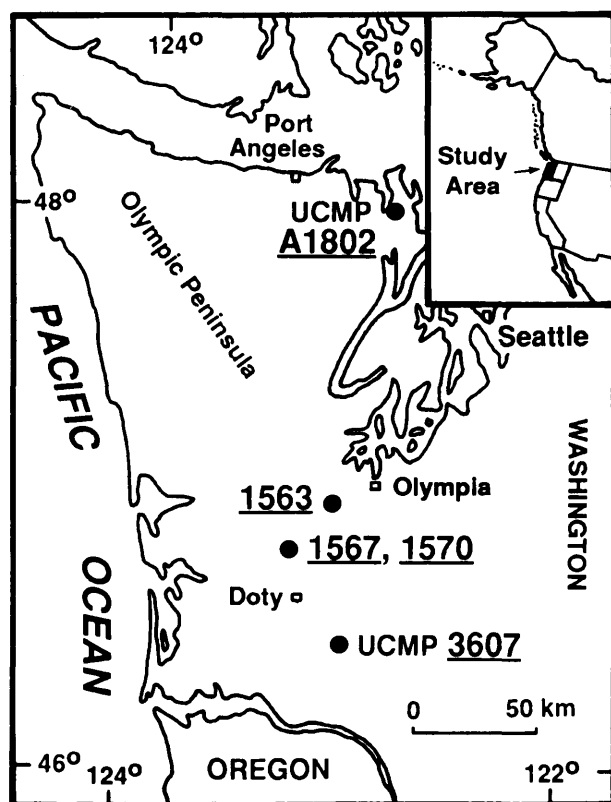


Figure 1

Index map to localities where *Cypraeogemmula warnerae* Effinger, 1938, has been found. Unless otherwise noted, localities are CSUN localities.

middle Eocene), "Transition" (lower middle Eocene), and "Tejon" (middle middle Eocene to upper Eocene). The stage names are placed in quotes because they are informal terms and generally the same as formation names. Givens (1974) modified the use of the "Capay Stage," and it is in this modified sense that the "Capay Stage" is used herein. The upper Eocene to lower Oligocene Pacific Northwest Galvinian Stage (= upper part of the "Tejon Stage") of Armentrout (1975) is also used in this report.

Abbreviations used for catalog and/or locality numbers are: CSUN, California State University, Northridge; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; UCMP, University of California Museum of Paleontology (Berkeley); UW, University of Washington, Seattle.

## SYSTEMATIC PALEONTOLOGY

Superfamily CYPRAEACEA Rafinesque, 1815

Family OVULIDAE Fleming, 1822

**Discussion:** We use the classification of Ponder & Warén (1988) herein. Dolin (1991a) noted that the family Ovulidae is characterized by a multispiral planktotrophic pro-

toconch with a sinusigeriform aperture and obliquely decussate sculpture. Bandel & Riedel (1994) confirmed that protoconch sculpture in the Ovulidae is distinguished by a pattern of rhombs, different from the coarsely cancellate protoconch found in the closely related family Cypraeidae. Bandel & Riedel (1994) also reported that, although the protoconchs of Ovulidae have a sinusigeriform aperture, this type of aperture is known from many gastropod taxa and usually cannot be used to characterize taxa higher than the species level.

We prefer not to assign *C. warnerae* to a subfamily until the diagnostic morphologic characters of the subfamilies of Ovulidae are more completely understood.

### Genus *Cypraeogemmula* Vredenburg, 1920

**Type species:** *Trivia scabriuscula* Koenen, 1890 [non *Trivia scabriuscula* (Gray, 1827)], = *Cypraea liliputana* Schilder, 1922, by monotypy, early Oligocene, Lattorf, northern Germany.

Koenen's (1890) name *Trivia scabriuscula* is a secondary homonym because Gray's (1827) name *Cypraea scabriuscula* is known to belong to the genus *Trivia*. Vredenburg (1920:114) used Koenen's species name when he proposed the type species of genus *Cypraeogemmula*. The replacement name, *Cypraea liliputana* Schilder, 1922, for Koenen's name was allocated to genus *Cypraeogemmula* by Schilder (1927).

### *Cypraeogemmula warnerae* Effinger, 1938

(Figures 2–8)

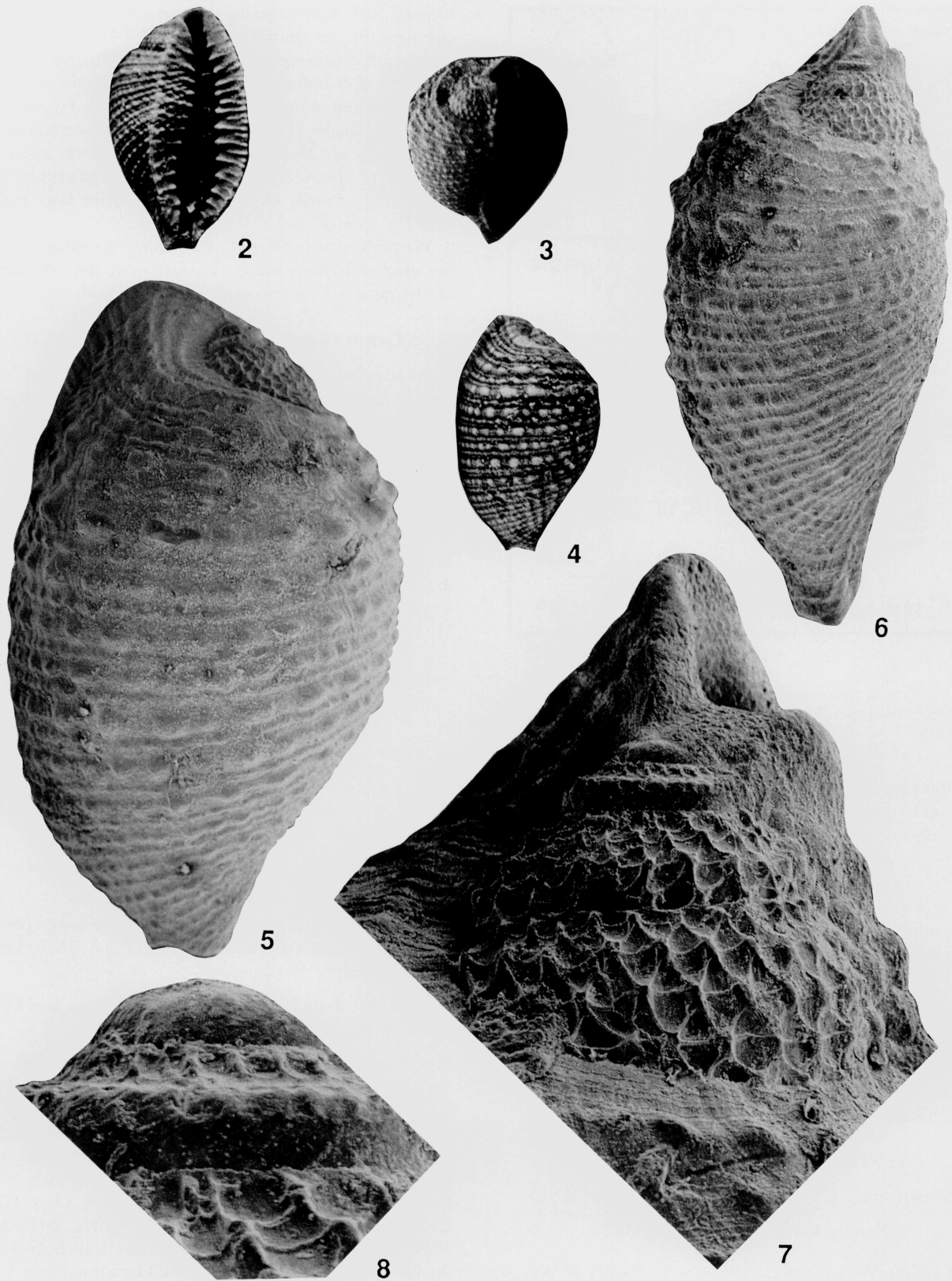
*Cypraeogemmula warnerae* Effinger, 1938:381, pl. 47, figs. 29, 35; Weaver, 1942 [1943]:394–395, pl. 77, fig. 2; Durham, 1944:117, 165; Schilder, 1961:147; Schilder & Schilder, 1971:22, 168; Groves, 1993:12; Squires & Goedert, 1995:table 1.

**Holotype:** UCMP 33588, lost (D. R. Lindberg, personal communication).

**Type locality:** "Gries Ranch beds" in the lower part of the Lincoln Creek Formation, UCMP loc. 3607, Lewis County, western Washington.

**Geographic distribution:** Jefferson, Thurston, and Lewis counties, western Washington.

**Stratigraphic distribution:** "Capay Stage" (middle lower Eocene) to Galvinian Stage (upper Eocene part). "CAPAY STAGE": Upper part of the Crescent Formation, Black Hills, Thurston County, western Washington (herein). MIDDLE EOCENE: Transition beds between the upper part of the Crescent Formation and the overlying lower part of the McIntosh Formation, northern Doty Hills, Lewis County, western Washington (Squires & Goedert, 1995). GALVINIAN STAGE: "Gries Ranch beds" in the lower part of the Lincoln Creek Formation, near Vader, Lewis County, western Washington (Effinger, 1938); lower part of the Quimper Sandstone, Discovery Bay,



Quimper Peninsula, Jefferson County, western Washington (Effinger, 1938; Durham, 1944).

**Discussion:** Ten specimens were found during the course of this present study. A single, exceptionally well preserved specimen 3 mm in height, was found at CSUN loc. 1563 in the upper part of the Crescent Formation in the Larch Mountain area, Black Hills, near Olympia, western Washington (Figures 2–8). Seven specimens were found at CSUN loc. 1567, and two were found at CSUN loc. 1570. Both of these localities are in the transition zone between the Crescent Formation and the McIntosh Formation in the northern Doty Hills area, Thurston County, western Washington. Preservation of the specimens at CSUN loc. 1567 is generally poor to good; two specimens show the protoconch. Preservation of the specimens at CSUN loc. 1570 is overall very good.

The specimens of *Cypraeogemmula warnerae* found during the course of this present study range from 2 to 5 mm in height. The spire is visible only on juvenile or early adult specimens. On more mature specimens between 4.5 and 5 mm in height, the spire is involute and completely obscured by the subsequent whorls. The lost holotype of *C. warnerae* measured 4.1 mm in height, and published illustrations of it (Effinger, 1938:pl. 47, figs. 29, 35; Weaver, 1942 [1943]:pl. 77, fig. 2) show no hint of a spire. Durham (1944:165) designated three non-figured referred specimens of *C. warnerae* (UCMP 35334–35336) from UCMP loc. A1802 in the lower part of the Quimper Sandstone, Quimper Peninsula, Jefferson County, western Washington. Specimen 35334 is 3.5 mm in height and shows a few of the spire whorls, although the shell is missing on the spire. Specimen 35335 is 5.5 mm in height and is the largest known specimen of *C. warnerae*. This poorly preserved specimen would have been involute if the posterior part of the shell had not been worn off, thereby exposing the spire. The third referred specimen is a worn fragment.

The holotype, Durham's three referred specimens, and specimens collected during the course of this present study indicate that adult specimens of *C. warnerae* are about 3 mm or greater in height, and the most mature specimens have an involute spire.

Effinger (1938) briefly described the spire of *C. warnerae*, so we assume that he observed juvenile or early adult specimens. Unfortunately, he did not illustrate any

of them as paratypes, nor did he assign any of them catalog numbers for future study. Based on an extremely well preserved specimen from CSUN loc. 1563, as well as additional specimen from CSUN loc. 1567, the following additional information can now be added: protoconch (= spire in this species), approximately 0.4 mm long, multispiral (four whorls), inclined to the right side, and entire right side covered by the body whorl; initial whorl of protoconch low, rounded, smooth, and naticiform; second whorl of protoconch tabulate with oblique axial sculpture anterior to the tabulation and with no ornamentation posterior to the tabulation, third and fourth whorls of protoconch with oblique decussate (rhomboidal) axial sculpture crossed by four to five spiral ribs, each spiral rib bisecting a rhomb and thereby producing a distinctive triangular pattern; protoconch set off from rest of teleoconch by a smooth "shelf."

Effinger (1938) and Weaver (1942[1943]) assigned *C. warnerae* to family Cypraeidae, but the pattern of rhombs observable on the protoconch of *C. warnerae* indicates that this species is an ovulid rather than a cypraeid. The rhomb pattern of *C. warnerae* is very close to that in other ovulids (Pezant, 1910:pl. 14, figs. 14a–c; 1911:24; Liltved, 1989:fig. 226; Dolin, 1991b:fig. 2b; Bandel & Reidel, 1994:pl. 8, fig. 10; text fig. 10). The rhomb pattern of *C. warnerae* is very different from the cypraeid cancellate pattern, which is illustrated in Bandel & Reidel (1994:pl. 8, fig. 9).

The type locality of *C. warnerae* is in the "Gries Ranch beds." Durham (1944) assigned these beds to his *Molopophorus stephensoni* Zone. Armentrout (1975) assigned this zone to the middle part of his Galvinian Molluscan Stage of late Eocene age and included the "Gries Ranch beds" in the lower part of the Lincoln Creek Formation.

Effinger (1938:table 1) listed *C. warnerae* as also present at Woodman Wharf on the Quimper Peninsula, Jefferson County, western Washington. Durham (1944:112) reported that UCMP loc. A1802 is the same as "Woodman Wharf." Durham (1944:117), furthermore, found six specimens of *C. warnerae* at UCMP loc. A1802 and reported that this locality is from his *Molopophorus stephensoni* Zone.

The specimens of *C. warnerae* from CSUN loc. 1563 are from rocks in the upper part of the Crescent Formation that Squires & Goedert (1994, in press) assigned to the "Capay Stage" (middle lower Eocene). The specimens of *C. warnerae* from CSUN locs. 1567 and 1570 are from

#### Explanation of Figures 2 to 8

SEM micrographs = Figures 5–8. All non-SEM specimens coated with ammonium chloride. Figures 2–8. *Cypraeogemmula warnerae* Effinger, 1938, LACMIP catalog number 11372, CSUN loc. 1563 [= LACMIP 16655], height 3 mm. Figure 2. Apertural view,  $\times 13.3$ . Figure 3. Oblique apical view, low-level lighting used to show "shelf" that separates protoconch from the teleoconch,  $\times 15$ . Figure 4. Abapertural view,  $\times 13.3$ . Figure 5. Abapertural view,  $\times 40$ . Figure 6. Left-lateral view,  $\times 40$ . Figure 7. Left-lateral view of protoconch,  $\times 150$ . Figure 8. Left-lateral view of apical part of protoconch,  $\times 400$ .

transition beds between the upper part of the Crescent Formation and the overlying lower part of the McIntosh Formation; Squires & Goedert (1995) assigned these transition beds to the middle Eocene.

Apparently *Cypraeogemmula warnerae* inhabited shallow-water marine environments even though its shells can be found in deep-water deposits. Although Effinger (1938) considered the "Gries Ranch beds" to represent a warm-water nearshore or littoral environment, Hickman (1984) believed that these beds, as well as the Quimper Sandstone, were probably deposited in deep water, subject to the influx of nearshore mollusks that were transported downslope. Squires & Goedert (1995) interpreted the depositional environment of CSUN locs. 1567 and 1570 as having been on the flank of an oceanic volcanic island in outer shelf to upper slope (bathyal) muds subject to the influx of shells of nearshore and shallow-marine megainvertebrates (mollusks, solitary corals, etc.) and pebbly basalt debris. Squires & Goedert (1994, in press) interpreted the depositional environment of CSUN loc. 1563 as adjacent to a rocky shoreline formed by the extrusion of basalt. Warm-water, shallow-marine mollusk shells and colonial corals were transported only a short distance and deposited in muddy matrix coquina that filled cracks between boulders of basalt. This last locality provides the best control as to the paleoecology of *C. warnerae*. We conclude that this species was a shallow-water marine species, even though it commonly ended up being transported into deeper waters. Its small size could have easily contributed to its being transported. Most extant species of ovulids are warm-water, shallow-marine forms that prey upon stony corals (either solitary or reef type) or on gorgonians (Keen, 1971).

The teleoconch morphology of *Cypraeogemmula liliputana* (Schilder, 1922) is very close to *C. warnerae*. The largest known specimens of *C. liliputana* are 3.2 mm in height. Based on illustrations and/or descriptions of the 3 mm-high holotype of *C. liliputana* (Koenen, 1890:565-566, pl. 39, figs. 8a-c; Wenz, 1941:1001, fig. 2874), the teleoconch of *C. liliputana* has a more projecting anterior canal, a more rectangular-shaped aperture, and more widely spaced primary spiral ribs. Although the spire is somewhat visible on the illustrations of the holotype of *C. liliputana*, the details are not discernible. Koenen (1890:565), in the description of this species, referred to the spire as consisting of four smooth, convex whorls that are inclined and attached to the body whorl. The relationship of the spire to the body whorl is the same as in *C. warnerae*. Koenen's (1890) description of the spire as smooth must have been based on observations without the aid of magnification. We concur with Schilder (1961) and Schilder & Schilder (1971) that *Cypraeogemmula liliputana* and *C. warnerae* both belong to the genus *Cypraeogemmula*. Vredenburg (1920) did not base his definition of this genus on protoconch characters, but knowing these characters is crucial in familial assignment. As discussed above, our studies of the protoconch of *C. warnerae* now allow assignment of

the genus *Cypraeogemmula* to the family Ovulidae. If the whereabouts of the holotype of *C. liliputana* ever becomes known or when suitable material becomes available, it would be helpful to have SEM micrographs of the spire of this species. We predict that its spire will be found to show rhombs as in the otherwise similar *C. warnerae*.

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- CSUN 1567, 1570 [= LACMIP locs. 16849, 16850]. Localities are about 4 m apart, in ascending stratigraphic order, in a quarry at E end of bluff overlooking W side of Garrard Creek, 46 m N and 518 m W of SE corner of section 21, T. 15 N, R. 5 W, U.S. Geological Survey, 7.5-minute, Cedarville Quadrangle, 1986, northern Doty Hills, extreme NW corner of Lewis County, western Washington. Transition zone between the upper part of the Crescent Formation and the overlying lower member of the McIntosh Formation. Age: Middle Eocene. Collectors: J. L. & G. H. Goedert, 1993-1994 (Squires & Goedert, 1995).
- UCMP 3607 [= UW 239]. South bank of Cowlitz River at old Gries Ranch, section 25, T. 11 N, R. 2 W, U.S. Geological Survey, 15-minute, Castle Rock Quadrangle, 1953, Lewis County, western Washington (Effinger, 1938:fig. 2; Weaver, 1942 [1943]). "Gries Ranch beds" in the lower part of the Lincoln Creek Formation. Age: Late Eocene. Collector: W. L. Effinger, circa middle 1930s.
- UCMP A1802. On beach 0.4 km N of Woodman's Station (= Woodman Wharf), Discovery Bay, SW 1/4 of NE 1/4 of section 8, T. 29 N, R. 1 W, U.S. Geological

Survey, 7.5-minute, Port Townsend South Quadrangle, 1981, southwestern Quimper Peninsula, Jefferson County, western Washington (Effinger, 1938; Durham, 1944). Lower part of the Quimper Sandstone. Age: Late Eocene. Collector: W. L. Effinger?, circa middle 1930s (Effinger, 1938; Durham, 1944).

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