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# A New Species of *Depressigyra*? (Gastropoda: Peltospiridae) from Cold-Seep Carbonates in Eocene and Oligocene Rocks of Western Washington

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*Abstract.* Continued study of chemosynthetic marine-invertebrate faunas preserved in carbonates formed by the oxidation of methane at ancient cold-seeps reveals, tentatively, the first fossil record of the gastropod family Peltospiridae and the genus *Depressigyra*. *Depressigyra*? ***statura*** sp. nov., was found in three cold-seep carbonates within bathyal marine strata in western Washington: the middle Eocene Humptulips Formation; the early Oligocene part of the Makah Formation; and the late Oligocene part of the Lincoln Creek Formation.

## INTRODUCTION

Taxonomic work on minute (< 5 mm height) gastropods from modern chemosynthetic communities such as those found near hydrothermal vents and cold seeps is resulting in the recognition of many new families, genera, and species (e.g., McLean, 1989; Warén & Bouchet, 1989, 1993). One recently described gastropod, *Depressigyra globulus* Warén & Bouchet, 1989, is the only known living species of the genus (Warén & Bouchet, 1993). It is one of the most common gastropods in chemosynthetic environments near hydrothermal vents along the Juan de Fuca Ridge (Warén & Bouchet, 1989). Fossils of a new species tentatively referable to the genus *Depressigyra* have been found in localized, methane-derived carbonates within bathyal siltstones in three different formations in western Washington (Figure 1). This is the first detailed study of a minute archaeogastropod from fossil chemosynthetic communities.

The abbreviation used for localities and specimens is LACMIP = Natural History Museum of Los Angeles County, Invertebrate Paleontology Section.

### Paleoenvironments

The fauna preserved in a carbonate within the middle to late Eocene Humptulips Formation (LACMIP loc. 12385) was recognized as a chemosynthetic cold-seep community by Goedert & Squires (1990) and Campbell & Bottjer (1993). Benthic foraminifera indicate bathyal depths of 1500 to 2000 m (W. W. Rau cited in Goedert & Kaler, 1996). Carbonate blocks (LACMIP locs. 8233 and 15911) within bathyal basin-plain turbidites of the early Oligocene part of the Makah Formation are allochthonous (Goedert & Campbell, 1995), but they are methane-derived and contain chemosynthetic taxa. This carbonate was precipitated at cold-seeps in a shelf or slope environment, and then broke into blocks up to 2.5 m across when it slid or slumped into deeper parts of a basin (Goedert & Campbell, 1995). A cold-seep carbonate (LACMIP loc. 16504) from the late Oligocene part of the Lincoln Creek Formation was first reported by Squires (1995); it contains a diverse chemosynthetic assemblage that is absent in the surrounding bathyal siltstone (Squires & Goedert, 1995; Rigby & Goedert, 1996).

All of these carbonates differ from other "normal" deep-water carbonates (e.g., nodules and concretions), in that they contain fossils of large numbers of organisms that are not present in surrounding strata, calcite and/or quartz lined vugs, and wavy-laminated carbonate crusts. These deep-water carbonates formed due to the bacterial oxidation of methane at cold-seeps. This interpretation was based on sedimentologic and paleontologic evidence (Campbell & Bottjer, 1993; Goedert & Squires, 1990; Rigby & Goedert, 1996; Squires, 1995; Squires & Goedert, 1991, 1995). The faunas contained in these distinctive carbonates and their depositional context compare well with western North American ancient and modern cold-seep carbonates described by Campbell & Bottjer (1993), Campbell et al. (1993), and Kulm & Suess (1990).

The new species of *Depressigyra*? is abundant and well preserved in both the Humptulips Formation and the Lincoln Creek Formation carbonates. Few specimens were found in the Makah Formation; however, most of the shell was lost during preparation because of the indurated nature of the micrite.

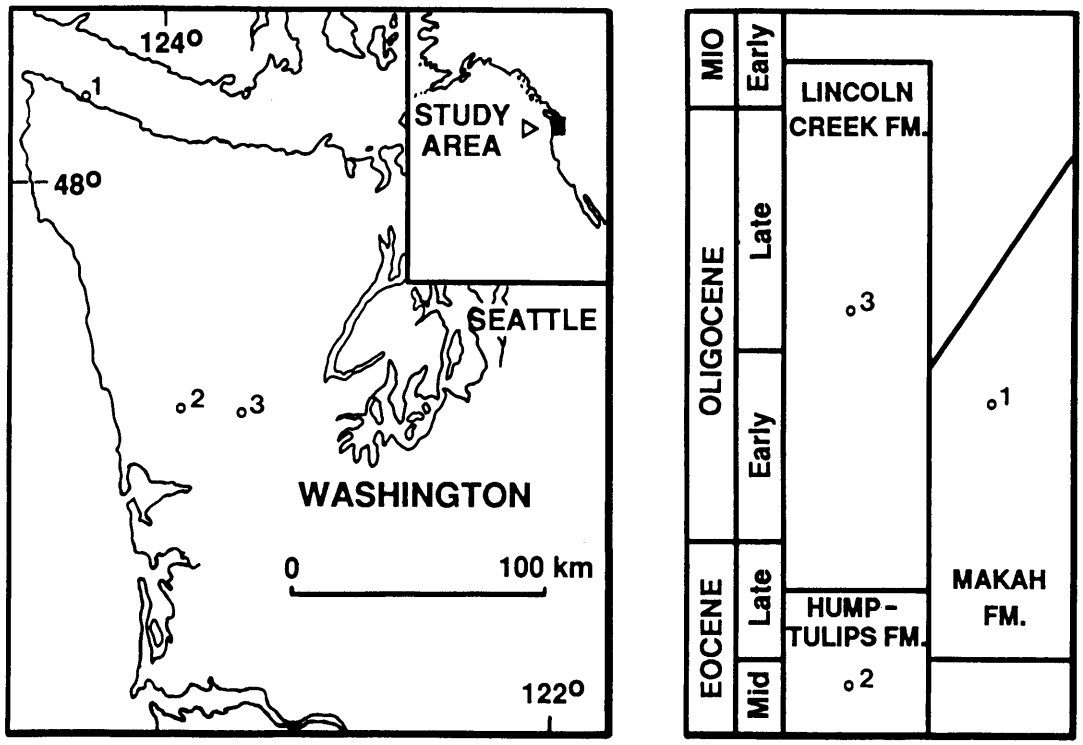


Figure 1

Generalized geographic and chronostratigraphic distribution of localities for *Depressigyra*? ***statura*** Goedert & Benham, sp. nov.; *1* = Makah Formation, LACMIP locs. 8233 and 15911; *2* = Humptulips Formation, LACMIP loc. 12385, *3* = Lincoln Creek Formation, LACMIP loc. 16504.

Table 1

Carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) stable-isotope analyses of carbonates from the Humptulips Formation (LACMIP loc. 12385) and the Lincoln Creek Formation (LACMIP loc. 16504). All values expressed per mil (‰) relative to PDB standard.

| Sample | $\delta^{13}C$ | $\delta^{18}O$ |
|---|---|---|
| LACMIP loc. 12385: | | |
| Serpulid? tube wall | − 20.8 | − 5.7 |
| Serpulid? tube wall | − 21.0 | − 5.7 |
| Serpulid? tube wall | − 26.2 | − 5.1 |
| Micrite | − 24.1 | − 6.0 |
| LACMIP loc. 16504: | | |
| Micrite | − 44.33 | + 1.6 |
| Micrite[1] | − 46.38 | + 2.6 |
| Fibrous splayed calcite[1] | − 46.73 | + 2.4 |

[1] Both samples from same hand specimen of carbonate.

Serpulid? tube sample analyses performed by T.M.B. Group, Inc., Miami, Florida; all others by Global Geochemistry Corp., Canoga Park, California.

## Stable Isotopes

Isotopic data, $\delta^{13}C$ and $\delta^{18}O$, for the Makah Formation carbonate confirmed that it had precipitated from methane-enriched fluids (Goedert & Campbell, 1995). Preliminary isotopic data (Table 1) indicate that the Humptulips Formation and Lincoln Creek Formation carbonates are also methane derived.

Isotopic signatures of serpulid?-tube walls and micrite from the Humptulips Formation (LACMIP loc. 12385) are problematic. The $\delta^{13}C$ values of the tubes (− 20.8 to − 26.2) are similar to some reported for living tube worms from hydrocarbon-seep communities on the Louisiana slope (Brooks et al., 1987). The value for the micrite is close to one sample reported by Goedert & Campbell (1995) from the Makah Formation. These values probably indicate a mixing of methane-derived carbon with less $\delta^{13}C$-depleted sources, perhaps dissolved inorganic carbon in seawater and/or particulate and dissolved organic carbon. The unusually low values for $\delta^{18}O$ may represent diagenetic modification, but they could also indicate elevated temperatures and/or meteoric influence of pore waters, or $\delta^{18}O$ depletion in marine pore water (Sass et al., 1991).

Samples from the Lincoln Creek Formation (LACMIP

loc. 16504) yielded very negative $\delta^{13}C$ values (− 44.33 to − 46.73). As in the Makah Formation carbonate, $\delta^{13}C$ values this negative are indicative of precipitation from a methane-enriched fluid source (Goedert & Campbell, 1995, and references therein). Values of $\delta^{18}O$ from the carbonate are positive but they are consistent with precipitation at or near ambient seawater temperatures (K. A. Campbell, personal communication, 1996).

## SYSTEMATIC PALEONTOLOGY

### Order ARCHAEOGASTROPODA Thiele, 1925

### Suborder NEOMPHALINA McLean, 1990

### Superfamily NEOMPHALOIDEA McLean, 1981

### Family PELTOSPIRIDAE McLean, 1989

**Remarks:** Warén & Bouchet (1989) considered the family Peltospiridae to be polyphyletic. Living peltospirid genera are differentiated by characters that include soft-part anatomy, radular structure, and protoconch sculpture. Additional studies may justify the reassignment of the genus *Depressigyra* to another family; therefore the current classification is tentative (Warén & Bouchet, 1993). This family has no previously reported fossil record. The genus *Depressigyra* was unintentionally referred to the family Hyalogyrinidae by Lewis & Marshall (1996:189).

### Genus *DEPRESSIGYRA* Warén & Bouchet, 1989

**Type species:** *Depressigyra globulus* Warén & Bouchet, 1989, by original designation. In their diagnosis of the genus *Depressigyra,* Warén & Bouchet (1989:80) stated that the aperture was "distinctly opisthocline," whereas it is actually prosocline. This error was confirmed by A. Warén (personal communication, 1997). Warén & Bouchet (1989) also stated in the diagnosis that the protoconch of *Depressigyra* has a net-sculpture, but in their description of *D. globulus* they stated that the protoconch sculpture was unknown. The original diagnosis of genus *Depressigyra* Warén & Bouchet, 1989, is therefore emended.

**Emended diagnosis:** Globular peltospirids of medium size; teleoconch almost smooth except for irregular and slightly sinuous growth lines, aperture round and distinctly prosocline; central and lateral teeth of radula unusually slender; no tentacular sexual dimorphism.

**Remarks:** This genus originally included two species, *D. globulus* Warén & Bouchet, 1989, living only at hydrothermal vents at various sites on the Juan de Fuca Ridge, and *D. planispira* Warén & Bouchet, 1989, living at vent sites on the East Pacific Rise. With additional data on shell and soft-part anatomy from new specimens, *Depressigyra planispira* subsequently became the type species of a new genus, *Planorbidella* Warén & Bouchet, 1993, making the genus *Depressigyra* monotypic.

At least four more gastropod genera living at methane-seeps and having shells similar to *D. globulus,* but possessing distinctive radulae and protoconchs, await description (A. Warén, personal communication, 1997). The protoconchs of all available specimens of both *D. globulus* and the new fossil species are too corroded to preserve any sculpture that may have been present. Therefore, the new species is tentatively referred to the genus *Depressigyra* entirely on the basis of similarity of the teleoconch with that of *D. globulus.* Future studies may warrant reassignment of the new species to another genus.

### *Depressigyra*? ***statura*** Goedert & Benham, sp. nov.

(Figure 2A–G)

"Naticid" Goedert & Squires, 1990, p. 1182, fig. 2g; Goedert & Kaler, 1996, p. 67, table 1. "Hyalogyrinid" Goedert & Campbell, 1995, p. 25, figs. 11, 12.

**Diagnosis:** A *Depressigyra*? with a spire elevated well above the body whorl.

**Description:** Shell small, globose, thin, nearly smooth except for numerous fine, sinuous, prosocline growth lines; aperture nearly round, prosocline, outer lip thin; whorls convex, suture impressed, spire elevated above body whorl and apex formed by a knoblike protoconch, protoconch surface corroded in all available specimens, appears to be about one whorl; largest shell with 2.25 post-larval whorls.

**Comparisons:** Except for the slightly more inflated whorls and higher spire, the shell of *D.*? ***statura*** sp. nov., resembles that of *D. globulus* Warén & Bouchet (1989: 80–81, figs. 30, 31, 45–47, 51–52, 78, 83). The sculpture of the protoconch of *D. globulus* is not known, the apex of all known specimens having been corroded (Warén & Bouchet, 1989). The only measurement for *D. globulus* is a maximum diameter of 5.4 mm (Warén & Bouchet, 1989:80), and all specimens of *D.*? ***statura*** sp. nov., are smaller (Table 2).

*Depressigyra*? ***statura*** sp. nov., somewhat resembles another living chemosynthetic community gastropod in the family Cyathermidae, *Cyathermia naticoides* Warén & Bouchet (1989: 70–72, figs. 6–10, 15, 16, 18, 21–23, 71, 80), but *D.*? ***statura*** sp. nov., lacks the very distinct and highly diagnostic deep, rounded notch in the lower part of the aperture.

**Material:** Holotype, LACMIP 7892, paratypes LACMIP 7893, 7894, 7895, 7896, 7988, LACMIP loc. 16504, Lincoln Creek Formation, late Oligocene. Paratype LACMIP 7897, hypotype LACMIP 8343, LACMIP loc. 12385, Humptulips Formation, middle Eocene. Hypotypes LACMIP 12318, 12319, LACMIP loc. 8233, Makah Formation, early Oligocene. Additional specimens are stored at

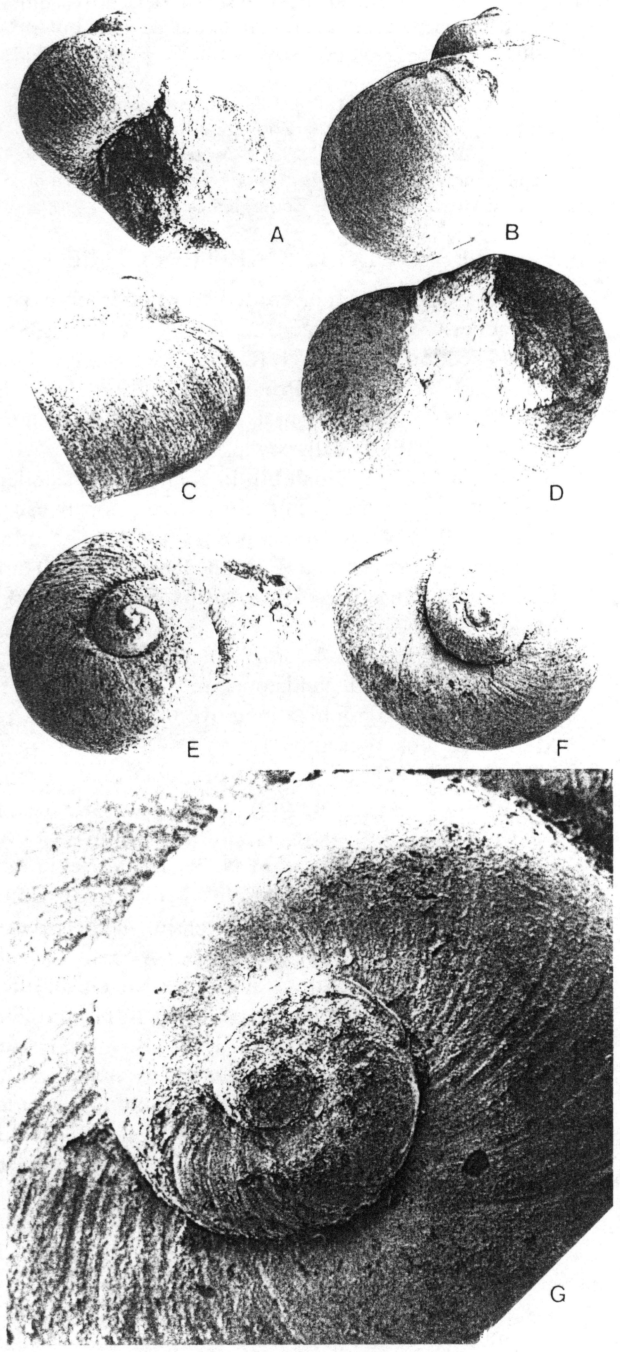


Figure 2

*Depressigyra*? ***statura*** Goedert & Benham, sp. nov., secondary electron micrographs. All from the Lincoln Creek Formation, LACMIP loc. 16504 unless otherwise noted. Outer lip of aperture broken or partially concealed by matrix in all specimens. A. holotype LACMIP 7892, apertural view, X14; B. paratype LACMIP 7893, back view, X14; C. paratype LACMIP 7988, lateral view showing prosocline aperture, X12; D. paratype LACMIP 7895, bottom view, X14; E. paratype LACMIP 7897, Humptulips Formation, LACMIP loc. 12385, oblique top view, X14; F. paratype LACMIP 7894, top view, X14; G. paratype LACMIP 7896, apex showing growth lines, suture, and corroded protoconch, X90.

Table 2

Measurements (in mm) of type specimens of *Depressigyra*? ***statura*** sp. nov.; D = diameter, H = height.

| Specimen | D | H |
|---|---|---|
| LACMIP 7892 | 2.6 | 2.9 |
| LACMIP 7893 | 2.7 | 2.9 |
| LACMIP 7894 | 2.8 | 3.1 |
| LACMIP 7895 | 3.1 | 3.4 |
| LACMIP 7896 | 2.0 | 2.5 |
| LACMIP 7897 | 2.4 | 3.0 |
| LACMIP 7988 | 2.5 | 2.6 |

LACMIP and California State University, Department of Geological Sciences, Northridge (CSUN).

**Etymology:** The species name, *statura,* Latin meaning stature, is in reference to the high spire, being contrary with the etymology for genus *Depressigyra,* alluding to a low spire.

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## APPENDIX: LOCALITIES CITED

LACMIP loc. 8233. Float eroded from bedrock exposed on modern beach terrace at Shipwreck Point, SE1/4 NE1/4 section 36, T. 33 N, R. 14 W, Sekiu River USGS 7.5-minute quadrangle, Provisional Edition 1984, Clallam County, Washington. Upper part of Makah Formation. Age: Early Oligocene.

LACMIP loc. 12385. Small hill in abandoned meander of the East fork of the Humptulips River, northwest part of Sec. 4, T. 20 N, R. 9 W, Burnt Hill USGS 7.5 minute quadrangle, Provisional Edition 1990, Grays Harbor County, Washington. Humptulips Formation. Age: Middle Eocene.

LACMIP loc. 15911. *In situ* isolated limestone block within thin-bedded sandstone and siltstone deposits, about 30 m stratigraphically above top of Jansen Creek Member, block measures 1.5 m (N–S) by 2.5 m (E–W), and is weathered out 0.75 m higher than surrounding siltstone; accessible only at low tide. Block is approximately 175 m southeast of tip of Shipwreck Point, SE1/4 NE1/4 Sec. 36, T. 33 N, R. 14 W, Sekiu River USGS 7.5-minute quadrangle, Provisional Edition 1984, Clallam County, Washington. Upper part of Makah Formation. Age: Early Oligocene.

LACMIP loc. 16504. Limestone block on north side of sharp bend of the Canyon River, 600 m N and 290 m E of SW corner of Sec. 25, T. 21 N., R. 7 W., Grisdale USGS 7.5 minute quadrangle, Provisional Edition 1990, Grays Harbor County, Washington. Upper part of the Lincoln Creek Formation. Age: earliest late Oligocene. This locality was covered by a large landslide in early 1997.