

# *PaleoBios*

---

OFFICIAL PUBLICATION OF THE UNIVERSITY OF CALIFORNIA MUSEUM OF PALEONTOLOGY



**Charles L. POWELL, II and N. Scott RUGH (2025). Two new species of bivalves (Mollusca: Bivalvia) from deep-water Eocene deposits in San Diego County: a questionable *Malletia* (Malletiidae) and an *Acesta* (Limidae)**

**Cover:** SDSNH 160264, holotype of a new species of *Acesta* from the Eocene Ardath Shale

**Citation:** Powell II, C. L., and N.S. Rugh. 2025. Two new species of bivalves (Mollusca: Bivalvia) from deep-water Eocene deposits in San Diego County: a questionable *Malletia* (Malletiidae) and an *Acesta* (Limidae). *PaleoBios* 42(5): 1-13.

**DOI:** <https://doi.org/10.5070/P9.41787>

Published under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC-BY-NC-SA) license.

# Two new species of bivalves (Mollusca: Bivalvia) from deep-water Eocene deposits in San Diego County: a questionable *Malletia* (Malletiidae) and an *Acesta* (Limidae)

Charles L. Powell, II<sup>1</sup> and N. Scott Rugh<sup>2</sup>

<sup>1</sup> Research Associate, Paleontology Department, San Diego Society of Natural History, Balboa Park, San Diego, California 92101; [powell2@sbcglobal.net](mailto:powell2@sbcglobal.net); <https://orcid.org/0000-0002-1913-555X>

<sup>2</sup> Temecula, California 92592; [srugh@sbcglobal.net](mailto:srugh@sbcglobal.net)

Fossils of two rarely encountered molluscan bivalve genera *Malletia*(?) (Malletiidae, Bivalvia, Mollusca) and *Acesta* (Limidae, Bivalvia, Mollusca) were collected from the early Eocene (“Domengine” California provincial molluscan stage) Ardath Shale, La Jolla Group in La Jolla, San Diego County, California. These specimens all represent new species. The new *Malletia*, *M. soledadensis* n. sp., is similar to the Holocene northeastern Pacific species *M. faba* Dall (1897) and *M. talama* Dall (1916) differing from the former in shell outline and the latter in having a prominent umbo. The new *Acesta*, *A. californica* n. sp., is somewhat similar in outline to the modern Philippine species *A. rathbuni* (Bartsch, 1913) but is more elongate and smaller. These two genera indicate a deep water outer shelf-slope paleoenvironment for the Ardath Shale.

**Keywords:** Eocene, Ardath Shale, La Jolla Group, Mollusca, Bivalvia

## INTRODUCTION

Two new species, one each in the molluscan bivalve genera *Malletia*? (Malletiidae, Bivalvia, Mollusca) and *Acesta* (Limidae, Bivalvia, Mollusca) are described from the early middle Eocene (Lutetian International Commission on Stratigraphy Stage) Ardath Shale in the La Jolla Group from La Jolla, San Diego County, California. The new species of *Malletia*(?) is represented by 77 specimens, while *Acesta* is represented by only three specimens. All specimens were collected during paleontological monitoring work during development of a private residential site at 7001 Country Club Drive, La Jolla, San Diego County, California (32.837056°, -117.260527°, elevation [from Google Earth] ±156 m) (Figure 1).

Both bivalve genera have a limited fossil record in California. The genus *Malletia* has been reported from the Cenozoic of California (Keen and Bentson 1944,

Groves and Squires 2021), however none of the species previously referred to the genus are currently identified as *Malletia* (Moore 1983). In the Neogene fossil record of California the genus *Acesta* is represented by only three species (Moore 1987) and now our fourth.

A fauna of 50 invertebrate taxa including an indeterminate solitary coral, the polychaete worm *Rotularia tejonensis* (Arnold, 1909 [1910]), 44 mollusks, including 22 bivalve taxa, 19 gastropod taxa, two scaphopods, an indeterminate nautiloid, three callianasid shrimp, and two echinoids, along with various vertebrate and plant debris (Table 1) are recognized from the La Jolla collecting site and were first reported by Rugh and Wirths (2023).

Eocene geology of the La Jolla area has been described by Kennedy and Moore (1971) and Deméré, Sundberg, and Schram (1979). Outcrops in the vicinity of the collection site (SDSNH localities 7686 and 7687) were mapped as Ardath Shale by Kennedy and Tan (2008),

**Citation:** Powell II, C. L., and N.S. Rugh. 2025. Two new species of bivalves (Mollusca: Bivalvia) from deep-water Eocene deposits in San Diego County: a questionable *Malletia* (Malletiidae) and an *Acesta* (Limidae). *PaleoBios* 42(5): 1-13.

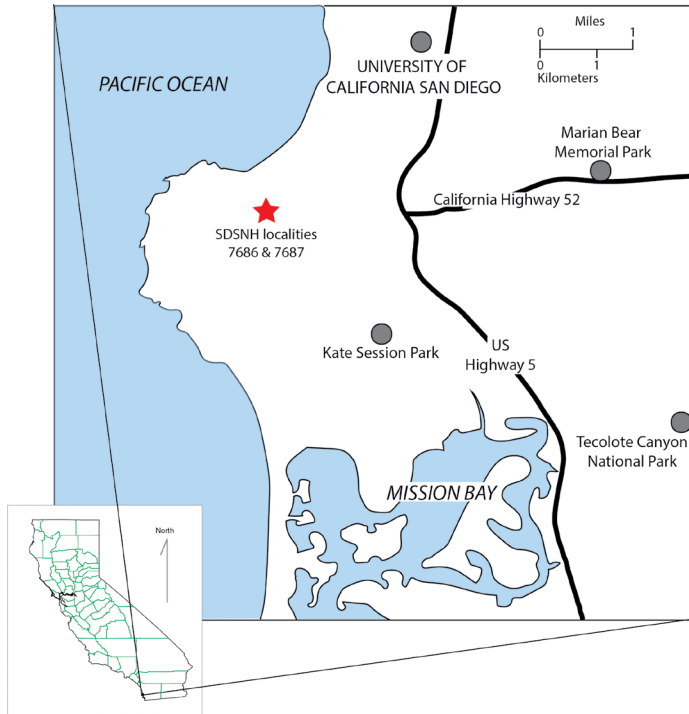
**DOI:** <https://doi.org/10.5070/P9.41787> **Date of Publication for New Taxonomic Names:** August 18, 2025  
Published under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC-BY-NC-SA) license.

**Table 1.** List of fossil taxa found in association with the new species from SDSNH locality 7687, from the Ardath Shale, formerly exposed in excavation along Country Club Drive, La Jolla, San Diego County, California and identified by Scott Rugh, modified herein (\*).

---

Anthozoa <a href="#">Ehrenberg, 1834</a>	<a href="#">Arene</a> cf. <a href="#">A. mcleani</a> <a href="#">Squires, 1988</a>
Scleractinia <a href="#">Bourne, 1900</a>	<a href="#">Calyptraea diegoana</a> ( <a href="#">Conrad, 1855</a> )
Indeterminate coral	<a href="#">Cerithium cliffensis</a> <a href="#">Hanna, 1927</a>
	<a href="#">Conus hornii</a> <a href="#">Gabb, 1864</a>
Annelida <a href="#">Lamarck, 1802</a>	<a href="#">Crommium?</a> <a href="#">Crossmann, 1888</a> sp.
Polychaeta <a href="#">Grube, 1850</a>	cf. <a href="#">Drillia cliffensis</a> <a href="#">Hanna, 1927</a>
<i>Rotularia tejonensis</i> ( <a href="#">Arnold, 1909 [1910]</a> )	" <a href="#">Fusinus</a> " <a href="#">Rafinesque, 1815</a> sp.*
	<a href="#">Gemmula tumata</a> <a href="#">Hanna, 1927</a>
Mollusca <a href="#">Linnaeus, 1758</a>	<a href="#">Natica (Carinacca) rosensis</a> <a href="#">Hanna, 1927</a>
Bivalvia <a href="#">Linnaeus, 1758</a>	Naticidae <a href="#">Guildin, 1834</a> indet.
<i>Acesta californica</i> <a href="#">Powell and Rugh n. sp.*</a>	<a href="#">Pleurofiisia fresnoensis</a> ( <a href="#">Arnold, 1909 [1910]</a> )
<i>Acila</i> <a href="#">H. and A. Adams, 1858</a> sp.	[syn. <a href="#">Surcula lindavistaensis</a> <a href="#">Hanna, 1927</a> ]
<i>Acutostrea idriaensis</i> <a href="#">Gabb, 1869</a>	<a href="#">Sassia?</a> <a href="#">Bellardi, 1873</a> sp.
<i>Cardiomya israelskyi</i> ( <a href="#">Hanna, 1927</a> )	<a href="#">Scaphander (Mirascapha) costatus</a> ( <a href="#">Gabb, 1864</a> )
<i>Cuneocorbula torreyensis</i> ( <a href="#">Hanna, 1927</a> )	<a href="#">Terebra?</a> <a href="#">Bruguière, 1789</a> sp.
<i>Gibbolucina (Eomiltha?) packi</i> ( <a href="#">Dickerson, 1916</a> )	<a href="#">Tornatellaea rosa</a> <a href="#">Hanna, 1927</a>
<i>Glycymeris rosecanyonensis</i> <a href="#">Hanna, 1927</a>	Trochidae? <a href="#">Rafinesque, 1815</a> indet.
<i>Glycymeris?</i> <a href="#">Mendes de Costa, 1778</a> sp.	<a href="#">Turritella uvasana</a> <a href="#">Conrad, 1855</a> s.l.
<i>Glyptoactis (Claibornicardia) sandiegoensis</i>	<a href="#">Turritella</a> <a href="#">Lamarck, 1799</a> sp.
( <a href="#">Hanna, 1927</a> )	Scaphopoda <a href="#">Bronn, 1862</a>
<i>Malletia? soledadensis</i> <a href="#">Powell and Rugh n. sp.*</a>	<i>Cadulus</i> <a href="#">Philippi, 1844</a> sp.
<i>Myrtucina roseburgensis</i> ( <a href="#">Turner, 1938</a> )	<i>Dentalium</i> <a href="#">Linnaeus, 1758</a> sp.
Mytilidae? <a href="#">Rafinesque, 1815</a> indet.	Cephalopoda <a href="#">Cuvier, 1797</a>
<i>Nemocardium linteum</i> ( <a href="#">Conrad, 1855</a> )	Nautiloidea <a href="#">Agassiz, 1847</a> indet.
Ostreidae <a href="#">Rafinesque, 1815</a> indet..	
<i>Pitar</i> cf. <i>P. (Lamelliconcha) avenalensis</i> <a href="#">Vokes, 1939</a>	Arthropoda <a href="#">von Siebold, 1848</a>
<i>Plicatula jancalensis</i> <a href="#">Squires, 1987</a>	Malacostraca <a href="#">Latreille, 1802</a>
<i>Portandia rosa</i> ( <a href="#">Hanna, 1927</a> )	Callianassidae <a href="#">Dana, 1852</a> indet.
<i>Parvamussium</i> cf. <i>P. interradiatum</i> ( <a href="#">Gabb, 1869</a> )*	<i>Neocallichirus rhino</i> <a href="#">Schweitzer and Feldmann, 2002</a>
<i>Pycnodonte? (Crenostrea?) stewarti</i> ( <a href="#">Hanna, 1927</a> )	<i>Vegarhron santiago</i> <a href="#">Schweitzer and Feldmann, 2002</a>
<i>Saccella gabbi</i> ( <a href="#">Gabb, 1869</a> )	
<i>Tellidorella mclellani</i> ( <a href="#">Hanna, 1927</a> )	Decapoda <a href="#">Latreille, 1802</a>
<i>Tellina (Angulus) vorbei</i> <a href="#">Hanna, 1927</a>	Echinodermata <a href="#">Klein, 1778</a>
Gastropoda <a href="#">Cuvier, 1795</a>	Ophiuroidea <a href="#">Gray, 1840</a> indet.
<i>Alvania?</i> <a href="#">Monterosato, 1884</a> sp.	Echinoidea <a href="#">Schumacher, 1817</a>
<i>Architectonica (Stellaxis) cf. A. (S.)</i>	<i>Schizaster</i> <a href="#">Agassiz, 1836</a> sp.
<i>cognata</i> <a href="#">Gabb, 1864</a>	

---

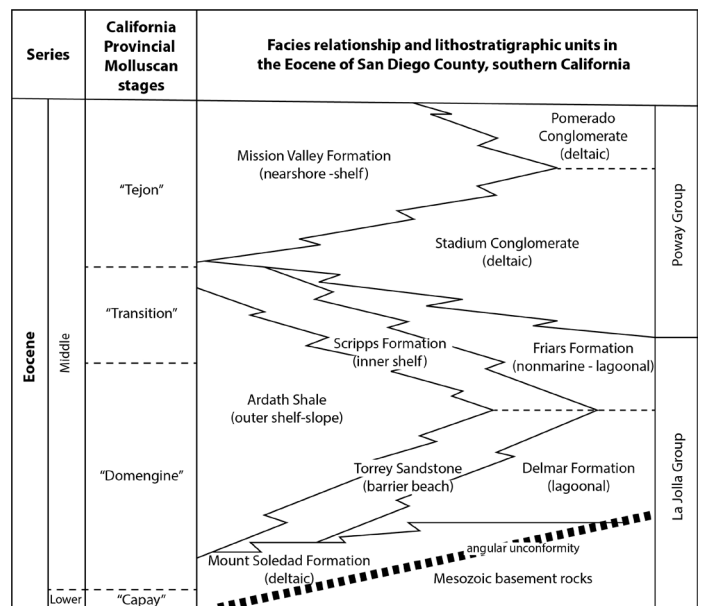


**Figure 1.** Index map showing the approximate position of SDSNH localities 7686 and 7687, at a private residence on Country Club Drive, La Jolla, San Diego County, California

within the La Jolla Group. The type section of the Ardath Shale contains thin beds of medium-grained sandstone and concretionary beds estimated to be up to 70 m thick (Kennedy and Moore 1971) (Figure 2). This geologic unit conformably overlies the Mount Soledad Formation, underlies and intertongues with the Scripps Formation and interfingers with the Torrey Sandstone (Kennedy and Moore 1971). Mollusks reported by Kennedy and Moore (1971) were assigned an early to middle Eocene age. Givens and Kennedy (1979) refer the mollusks to the “Domengine” California Provincial molluscan stage of Clark and Vokes (1936), modified by Givens (1974), and Saul (1983).

The “Domengine” California provincial molluscan stage (CPMS) (informal) was originally proposed by Clark (1926) as the “Domengine Horizon” period of deposition characterized by a distinctive molluscan fauna that occurs stratigraphically between the Meganos and Tejon “horizons,” with a type section in the Domengine Formation north of Coalinga, Kings County, central California. Clark and Vokes (1936) later referred these beds to the “Domengine” CPMS stage. Domengine CPMS is placed in

quotes for this biostratigraphic unit to separate it from the similarly named lithostratigraphic unit. Stage is in lowercase as the “Domengine” CPMS has never, along with all other California provincial molluscan stages, been formally defined. According to Givens and Kennedy (1979) the stage is characterized in San Diego County by the restricted stratigraphic occurrence of the gastropods *Turritella andersoni lawsoni* Dickerson (1916) and *T. uvasana applinae* Hanna (1927); the lowest stratigraphic occurrence of the bivalves “*Macoma*” *viticola* Anderson and Hanna (1925), and *Tellina castacana* Anderson and Hanna (1925), the gastropods *Ectinochilus canalifera supraplicatus* (Gabb, 1864), *Euspira clementensis* (Hanna, 1927), *Laevityphis antiquus* (Gabb, 1864), *Phalium (Semicassis) tuberculiformis* (Hanna, 1924), *Priscoficus cooperiana* (Stewart, 1927), *Ranellina pilsbryi* Stewart (1927), *Whitneya ficus* (Gabb, 1864) [as *Strepsidura ficus* (Gabb, 1864) fide Givens and Garvie, 2016], *T. scrippensis* Hanna (1927); and the highest stratigraphic occurrence of the gastropods *Architectonica (Stellaxis) cognata* Gabb (1864), *Crommium andersoni* (Dickerson, 1914b), *Exputens llajasensis* Clark (1934), *Homalopoma umpquaensis* Merriam and Turner (1937), and *Velates perversa* (Gmelin, 1791).



**Figure 2.** Stratigraphic relations and environments of Eocene rocks in the La Jolla area, San Diego County, California after Kennedy and Moore (1971) and Deméré, Sundberg, and Schram (1979). The new species described here are from the Ardath Shale.

## MATERIALS AND METHODS

All specimens were collected during paleontological monitoring during grading at the house site in La Jolla. A report on the site prepared by Todd A. Wirths and N. Scott Rugh (Brian F. Smith and Associates, Poway, California) and the specimens were donated to the SDSNH. Detailed locality data is on file with SDSNH. Both species are represented by well-preserved casts and molds that preserve sufficient details to be described as new.

Taxonomy follows MolluscaBase (MolluscaBase eds. 2025).

Measurements are defined as follows: height=the greatest distance between the dorsal and ventral termini (edge); length=the greatest distance between the anterior and posterior termini; convexity=the greatest distance between the valve or valves, depending on the specimen.

**Institutional abbreviations:** **OCPC** - Orange County Paleontological Collection, part of the County of Orange Paleontological and Archeological collection; **SDSNH** - San Diego Society of Natural History for collections in the Paleontology Department, San Diego Natural History Museum; **UCMP** - University of California Museum of Paleontology, Berkeley.

## SYSTEMATIC PALEONTOLOGY

PHYLUM MOLLUSCA LINNAEUS, 1758

CLASS BIVALVIA LINNAEUS, 1758

SUBCLASS PROTOBRANCHIA PELSENEER, 1889

ORDER NUCULANIDA CARTER, D. C. CAMPBELL, AND  
M. R. CAMPBELL, 2000

SUPERFAMILY NUCULANOIDEA

H. AND A. ADAMS, 1858 (1854)

FAMILY MALLETIIDAE H. AND A. ADAMS, 1858 (1846)

GENUS *MALLETIA* DES MOULINS, 1832

**Type species**—*Malletia chilensis* Des Moulins, 1832 by monotype. Modern, Chile.

The genera *Malletia* (family Malletiidae) and *Portlandia* (family Yoldiidae Habe, 1977) have species with similar shell outlines, but according to Coan et al. (2000) the former can be distinguished from *Portlandia* in having a large, oval shell with inequilateral valves, while the latter has a solid, sub-quadrate shell, with a produced posterior end set off by a radial furrow. In addition, the distinctive resilifer (chondrophore) in yoldiids distinguishes them from malletiids (C. Hickman, written commun., 6/2022; P. Valentich-Scott, written commun.,

6/2022). Specimens from the Ardath Shale lack a radial furrow, appear to lack a resilifer, and hinge dentition is more similar to the genus *Malletia* than *Portlandia*

*MALLETIA SOLEDADENSIS* POWELL AND RUGH, N. SP.  
LSID URN:LSID:ZOOBANK.ORG:ACT:8FC185A9-DF05-49EC-  
9498-E3E77CE91491

FIGURE 3A-H

**Diagnosis**—The small size, oval outline with a larger posterior end and a prominent umbo separates this species from other species of *Malletia* from the northeastern Pacific.

**Holotype**—SDSNH 171127 (Figure 3a).

**Type locality**—SDSNH locality 7687 collected during construction at a private residence on Country Club Drive, La Jolla, San Diego County, California. More detailed locality information can be requested from SDSNH.

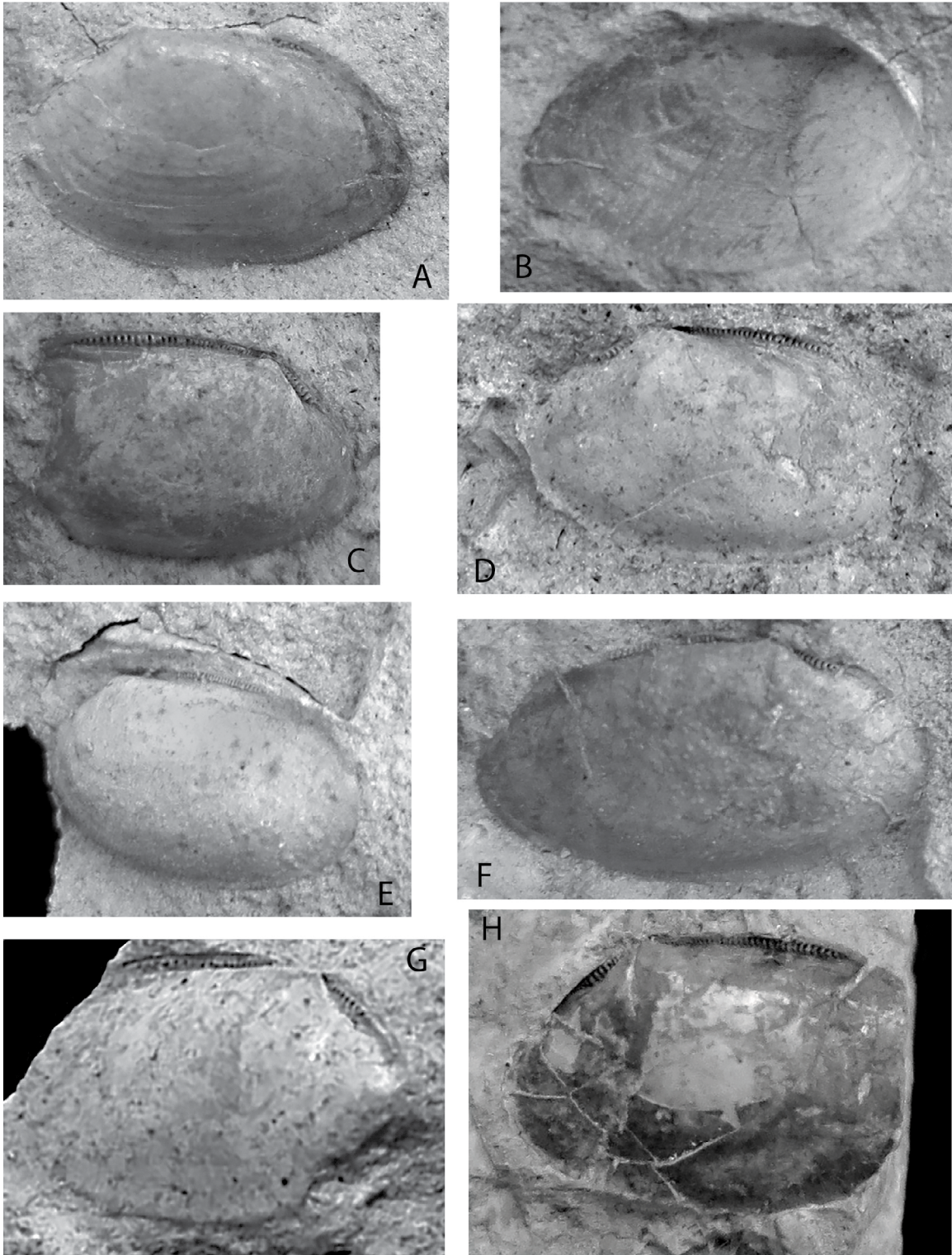
**Paratypes**—Seven specimens from SDSNH locality 7687 are designated paratypes: SDSNH 171128 (mold of holotype showing irregular faint growth zones; Figure 4b); SDSNH 171129 (cast showing 10 teeth anterior of the umbo about 29 hinge teeth posterior and lacking resilifer; Figure 4c); SDSNH 171130, height 6 mm, length 11 mm (cast); SDSNH 171131, height 8 mm, length 13 mm (shows > 26 teeth posterior of the umbo; cast); SDSNH 171132, height 8 mm, length 13 mm (cast); SDSNH 171133, height 7 mm, length 10 mm (18 teeth posterior of umbo, 8 anterior, short anterior hinge; cast); SDSNH 171134, height 9 mm, length 14 mm; (casts).

**Referred specimens**—Sixty-nine additional specimens are reported from SDSNH locality 7687 (Specimen numbers - SDSNM 160170 [15 internal and external molds], SDSNH 160203 [11 internal and external molds], SDSNH 168286 [one internal mold], SDSNH 160270 [29 internal and external molds], and SDSNH 160271 [13 internal and external molds]).

**Occurrences**—Known only from SDSNH locality 7587 in the type area on Country Club Drive, La Jolla, San Diego County, California, in the Ardath Shale, La Jolla Group, early Eocene.

**Etymology**—Named for the Mt. Soledad area of La Jolla, San Diego County, California.

**Description**—Specimens are small casts and molds with no preserved original shell. The holotype/paratype pair is a right valve cast and mold (Figure 4a, b) that is about 15 mm long and 10 mm high with a generally oval outline; the dorsal anterior side below the umbo is moderately inclined, the posterior end broadly-rounded. The umbo is located slightly anterior of the first third of the shell. The external mold paratype (Figure 3b)



**Figure 3a-h.** *Malletia soledadensis* Powell and Rugh, n. sp. **a.** SDSNH holotype 171127 from SDSNH locality 7587, height 10 mm, length 15 mm (26 posterior teeth, around 8 anterior; cast); **b.** SDSNH paratype 171128 from SDSNH locality 7687, height 9 mm, length 14 mm; **c.** SDSNH paratype 1711729 from SDSNH locality 7687, height 8 mm, length 10 mm (no resilifer, 29 teeth posterior, 10 anterior; cast); **d.** SDSNH paratype 171130 from SDSNH locality 7687, height 6 mm, length 11 mm; **e.** SDSNH paratype 171131 from SDSNH locality 7687, height 8 mm, length 13 mm (shows > 26 teeth posterior of the umbo; cast); **f.** SDSNH paratype 171132 from SDSNH locality 7687, height 8 mm, length 13 mm (cast); **g.** SDSNH paratype 171133 from SDSNH locality 7687, height 7 mm, length 10 mm (18 teeth posterior of umbo, 8 anterior, short anterior hinge; cast); **h.** SDSNH paratype 171134 from SDSNH locality 7687, height 9 mm, length 14 mm.

has shallow, broad comarginal bands with few pustules scattered near the anterior-dorsal margin that are not present in the cast, although this could be an artifact of preservation. However the cast does show small, slight, broadly rounded comarginal growth lines.

Paratype SDSNH 171130 (Figure 3d) is another cast and mold of a right valve of similar shape and features about 11 mm long and 6 mm high; the cast shows about eight taxodont teeth anterior of the umbo and 26 teeth posterior of the umbo. The umbo covers where the resilifer would be so it is unclear if there is a resilifer. This character would distinguish whether this taxon is a *Portlandia* or a *Malletia*. Paratype 117129 (Figure 3c) with the best-preserved hinge, is a partial left valve with the posterior end missing. The hinge has eight teeth anterior to the umbo that increase in size from smaller to larger away from the umbo and about 29 teeth posterior to the umbo that are smallest near the umbo, largest size midway and then become small again. In addition, the umbo hides very little and no resilifer appears to be present although the area is partially obscured. Additional paratypes show no additional features.

**Discussion**—In California two fossil species referred to *Malletia* have been reported (Keen and Bentson 1944; Groves and Squires 2021): *M. chehalisensis* Arnold (1908) described from late Eocene to early Miocene Lincoln Creek Formation in Chehalis County, Washington and reported from the Eocene to Oligocene San Lorenzo Formation in the Santa Cruz Mountain (Arnold 1908, 1909 [1910]) and *M. packardi* Clark, 1918 described from the early Oligocene Kirker Formation of Contra Costa County, but also occurring in the late Eocene Markley Formation (Clark 1938) and late Oligocene and (or) early Miocene San Ramon Formation (Clark 1918) in Contra Costa County. The paratype of *M. packardi* (Figure 4) shows a poorly preserved mold with a taxodont hinge similar in preservation to our specimens. Clark (1918), Hickman (1969) and Moore (1983) referred this species to the genus *Portlandia* Mörch, 1857, while Weaver (1942) refers it to the genus *Yoldia* Möller, 1842. Specimens of *M. chehalisensis* examined by Hickman (1969) show the distinctive resilifer of a Yoldiidae making placement in *Portlandia* or *Yoldia* correct. In addition, Hickman (1969) synonymized *Yoldia impressa* (Conrad, 1849) of Reagan (1909), *Portlandia reagani* (Dall, 1922) of Moore (1963) and questionably *M. packardi* Clark (1918) under *P. chehalisensis*. An indeterminate *Malletia* was reported by Nilsen et al. (1973) from the late Eocene/early Oligocene San Emigdio Formation (Wagner and Schilling 1923), but the specimen(s) could not be located for comparison.



**Figure 4.** Paratype of *Malletia packardi*, UCMP 11280, from Eocene Markley Formation of Contra Costa County, California, showing internal mold of taxodont hinge and similar preservation to *Malletia* from Ardath Shale. Image by Bob Day.

These fossil species are distinct from our new *Malletia* species by the nearly centrally placed umbo.

Five modern species of *Malletia* occur in the north-eastern Pacific today: *M. alata* Bernard, 1989, *M. faba* Dall, 1897, *M. pacifica* Dall, 1897, *M. talama* Dall, 1916, and *M. truncata* Dall, 1908. Of these, *M. faba* is most similar in shell outline to our species, differing in having: 1) a broader umbo closer to the anterior end, 2) the posterior end being more broadly rounded, and 3) different numbers of teeth in the hinge. It also resembles in outline *M. talama*, but this species has a gently-curved dorsal margin whereas our new species has a significant umbo. Modern specimens of this genus occur from slope to bathyal water depths with all but one species occurring deeper than 400 m (200–4134 m; Coan et al. 2000).

*Malletia* occurs worldwide from the late Paleozoic to Holocene (Arnold, 1908, 1909 [1910], Clark 1918, Wagner and Schilling 1923, Lambrecht 1929, Cooke 1953, Camacho 1957, Mizuno 1964, Sohl 1964, Owens et al. 1970, Hayami 1975, Chinzei and Aoshima 1976, Sohl and Koch 1983, Dagys and Kurushin 1985, Honda 1988, Bogomolov 1989, Landman and Waage 1993, Nobuhara and Tanaka 1993, Suzuki 1995, Szente 1995, Zakharov et al. 1999, Amano et al. 2000, Suzuki 2000, del Rio 2002, Stilwell and Henderson 2002, Jiang et al. 2004, Kafanov and Ogasawara 2004, Amano and Jenkins 2007, Konstantinov et al. 2007, Nielsen and Valdovinos 2008, Amano et al. 2018, Biakov et al. 2018) worldwide.

SUBCLASS AUTOBRANCHIA GROBBEN, 1894  
 INFRACLASS PTERIOMORPHIA BEURLLEN, 1944  
 ORDER LIMIDA MOORE, 1952 IN MOORE, LALICKER, AND  
 FISHER (1952)  
 SUPERFAMILY LIMOIDEA RAFINESQUE, 1815  
 FAMILY LIMIDAE RAFINESQUE, 1815  
 GENUS *ACESTA* H. ADAMS AND A. ADAMS, 1858

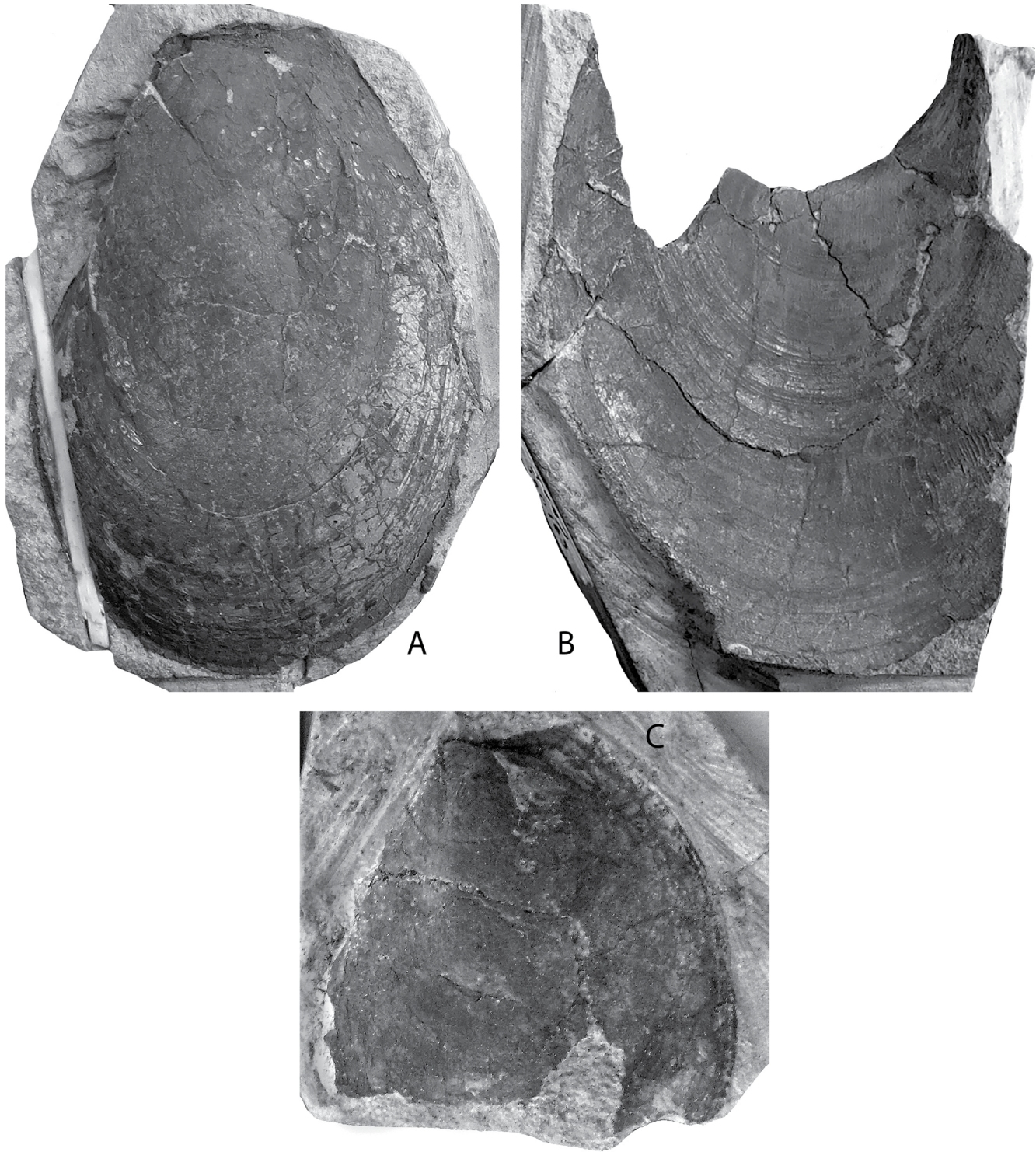


Figure 5a-h. *Acesta californica* Powell and Rugh, n. sp. a. SDSNH holotype 160264 height 85 mm, length 56 mm. Mold, left valve from SDSNH locality 7687. Note evenly spaced comarginal sculpture expressed well on the posterior-dorsal margin; b. SDSNH holotype 160264 height 69 mm, length 53 mm. Cast of specimen in figure 3a, left valve from SDSNH locality 7687. Note faint, irregular radial sculpture on the mid-dorsal margins and crossed by comarginal ribs on the upper-central part of the specimen; c. SDSNH paratype 160265, height 42 mm, length 41 mm. Cast of partial left valve from SDSNH locality 7687, which shows the hinge area better than the holotype.

**Type species**— By monotype, *Ostrea excavata* Fabricius, 1779. Northeastern Atlantic continental margin, Azores, Canaries; Pleistocene.

H.E. Vokes (1963) reviewed all modern and fossil *Acesta* species worldwide and described a new modern species from the Gulf of Mexico. He listed 13 taxa and removed a number of others including *Acesta hamilini*, without comment, a decision with which we disagree with regards to *A. hamilini*. Currently over 70 species are recognized in the genus (Hickman 2023, MolluscaBase eds. 2025). Interestingly the ecology of *Acesta* has only recently been determined (Clague et al. 2012; Hickman 2023) with species living in muddy sediment on the ocean floor and accumulations on vertical rock walls and overhangs.

In California three Tertiary fossil species and two modern species of *Acesta* are known. California fossil record includes: *A. hamilini* (Dall, 1900), *A. multiradiata* (Gabb, 1869), and *A. (Plicacesta) haseltinei* (Dickerson, 1914a) (Moore 1987, Groves and Squires 2021). To this we add our fourth new species from the Eocene of San Diego and a fifth unidentified Miocene species from Orange County, southern California (OCPC collections). In addition, two modern species are known from off central and southern California: *Acesta mori* (Hertlein, 1952) and *A. sphoni* (Hertlein, 1963), at continental slope to bathyal water depths.

*ACESTA CALIFORNICA* POWELL AND RUGH, N. SP.

LSID URN:LSID:ZOOBANK.ORG:ACT:BE7523EA-7BE7-40A4-BDF8-CAC87CC6BBAA

FIGURE 5A-C

**Diagnosis**—The large size and sub-oval outline with a flat anterior end and a broad, apparently shallow resilifer set this species apart from all modern and fossil *Acesta* from California. It has a somewhat similar shape to *A. rathbuni* (Bartsch, 1913), a modern species from the Philippine Islands, but differing in its smaller size and more elongate shell.

**Holotype**—SDSNH holotype 160264 (mold and cast of right valve; cast 85 mm high, approximately 56 mm wide; mold 69 mm high, 53 mm wide.)

**Type locality**—SDSNH locality 7687, from an excavation now occupied by a private residence on Country Club Drive, La Jolla, San Diego County, California (32.983°, -117.259°, elevation ± 156 m [from Google Earth]).

**Paratypes**—SDSNH paratype 160265 (mold and small fragment of cast) from SDSNH locality 7687.

**Referred Specimens**—SDSNH 160166 (SDSNH locality 7687 (mold and cast of hinge area).

**Occurrence**—Known only from the type locality in the Ardath Shale, La Jolla Group which was exposed during construction of a private residence on Country Club Drive, La Jolla, San Diego County, California.

**Etymology**—Name for the state of California.

**Description**—*Acesta californica* is large, to about 80 mm long and a little less than 60 mm wide. All specimens are casts and molds with little or no original shell material present. The specimens are generally an elongate-ovate in outline modified in having a flat anterior end with a straight anterior-dorsal margin. The valve is somewhat inflated, with a flat hinge line and a broad, apparently shallow resilifer. Sculpture of faint, fine, irregular radial threads observable over a small area on the mold of the holotype. In addition, sculpture consists of regularly spaced, fine co-marginal growth lines.

**Discussion**—Three species of *Acesta* have been reported from the Cenozoic fossil record in California: *Acesta hamilini*, *A. (Plicacesta) haseltinei*, and *A. multiradiata* (Moore, 1987). *Acesta hamilini* occurs in the Pliocene of southern California and is reported in the Capistrano (Vedder 1972) and Fernando (Arnold 1907, Woodring 1938, Mount 1970) formations. *Acesta (Plicacesta) haseltinei* (synonym *Lima perrini* Waring, 1914 fide Moore 1987) was described from the Paleocene Martinez Formation (Dickerson 1914a, age modified by Stewart 1949). It also occurs in the “Martinez” Formation (Squires and Saul 2007), and the Santa Susana Formation (Zinsmeister 1983), both of Paleocene age, as well as in unnamed Eocene rocks (Waring 1914). Lastly, *A. multiradiata* occurs in Paleocene and Eocene rocks being reported in the Paleocene Martinez (Weaver 1905) and Sepultura(?) formations (Gardner in Darton 1921) and the Eocene Tejon Formation (Stanton 1896, Arnold 1906).

As illustrated by Moore (1987, pl. 10, figs. 4, 7) the holotype of *Acesta hamilini* is an incomplete specimen that can be easily distinguished from our new species by its smaller size and more elongate shell. The poorly preserved holotype of *A. multiradiata* (Moore 1987, pl. 9, fig. 10; pl. 10, figs. 10, 11) is also easily distinguished by its small size, more pointed anterior end, and by having fine radial ribs that cross the entire shell surface, a feature much less distinct and only seen on a small portion of the cast of our new species. Sculpture on the holotype of *A. (P.) haseltinei* shows it belongs in the subgenus *Plicacesta* Vokes (1963), which is distinguished by having strong radial ribs easily separating it from our new species. The holotype of *Lima perrini* Waring (1914) that Moore (1987; pl. 10, fig. 10) synonymised under *A. (P.) haseltinei* (Moore 1987, pl. 10, fig. 11) is poorly preserved and

shows an *Acesta* smaller and significantly wider than *A. californica* n. sp. There are also a few specimens identified as *A. hamilini* (Wirths et al. 2019) collected from the a paleontological monitoring project for the Portola Center in Lake Forrest, southern Orange County from the middle to late Miocene La Vida Member of the Puente Formation (OCPC locality 5514; Accession: OCPC 2020-PC-003) that can be distinguished from *A. californica* n. sp. in being smaller, shorter, and comparatively wider.

Two modern *Acesta* are known to occur along coastal California: *A. (A.) mori* and *A. (Plicacesta) sphoni*. Both have been reported intermittently between 27° and 46° north latitude, the former primarily in deeper water 1029-1996 m and the latter from shallower depths (545-860 m) (Clague et al. 2012). *Acesta mori*, differs from *A. californica* n. sp. in being much smaller to 62 mm (Coan et al. 2000), in being wider, and in lacking the auricle on the anterior side of the umbo. *Acesta sphoni* differs in having sculpture across the shell and in being smaller.

#### PALEOBATHYMETRY AND LIFE HABITS

Given the modern bathymetric distribution of these genera off California today, a marine environment at bathyal depths (200-2000 m; Coan et al. 2000, Clague et al. 2012) is envisioned for the Ardath Shale exposures containing these new species. Off the southern California coast today the limid *Acesta (Plicacesta) sphoni* is a byssally-attached (CPII personal observation, 2015-2016) epifaunal suspension feeder as are other *Acesta* (Clague et al. 2012), and this is the life habit envisioned for *A. californica* n. sp. While *Malletia soledadensis* n. sp. is a siphonate, labial palp deposit feeder living in sediment. These distinct life habitats could explain why so few specimens of *A. californica* n. sp. have been collected compared to *Malletia soledadensis* n. sp.

#### ACKNOWLEDGMENTS

We thank Todd A. Wirths (Brian Smith and Associates, Inc, Poway, CA) for allowing us to report on these specimens of *Acesta* and *Malletia* and Tom Deméré and Kesler Randall for making the specimens available for study. Sven N. Nielsen (Instituto de Ciencias de la Tierra, UACH, Chile) helped with finding references for the order Limida. In addition, we thank Tom Déméré and Kesler Randall (both with San Diego Natural History Museum, San Diego, CA), Lindsey Groves (Natural History Museum of Los Angeles County, Los Angeles, CA), Carole Hickman (Museum of Paleontology, University of California,

Berkeley), and Judy T. Smith (Smithsonian, Washington, D.C.), for their helpful reviews.

#### LITERATURE CITED

- Adams, H. and A. Adams. 1854, 1846, 1858 (1853-1858). The Genera of Recent Mollusca; Arranged According to their Organization. London, van Voorst. 1:xl + 484 pp.; 2:661 pp.; 3:138 pls. [Published in parts: 1: i-xl (1858), 1-256 (1853), 257-484 (1854); 2:1-92 (1854), 93-284 (1855), 285-412 (1856), 413-540 (1857), 541-661 (1858)3:pl. 1-32 (1853), 33-72 (1954), 73-96 (1855), 97-112 (1856), 113-128 (1857), 129-138 (1858)].
- Agassiz, L. 1836. Prodrome d'une Monographie des Radiaires ou Echinodermes. *Mémoires de la Société des Sciences naturelles de Neuchâtel* 1:168-199.
- Agassiz, L. 1847. Lettre sur quelques points de'organisation des animaux reyonnés. Paris. *Comptes rendus* 25:677-682.
- Amano, A., and R.G. Jenkins. 2007. Eocene drill holes in cold-seep bivalves of Hokkaido, northern Japan. *Marine Ecology* 28:108-114.
- Amano, A., K. Hryniewicz, and R.G. Jenkins. 2018. A newly discovered Paleocene species of Boreocomitas (Gastropoda: Pseudomelatomidae) from eastern Hokkaido, Japan, with implications for the biogeography of the Paleocene Bering Strait. *The Nautilus* 132(3-4):117-123.
- Amano, K., M. Suzuki, and T. Sato. 2000. Warm-water influx into Japan Sea in the middle Pliocene - Molluscan faunas from the Tentokuji Formation around Mt. Taihei in Akita Prefecture. *Journal of the Geological Society of Japan* 106(4):299-306.
- Anderson, F.M., and G.D. Hanna. 1925. Fauna and stratigraphic relations of the Tejon Eocene at the type locality in Kern County, California. *Occasional Paper, California Academy of Sciences* 11:249 pp.
- Arnold, R. 1906. The Tertiary and Quaternary pectens of California. *U.S. Geological Survey Professional Paper* 47:1-264.
- Arnold, R. 1907. New and characteristic species of fossil mollusks from the oil-bearing Tertiary formations of southern California. *Proceedings of the U.S. National Museum* 32(1545):525-546.
- Arnold, R. 1908. Descriptions of new Cretaceous and Tertiary fossils from the Santa Cruz Mountains, California. *Proceedings of the U.S. National Museum* 34(1617):345-390.
- Arnold, R. 1909 [1910]. Paleontology of the Coalinga District, Fresno and Kings Counties, California. *U.S. Geological Survey Bulletin* 396:1-173.
- Bartsch, P. 1913. The giant species of the molluscan genus Lima obtained in Philippine and adjacent waters

- [Scientific results of the Philippine cruise of the Fisheries steamer Albatross, 1907-1910, no. 26]. *Proceedings of the United States National Museum* 45(1978):235-240.
- Bellardi, L. 1873. *I molluschi dei terreni terziarii del Piemonte e della Liguria. Parte I. Cephalopoda, Pteropoda, Heteropoda. Gasteropoda (Muricidae et Tritonidae)*. Stamperia Reale, Torino, 264 pp.
- Bernard, F.R. 1989. Seven new species of *Palaeotaxodonta* (Bivalvia) from the northeastern Pacific Ocean. *Venus (The Japanese Journal of Malacology)* 48(2):67-72.
- Beurlen, K. 1944. Beiträge zur Stammesgeschichte der Muscheln. *Mathematisch-Naturwissenschaftlichen Abteilung der Bayerischen Akademie der Wissenschaften zu München, Sitzungsberichte* 1944(1-2):133-145.
- Biakov, A.S., R.V. Kutygin, N.A. Goryachev, S.S. Burnatny, A.N. Naumov, A.V. Yadrenkin, I.L. Vedernikov, M.F. Tretyakov, and I.V. Brynko. 2018. Discovery of the Late Changhsingian bivalve complex and two fauna extinction episodes in northeastern Asia at the end of the Permian. *Doklady Biological Sciences* 480:78-81.
- Bianchi, F.M., and Gonçalves, L.T. 2021. Getting science priorities straight: how to increase the reliability of specimen identification? *Biology Letters* 17(4):4 pp.,
- Bogomolov, Y. I. 1989. Poliptikhity (Ammonity) i biostratigrafiya boreal'nogo Valanzhina. Akademiya Nauk SSSR, Sibirskoe Otdelenie *Trudy Instituta Geologii I Geofiziki* 696:1-199.
- Bourne G.C. 1900. Chap. 6. The Anthozoa. In: Lankester E.R. (ed), *A Treatise on Zoology. Part II. The Porifera and Coelenterata*. London, Adam & Charles Black. Pp. 1-84.
- Bronn H.G. 1862. *Die Klassen und Ordnungen der Weichthiere (Malacozoa)*. Kopflose Weichthiere (Malacozoa Acephala) Weichthiere. Leipzig. 1306 pp.
- Bruguière J.G. 1789 (1789-1792). *Encyclopédie méthodique ou par ordre de matières. Histoire naturelle des vers*, 1. Paris: Pancoucke. 1-344 [Livraison 32, June 1789]; 345-757 [Livraison 48, 13 Feb. 1792].
- Camacho, H.H. 1957. Descripción de una fauna marina paleocena procedente de Tierra del Fuego (Argentina). *Ameghiniana* 1(1-2):86-100.
- Carter, J.G., D.C. Campbell and M. Campbell. 2000. Cladistic perspectives on early bivalve evolution. Pp. 47-79, in E.M. Harper, J.D. Taylor, and J.A. Crame (eds.), *The evolution of the Bivalvia*. *The Geological Society, London, Special Publications* 177:47-79.
- Chinzei, K., and M. Aoshima. 1976. Marine thermal structure of the Plio-Pleistocene warm water in central Japan. *Journal of the Faculty of Science, University of Tokyo* 19(3):179-203.
- Clague, G.E., W.J. Jones, J.B. Paduan, D.A. Clague, and R.C. Vrijenhoek. 2012. Phylogeography of Aacea clams from submarine seamounts and escarpments along the western margin of North America. *Marine Ecology* 33:75-87.
- Clark, B.L. 1918. The San Lorenzo series of middle California. *University of California Publications in Geological Sciences* 11(2):45-234.
- Clark, B.L. 1926. The Domengine horizon, middle Eocene of California. University of California Publications, Bulletin of the Department of Geology 16:99-118.
- Clark, B.L. 1934. A new genus and two new species of Lamellibranchiata from the middle Eocene of California. *Journal of Paleontology* 8(3):270-272.
- Clark, B.L. 1938. Fauna of the Markley Formation (upper Eocene) on Pleasant Creek, California. *Geological Society of America Bulletin* 49(5):683-730.
- Clark, B.L., and H.E. Vokes. 1936. Summary of marine Eocene sequences of western North America. *Geological Society of America Bulletin* 47(6):851-878.
- Coan, E.V., P.V. Scott, and F.R. Bernard. 2000. Bivalve seashells of western North America: Marine bivalves mollusks from Arctic Alaska to Baja California. *Santa Barbara Museum of Natural History Monographs no. 2, Studies in Biodiversity no. 2*:764 pp.
- Conrad, T.A. 1849. Mollusca. Pp. 723-728 in Dana, J.D. (ed.) *Geology. With a Folio Atlas of twenty-one Plates. United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, (1842) Under the Command of Charles Wilkes, U.S.N. 10* (Appendix 1, Description of fossils, III. fossils from northwestern America. Sherman, Philadelphia, 756 pp.
- Conrad, T.A. 1855. Report of Mr. T. A. Conrad on the fossil shells collected in California by Wm. P. Blake, geologist of the expedition under the command of Lieutenant R.S. Williamson, United States Topographical Engineers. Pp. 5-21, in Description of the fossils and shells collected in California by William P. Blake, Geologist of the United States Pacific Railroad Survey in California. under the command of Lieut. R. S. Williamson, In 1853-54. Article 1 of *Appendix to the Preliminary Geological Report of William P. Blake, Geologist of the Survey in California Under the Command of Lieut. R. S. Williamson*. *Palæontology*.
- Cooke, C.W. 1953. American Upper Cretaceous Echinoidea. *United States Geological Survey Professional Paper* 254-A:1-44.
- Crossmann, M. 1888. Catalogue illustré coquilles fossiles de l'Eocene des environs de Paris. *Annales de la Société Royale Malacologique de Belgique* XXIII:3-324. Bruxelles, P. Weissenbruch.
- Cuvier, G. 1795. Second Mémoire sur l'organisation et les rapports des animaux à sang blanc, dans lequel on traite de la structure des Mollusques et de leur division en ordre, lu à la société d'Histoire Naturelle de Paris, le 11 prairial an troisième [30 May 1795]. *Magazin Encyclopédique, ou Journal des Sciences, des Lettres et des Arts*, 1795 [1. année] 2:433-449.
- Dagys, A.S., and N.I. Kurushin. 1985. Triasovye brachiopody i dvustvorchatye mollyuski severa sredney Sibiri. *Akademiya Nauk SSSR, Sibirskoe Otdelenie Trudy Instituta Geologii I Geofiziki* 633:1-160.
- Dall, W.H. 1897. Notice of some new or interesting species of shells from British Columbia and the adjacent region. *Bulletin of the Natural History of British Columbia* 2(1):1-18.
- Dall, W.H. 1900. A new species of *Lima*. *The Nautilus* 14(2):15-16.
- Dall, W.H. 1908. Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U.S. Fish Commission steamer "Albatross," during 1891,

- Lieut.-Commander Z.L. Tanner, U.S.N., commanding. XXXVII. Reports on the scientific results of the expedition to the eastern tropical Pacific, in charge of Alexander Agassiz, by the U.S. Fish Commission steamer "Albatross", from October, 1904 to March, 1905, Lieut.-Commander L.M. Garrett, U.S.N., commanding. XIV. The Mollusca and Brachiopoda. *Bulletin of the Museum of Comparative Zoology*. 43(6):205-487, pls 1-22.
- Dall, W.H. 1916. Diagnoses of new species of marine bivalve mollusks from the northwest coast of America in the United States National Museum. *Proceedings of the U.S. National Museum* 52(2183):393-417.
- Dall, W.H. 1922. Fossils of the Olympic Peninsula. *American Journal of Science, series 5*, 4:305-314.
- Dana, J.D. 1852. Conspectus crustaceorum, &c. Conspectus of the Crustacea of the exploring expedition under Capt. C. Wilkes, U.S.N. Macroura. *Proceedings of the Academy of Natural Sciences of Philadelphia* 6:10-28.
- Darton, N.H. 1921. Geologic reconnaissance in Baja California. *Journal of Geology* 29:720-748.
- del Rio, C. 2002. Molluscos del Terciario marino. *Geología y Recursos Naturales de Santa Cruz* 2(9):1-22.
- Deméré, T.A., F.A. Sundberg, and F.R. Schram. 1979. Paleocology of a protected biotype from the Eocene Mission Valley Formation, San Diego County, Pp. 97-102 in P.L. Abbott (ed.) *Eocene Depositional Systems, San Diego, California*. Pacific Section, Society of Economic Paleontologists and Mineralogists.
- Des Moulins, C. 1832. Description d'un nouveau genre de coquille vivant, bivalve, des mers du Chile. *Actes de la Société Linnéenne de Bordeaux* 5 (26):83-92.
- Dickerson, R.E. 1914a. Fauna of the Martinez Eocene of California. *Bulletin of the Department of Geology, University of California* 8(6):61-180.
- Dickerson, R.E. 1914b. The fauna of the *Siphonalia sutterensis* Zone in the Roseburg quadrangle, Oregon. *Proceedings of the California Academy of Sciences, series 4*, 5(3):113-128.
- Dickerson, R.E. 1916. Stratigraphy and fauna of the Tejon Eocene of California. *University of California Publications Bulletin of the Department of Geology* 9(17):363-524.
- Ehrenberg, C.G. 1834. Beiträge zur physiologischen Kenntniss der Corallenthiere im allgemeinen, und besonders des rothen Meeres, nebst einem Versuche zur physiologischen Systematik derselben. *Abhandlungen der Königl. Akademie der Wissenschaften, Berlin* 1:225-380.
- Fabricius, J.C. 1779. *Reise nach Norwegen mit Bemerkungen aus der Naturhistorie und Oekonomie*. Hamburg Carl Ernst Bohn:388 pp.
- Gabb, W.M. 1864. Description of the Cretaceous fossils. *Geological Survey of California, Palaeontology* 1:57-217
- Gabb, W.M. 1869. Cretaceous and Tertiary fossils. *Geological Survey of California, Palaeontology* 2:299 pp.
- Givens, C.R. 1974. Eocene molluscan biostratigraphy of the Pine Mountain area, Ventura County, California. *University of California Publications in Geological Sciences* 109:1-107.
- Givens, C.R., and C.L. Garvie. 2016. *Strepsidura ficus* (Gabb) of Harris (1895), Eocene of Texas: a volutid gastropod species distinct from *Whitneya ficus* Gabb, 1864, Eocene of California. *Journal of Paleontology* 68(2):274-278.
- Givens, C.R., and M.P. Kennedy. 1979. Eocene molluscan stage and their correlation, San Diego area, California. Pp. 81-95 in P.L. Abbott (ed.) *Eocene Depositional Systems, San Diego, California*. Pacific Section, Society of Economic Paleontologists and Mineralogists.
- Gmelin, J.F. 1791. Vermes. Pp. 3021-3910, in Gmelin J.F. (ed.) *Caroli a Linnaei Systema Naturae per Regna Tria Naturae*, Ed. 13. Tome 1(6). G.E. Beer, Lipsiae [Leipzig].
- Gray, J.E. 1840. XXII. A synopsis of the genera and species of the class *Hypostoma* (Asterias, Linnaeus). *Annals and Magazine of Natural History* 6:175-184.
- Grobber, K. 1894. Zur Kenntnis der Morphologie, der Verwandtschaftsverhältnisse und des Systems der Mollusken. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe* 103:61-86.
- Groves, L.T., and R.L. Squires. 2021. Checklist of California Paleogene-Neogene marine Mollusca since Keen and Bentson (1944). *PaleoBios* 38:1-360.
- Grube, A.E. 1850. Die Familien der Anneliden. *Archiv für Naturgeschichte, Berlin*. 16(1):249-364.
- Guilding, L. 1834. Observations on *Naticina* and *Dentalium*, two genera of molluscous animals. *Transactions of the Linnean Society of London* 17(1):29-35.
- Habe, T. 1977. *Systematics of Mollusca in Japan. Bivalvia and Scaphopoda*. Hokuryukan, Tokyo. 372 pp.
- Hanna, G.D. 1924. Rectifications of nomenclature. *Proceedings of the California Academy of Sciences, 4th series*, 13(10)151-186.
- Hanna, M.A. 1927. Geology of the La Jolla quadrangle, California. *University of California Publications in Geological Sciences* 16(7):187-246.
- Hayami, I. 1975. A systematic survey of the Mesozoic Bivalvia from Japan. *The University Museum, The University of Tokyo, Bulletin* 10:1-249.
- Hertlein, L.G. 1952. Description of a new pelecypod of the genus *Lima* from deep water off central California. *Proceedings of the California Academy of Sciences, series 4*, 27(12):377-381.
- Hertlein, L.G. 1963. A new species of giant *Lima* from off southern California (Mollusca: Pelecypoda). *Occasional Papers of the California Academy of Sciences* 40:1-6.
- Hickman, C.S. 1969. The Oligocene marine molluscan fauna of the Eugene Formation in Oregon. *University of Oregon Museum of Natural History Bulletin* 16:1-112.
- Hickman, C.S. 2023. Paleogene marine bivalves of the deep-water Keasey Formation in Oregon, Part II. The pteriomorphs. *PaleoBios* 40(5):1-51.
- Honda, Y. 1988. Molluscan fossils from the Atsunai Group, Kushiro Coal Field, eastern Hokkaido, northern Japan. *Sato Ho-on Kai Special Publication (Professor T. Kotaka Commemorative Volume)*:351-363.
- Jiang, B.Y., C. Huawei, and S. Jingeng. 2004. Early Cretaceous *Aucellina* (Bivalvia) from the Dajiashan area, northeastern China. *Journal of Asian Earth Sciences* 23(3):365-371.
- Kafanov, A.I., and K. Ogasawara. 2004. Neogene and Paleogene Molluscan (Bivalvia) Cenozones of the Russian Northeast. *Science Reports of the Institute of Geoscience, University of Tsukuba, Section B: Geological Sciences* 25:9-45.

- Keen, A.M., and H. Bentson. 1944. Check list of California Tertiary marine Mollusca. *Geological Society of America, Special Paper* 56:1-280.
- Kennedy, M.P., and G.W. Moore. 1971. Stratigraphic relations of Upper Cretaceous and Eocene formations, San Diego coastal area, California. *American Association of Petroleum Geologists Bulletin* 55(5):709-722.
- Kennedy, M.P., and S.S. Tan. 2008. Geologic map of the San Diego 30' x 60' quadrangle, California. *California Geological Survey, Regional Geologic map 3*, scale 1:100,000.
- Klein, J.T. 1778. *Naturalis Dispositio Echinodermatum. Accessit Lucubratiuncula de Aculeis Echinorum Marinorum et Specilegium de Belemnitis*. Edita et Descriptionibus Novisque Inventis et Synonymis Auctorum Auca a Nathanaele Godofredo Leske. Officina Gleditdchiana, Lipsiae (Leipzig), xx + 278 pp.
- Konstantinov, A.G., E.S. Sobolev, and A.V. Yadrenkin. 2007. Detailed biostratigraphy of Triassic deposits in the Lena lower reaches (northern Yakutia). *Russian Geology and Geophysics* 48(9):721-736.
- Lamarck, J.B.M. 1799. Prodrome d'une nouvelle classification des coquilles, comprenant une rédaction appropriée des caractères génériques, et l'établissement d'un grand nombre de genres nouveaux. *Mémoires de la Société d'Histoire Naturelle de Paris* 1:63-91.
- Lamarck, J.-B. de. 1802. Discours d'Ouverture, Prononcé le 27 floréal An 10, au Muséum d'Histoire naturelle. Recherches sur l'organisation des corps vivans. *Bulletin Scientifique de la France et de la Belgique. (5th series)* 40:483-517 [Les Annelides p. 494].
- Lambrech, K. 1929. *Neogaornis wetzeli*, n. g., n. s., der erste Kreidevogel der südlichen Hemisphäre. *Paläontologische Zeitschrift* 11:121-128.
- Landman, N.H., and K.M. Waage. 1993. Scaphitid ammonites of the Upper Cretaceous (Maastrichtian) Fox Hills Formation in South Dakota and Wyoming. *Bulletin of the American Museum of Natural History* 215:1-257.
- Latreille, P.A. 1802. Histoire naturelle, générale et particulière des Crustacés et des Insectes. Ouvrage faisant suite à l'histoire naturelle générale et particulière, composée par Leclerc de Buffon, et rédigée par C.S. Sonnini, membre de plusieurs Sociétés savantes. Dufart, Paris. Vol. 3. 476 pp.
- Linnaeus, C. 1758. *Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Editio decima, reformata [10th revised edition], vol. 1:824 pp. Laurentius Salvius: Holmiae.
- Mendes da Costa, E. 1778. Historia naturalis testaceorum Britanniae, or, the British conchology; containing the descriptions and other particulars of natural history of the shells of Great Britain and Ireland: illustrated with figures. In English and French. - Historia naturalis testaceorum Britanniae, ou, la conchologie Britannique; contenant les descriptions & autres particularités d'histoire naturelle des coquilles de la Grande Bretagne & de l'Irlande: avec figures en taille douce. En anglois & françois. i-xii, 1-254, i-vii, [1]. London. Millan, White, Emsley & Robson.
- Merriam, C.W., and F.E. Turner. 1937. The Capay middle Eocene of northern California. *University of California Publications in Geological Sciences* 24(6):91-114.
- Mizuno, A. 1964. Summary of the Paleogene molluscan faunas in North Japan. *Geological Survey of Japan Report* 207:1-28.
- Möller, H.P.C. 1842. Index Molluscorum Groenlandiae. *Naturhistorisk Tidsskrift* 4:76-97.
- MolluscaBase eds. 2025. [MolluscaBase](https://www.molluscabase.org). Accessed at <https://www.molluscabase.org> on 2025-08-15.
- Moore, R.C. in Moore, R.C., C.G. Lalicher, and A.G. Fisher. 1952. *Invertebrate Fossils*. McGraw-Hill Book Company, New York. 766 pp.
- Moore, E.J. 1963. Miocene marine mollusks from the Astoria Formation in Oregon. *U.S. Geological Survey Professional Paper* 419:1-109.
- Moore, E.J. 1983. Tertiary marine pelecypods of California and Baja California: Nuculidae through Malleidae. *U.S. Geological Survey Professional Paper* 1228A:A1-A108.
- Moore, E.J. 1987. Tertiary marine pelecypods of California and Baja California: Plicatulidae to Ostreidae. *U.S. Geological Survey Professional Paper* 1228C:C1-C53.
- Mörch, O.A.L. 1857. Fortegnelse over Grønlands Bløddyr, Prodromus fauna molluscorum grønlandicae. Pp. 75-100, in Rink, H.J. (ed.) *Grønland Geographisk og Statistisk Beskrevet. Naturhistoriske Bidrag til en Beskrivelse ad Grønland. V. 4*. Rink, Copenhagen.
- Monterosato, T. A. di. 1884. *Nomenclatura generica e specifica di alcune conchiglie mediterranee*. Virzi, printed for the author, Palermo:152 pp.
- Mount, J.D. 1970. A new record of the rare bivalve *Lima hamlini* in the Pliocene of Los Angeles, California. *Bulletin of the Southern California Paleontological Society* 2(5):4-5.
- Nielson, S.N., and C. Valdovinos. 2008. Early Pleistocene mollusks of the Tubul Formation, south-central Chile. *The Nautilus* 122(4):201-216.
- Nilsen, T.H., T.W. Dibblee, Jr., and W.O. Addicott. 1973. Lower and middle Tertiary stratigraphic units of the San Emigdio and western Tehachapi Mountains, California. *U.S. Geological Survey Bulletin* 1372H:H1-H23.
- Nobuhara, T., and T. Tanaka. 1993. Palaeoecology of Akebiconcha kawamura (Bivalvia: Vesicomysidae) from the Pliocene Tamari Silt Formation in the Kakegawa area, central Japan. *Palaeogeography, Palaeoclimatology, Palaeoecology* 102:27-40.
- Owens, J.P., J.P. Minard, N.F. Sohl and F. James Mello. 1970. Stratigraphy of the outcropping post-Magothy Upper Cretaceous formations in southern New Jersey and northern Delmarva peninsula, Delaware and Maryland. *U.S. Geological Survey Professional Paper* 674:1-60.
- Pelseneer, P. 1889. Sur la classification phylogenetique de pelecypods. *Bulletin Scientifique de la France et de la Belgique* 20(sér. 3:2):(1-4):27-52.
- Philippi, R.A. 1844. *Enumeratio molluscorum Siciliae cum viventium tum in tellure tertiaria fossilium, quae in itinere suo observavit. Vol. 2*. Halle [Halis Saxorum], Eduard Anton:303 pp.
- Rafinesque, C.S. 1815. *Analyse de la Nature ou Tableau de l'Universe et des Corps Organisées*. Palermo Barravecchia. 223 pp.

- Reagan, A.B. 1909. Some notes on the Olympic Peninsula, Washington. *Transactions of the Kansas Academy of Sciences* 22:131-238.
- Rugh, N.S., and T.A. Wirths. 2023. New records of the fossil bivalve genera *Acesta* (family Limeade) and *Malletia* (family Malletiidae) for the Eocene of San Diego County, California. *55th Annual Report of the Western Society of Malacologists* (Pasadena, CA):55-64.
- Saul, L.R. 1983. Notes on Paleogene turritellas, venericardias, and molluscan stages of the Simi Valley area. Pp. 71-80 in M.V. Filewicz (eds.), *Cenozoic geology of the Simi Valley area. Pacific Section Society of Economic Paleontologists and Mineralogists Guidebook* 35.
- Schumacher, C.F. 1817. Essai d'un nouveau système des habitations des vers testacés. Schultz, Copenhagen. iv + 288 pp.
- Schweitzer, C.E., and R.M. Feldmann. 2002. New Eocene decapods (Thalassinidae and Brachyura) from southern California. *Journal of Crustacean Biology* 22:938-967.
- Scott, R.N., and Wirths, T.A., 2023, New records of the fossil bivalve genera *Acesta* (family limidae) and *Malletia* (family Malletiidae) for the Eocene of San Diego County, California. *55th Annual Report of the Western Society of Malacologists*, 2022:51-60.
- Sohl, N.F. 1964. Gastropods from the Coffee Sand (Upper Cretaceous) of Mississippi. *U.S. Geological Survey Professional Paper* 331C:345-394.
- Sohl, N.F., and C.F. Koch. 1983. Upper Cretaceous (Maestrichtian) Mollusca from the Haustator bilira Assemblage Zone in the East Gulf Coastal Plain. *U.S. Geological Survey Open-File Report* 83-451:1-239.
- Squires, R.L. 1987. Eocene molluscan paleontology of the Whitaker Peak area, Los Angeles and Ventura counties, California. *Contributions in Science (Natural History Museum of Los Angeles County)* 388:1-14.
- Squires, R.L. 1988. Eocene macropaleontology of northern Lockwood Valley, Ventura County, California. *Contributions in Science (Natural History Museum of Los Angeles County)* 398:1-23.
- Squires, R.L., and L.R. Saul. 2007. Paleocene pareorine turritellid gastropods from the Pacific slope of North America. *The Nautilus* 121(1):1-16.
- Stanton, T.W. 1896. The faunal relations of the Eocene and Upper Cretaceous on the Pacific Coast. Pp. 1005-1060 in Walcott, C.D., *Seventeenth annual report of the United States Geological Survey to the Secretary of the Interior, 1895-1895; part 1, Director's report and other papers. U.S. Geological Survey Annual Report* 17(1).
- Stewart, R.B. 1927. Gabb's California fossil type gastropods. *Proceedings of the Academy of Natural Sciences of Philadelphia* 78:287-447.
- Stewart, R. 1949. Lower Tertiary stratigraphy of Mount Diablo, Marysville Buttes, and westborder of lower Central Valley of California. *U.S. Geological Survey Oil and Gas Investigations Preliminary Chart OC-34*, 2 wall charts.
- Stilwell, J.D., and R.A. Henderson. 2002. Description and paleobiogeographic significance of a rare Cenomanian molluscan faunule from Bathurst Island, northern Australia. *Journal of Paleontology* 76(3):447-471.
- Suzuki, A. 1995. Cephalopod fossil from the Miocene Tomikusa Group in the southern part of Nagano Prefecture, central Japan. *Bulletin of the Mizunami Fossil Museum* 22:115-120.
- Suzuki, A. 2000. An Eocene cold-water molluscan assemblage from the Poronai Formation in the Mikasa area, central Hokkaido, northern Japan. *Earth Science (Chikyu Kagaku)* 54:363-368.
- Szente, I. 1995. Bivalvia from the Bathonian (Middle Jurassic) of the Mecsek Mts., Hungary. *Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica* 30:93-109.
- Turner, F.E. 1938. Stratigraphy and Mollusca of the Eocene of western Oregon. *Geological Society of America Special Paper* 10:1-130.
- Vedder, J.G. 1972. Review of stratigraphic names and mega-faunal correlations of Pliocene rocks along the southeast margin of the Los Angeles Basin, California. Pp. 158-172 in E.H. Stinmeyer (ed.), *Pacific Coast Miocene Biostratigraphy Symposium. Pacific Section, Society for Economic Geologists and Paleontologists, Bakersfield.*
- Vokes, H.E. 1939. Molluscan faunas of the Domengine and Arroyo Hondo formations of the California Eocene. *Annals of the New York Academy of Sciences* 38:246 pp.
- Vokes, H.E. 1963. Studies on Tertiary and recent giant Limidae. *Tulane Studies in Geology and Paleontology* 1(2):75-92.
- von Siebold, C.T. 1848 (1846-1848). Lehrbuch der vergleichenden Anatomie der Wirbellosen Thiere. Erster Theil. In: Siebold, C.T., and H. Stannius (eds.) *Lehrbuch der vergleichenden Anatomie*. Verlag von Viet and Comp., Berlin:679 pp.
- Wagner, C.M., and K. H. Schilling. 1923. The San Lorenzo Group of the San Emigdio region, California. *University of California Publications, Bulletin of the Department of Geological Sciences* 14(6):235-276.
- Waring, C.A. 1914. Eocene Horizons of California. *Journal of Geology* 22(8):782-785.
- Weaver, C.E. 1905. Contribution to the paleontology of the Martinez Group. *University of California, Bulletin of the Department of Geology* 4(5):101-123.
- Weaver, C.E. 1942. Paleontology of the marine Tertiary formations of Oregon and Washington. *Washington University (Seattle) Publications in Geology* 5(1-3):789 pp.
- Woodring, W.P. 1938. Lower Pliocene mollusks and echinoids from the Los Angeles Basin, California and their inferred environments. *U.S. Geological Survey Professional Paper* 190:1-67.
- Zakharov, V.A., V.A. Kazanenkov, Yu.I. Bogomolov, N.K. Lebedeva, V.A. Marinov, Yu.N. Karogodin, and E.B. Peshchevitskaya. 1999. Biostratigraphy of the Neocomian of the northern Ob' region. *Russian Geology and Geophysics* 40(8):1117-1129.
- Zinsmeister, W.J. 1983. New late Paleocene molluscs from the Simi Hills, Ventura Hills, Ventura County, California. *Journal of Paleontology* 57(6):1282-1303.