

## THE EASTERN PACIFIC RECENT SPECIES OF THE CORBULIDAE (BIVALVIA)

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### ABSTRACT

There are 18 Recent species of the Corbulidae in the eastern Pacific, of which one has been introduced from the northwestern Pacific. Division of *Corbula* into additional genera is premature without new characters and a formal cladistic analysis. Seven subgenera are utilized, with six species remaining in *Corbula*, s. l. Three new species are described: *C. (Caryocorbula) ota*, *C. (Varocorbula) grovesi*, and *Corbula* (s. l.) *colimensis*. One neotype and 14 lectotypes are designated. The distributions and habitats of the species are documented, along with their fossil occurrences and the relationships to other Recent and fossil species.

Key words: Corbulidae, *Corbula*, eastern Pacific, western Atlantic.

### INTRODUCTION

#### Previous Treatments

Deshayes (1845–1848: 212–237, pls. 20, 21) described and illustrated the anatomy of *Corbula gibba* (Olivi, 1792) (as "*C. striata*" Fleming, 1828, ex Walker ms, one of its synonyms) and *Lentidium mediterraneum* (Costa, 1829). White (1942) described but did not figure the pericardial area of *C. gibba*, and Yonge (1946) discussed the anatomy of *C. gibba* (without reference to Deshayes' earlier treatment). Morton (1986) discussed the biology and functional morphology of *C. crassa* Reeve, 1843, at the same time questioning whether the Corbulidae are properly placed in the Myoidea. However, the only molecular phylogenies thus far published that have included a corbulid closely ally *Corbula* to *Mya* (Adamkewicz et al., 1997; Steiner & Hammer, 2000).

Important early papers describing a number of species of *Corbula* at the same time are those of G. B. Sowerby I (1833), Hinds (1843), and C. B. Adams (1852a, b). Reeve (1843–1844) published the only comprehensive monograph on *Corbula*. Tryon (1869) listed the then-known species. Lamy (1926) discussed the species of Lamarck, and then gave synonymies for many of the known species (Lamy, 1941).

Dall (1898, 1900) discussed the genera of

the family in connection with his review of the fossil species of the eastern United States. Vokes (1945) and Keen (1969b) also covered the genera of the family. Zhuang & Cai (1983) treated the species of China, and Habe (1977: 280–284) those of Japan.

Anderson (1994, 1996) discussed the species of the Neogene of the Dominican Republic, and showed that the eastern Pacific corbulids now average larger than those of the western Atlantic (Anderson, 2001).

McLean (1942) discussed sculptural differences between very inequivalve and less inequivalve species of *Corbula*. Bacesco et al. (1957) and Gomoiu (1965) treated populations of *Lentidium mediterraneum* (Costa, 1829), and Hrs-Brenko (1981) those of *Corbula gibba*. Lewy & Samtleben (1979), de Cauwer (1985), Morton (1986), Anderson (1992), Harper (1994), and Kardon (1998) discussed predation of corbulids and the role of the thick layer of conchiolin in combatting it.

A preliminary outline of the results of the present study is given in Coan & Skoglund (2001).

#### Format

In the following treatment, each valid taxon is followed by a synonymy, information on type specimens and type localities, notes on distribution and habitat, and an additional discussion.

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The synonymies include all major accounts about the species, but not most minor mentions in the literature. The entries are arranged in chronological order under each species name, with changes in generic allocation from the previous entry, if any, and other notes given in brackets.

The distributional information is based on Recent specimens I have examined, except as noted. Fossil occurrences are taken from the literature, except as noted.

References are provided in the Literature Cited for all works and taxa mentioned.

### Abbreviations

The following abbreviations are used in the text: AMNH, American Museum of Natural History, New York, New York, USA; ANSP, Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, USA; BMNH, British Museum (Natural History) collection, The Natural History Museum, London, England; BMSM, Bailey-Matthews Shell Museum, Sanibel, Florida, USA; CAS, California Academy of Sciences, San Francisco, California, USA; ICZN, International Commission on Zoological Nomenclature; LACM, Natural History Museum of Los Angeles County, California, USA; MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA; SBMNH, Santa Barbara Museum of Natural History, Santa Barbara, California, USA; UCMP, University of California Museum of Paleontology, Berkeley, California, USA; UMML, University of Miami Marine Laboratory, Rosenstiel School of Marine and Atmospheric Sciences, Miami, Florida, USA; and USNM, United States National Museum collection, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA.

The eastern Pacific Corbulidae in the private collections of Carol C. Skoglund, Phoenix, Arizona, USA; and Kirstie L. Kaiser, Puerto Vallarta, Jalisco, México, were also examined.

### Morphological Characters

In spite of the morphological plasticity of corbulids, there are a number of characters that are useful in distinguishing among the species. Some of these characters are summarized in Table 1.

Overall shape is a useful criterion, with some species oval, some trigonal, and some

other shapes. All corbulids are inequivalve, with the right valve larger than the left, which fits into it, overlapping most conspicuously posteroventrally. Most eastern Pacific species are only slightly inequivalve, and only three very inequivalve. Some species may become thick-shelled as adults, whereas others are never greatly thickened. The anterior end is rounded in all species, but more broadly in some and more sharply in others. The shape of the posterior end is more characteristic of each. In some, it may be extended by a short, shelly "spout" (e.g., Figs. 2, 3), but this may be present in only some specimens; other species never have a spout. A useful character is the nature of the division between the central and posterior slopes. In some, it is delineated by a carina, a ridge, a change in angle, and/or a change in sculpture; in others, it is scarcely set off. Similarly, a narrow, elongate escutcheon of different degrees of prominence may be present; it is generally widest and more evident in the right valve.

Sculpture, while variable in some species, can nonetheless be of diagnostic value. Com-marginal sculpture predominates, but radial ribs are present in some taxa. Color provides a useful character for several species.

In some taxa, the hinge plate is broad, in others narrow. In general, the conspicuous tooth in the right valve is too variable in shape to be a useful diagnostic tool. The resilifer in the right valve may be visible on the hinge plate, or recessed beneath it. The chondrophore in the left valve may be very projecting or only slightly projecting, and it may be conspicuously divided into sections in some. At its posterior margin, a small tooth may be present, which varies in prominence among species. (It articulates on the posterior side of a small tooth in the resilifer of the right valve.) The pallial line, and its sinus, if present, have informative characters, as shown in the drawings (Figs. 40–57). A small sinus is evident in some taxa, not in others; in some, a small posterior extension is visible at the posteroventral corner of the pallial line (e.g., Fig. 40).

## SYSTEMATIC ACCOUNT

### Family Corbulidae Lamarck, 1818

Lamarck, 1818: 493, as "corbulidées" (accepted under ICZN Code, 1999: Art. 11.7.2)

TABLE 1. Key Differentiating Characters, Size, and Frequency of Eastern Pacific *Corbula*

	Inequi- valvness	Shape	Sculpture	External color	Separation between central & posterior slopes	Escutcheon	Max. size, mm	No. E. Pac. lots studied
<i>C. amythestina</i>	slightly	ovate-trigonal	moderate commarginal	purple	moderate ridge	defined by low ridge	30.8	67
<i>C. nasuta</i>	slightly	ovate-elongate	moderate commarginal	white	ridge	defined by ridge	18.4	875
<i>C. ostra</i>	slightly	ovate-elongate	moderate commarginal	purple medially	rounded ridge	weakly defined	26.1	107
<i>C. ovulata</i>	slightly	ovate-elongate	moderate commarginal	white	low ridge	defined by ridge	29.2	58
<i>C. porcella</i>	slightly	ovate-subquadrate	moderate commarginal	white	strong ridge	defined by sharp ridge	10.2	68
<i>C. esmeralda</i>	slightly	ovate-elongate	broad commarginal undulations	white	sharp ridge	defined by ridge	22.5	6
<i>C. bicarinata</i>	slightly	ovate-subquadrate	moderate commarginal	white	sharp ridge	defined by sharp ridge	13.0	257
<i>C. ventricosa</i>	slightly	ovate to trigonal	fine commarginal	white	low ridge	evident in most	35.0	78
<i>C. amurensis</i>	decidedly	ovate	smooth	white	not in RV; angle in LV	not evident	19.7	2
<i>C. tenuis</i>	slightly	elongate-subquadrate	fine commarginal	white	sharp angle	defined by keel	24.5	30
<i>C. grovesi</i>	very	trigonal-ovate	RV — fine commarginal; LV — smooth, faint radials	white	no separation	present	11.0	1
<i>C. obesa</i>	very	ovate	beaks — radials; RV — heavy commarginal; LV — fine commarginal	white	rounded ridge	not evident	12.7	38
<i>C. biradiata</i>	slightly	ovate-elongate	moderate to fine com- marginal	color zones, white in some	sharp ridge	defined by ridge	20.8	248
<i>C. collimensis</i>	slightly	ovate	moderate commarginal	white	rounded ridge	weakly defined	14.0	8
<i>C. ira</i>	slightly	ovate-subquadrate	strong commarginal	white	sharp ridge	defined by ridge	13.6	85
<i>C. luteola</i>	slightly	ovate	fine commarginal	white or pink	rounded ridge	evident	10.2	157
<i>C. marmorata</i>	slightly	ovate-subquadrate	moderate, undulating commarginal	various, mottled	rounded ridge	evident, narrow	8.2	299
<i>C. speciosa</i>	very	ovate-trigonal	RV — commarginal undu- lations; LV — fine, lamellar, oblique	white to yel- low, red ribs	rounded ridge	in juveniles only	20.6	137

Total lots studied: 2,521



Two Recent subfamilies are current recognized, the Corbulinae and the Lentidiinae Vokes, 1945 (pp. 6, 23–24), the latter containing only the living genus *Lentidium*, which is briefly discussed below.

Subfamily Corbulinae Lamarck, 1818  
Genus *Corbula* Bruguière, 1797

*Corbula* Bruguière, 1797: pl. 230, genus without named species (ICZN Code, 1999: Art. 12.2.7); description by Lamarck (1799: 89); original list by Lamarck (1801: 237) (ICZN Code, 1999: Art. 67.2.2).

Type species (subsequent designation of Schmidt, 1818: 77, 177): *Corbula sulcata* Lamarck, 1801: 137 (species based on Bruguière, 1797: pl. 230, fig. 1a–c). Recent; west Africa.

Not to be confused with *Corbula* Röding, 1798: 184–185, the type species of which (subsequent designation of Winckworth, 1930: 15) is *Corbula anomala* Röding, 1798, a junior synonym of *Venus deflorata* Linnaeus, 1758: 687. *Corbula* Röding is thus a synonym of *Asaphis* Modeer, 1793 (pp. 176, 182), a member of the Psammobiidae (Keen, 1969a: 633; Willan, 1993: 5–6)

*Aloides* Megerle von Mühlfeld, 1811: 67

Type species (monotypy): *A. guineensis* Megerle von Mühlfeld, 1811: 67; = *Corbula sulcata* Lamarck, 1801, making *Aloides* an objective synonym of *Corbula*.

The genus *Corbula* Bruguière was long a source of nomenclatural confusion, and a number of authors, lacking key pieces of literature as well as the modern nomenclatural rules, attempted to sort out the taxonomic tangle (Vokes, 1945; J. Q. Burch, 1960). The formula given above represents the consensus under the current rules.

*Corbula sulcata*, which occurs from Mauritania to Angola, is large, heavy, and subequivalve. It has heavy commarginal sculpture in the right valve and finer commarginal sculpture in the left valve. Its posterior end has two radial ridges, one between the central and posterior slopes and another defining a broad escutcheon. The hinge is very heavy. None of the Recent species in the New World is closely similar to the type species of *Corbula*.

There are a bewildering array of specific and generic taxa in this subfamily, with character sets that do not covary. Many of the genera were established based mostly on single characters, such as *Anisocorbula* Iredale,

1930 (p. 404), for an elongate species with a sharp posterior keel, *Solidicorbula* Habe, 1949 (p. 2), for a thick-shelled species, and *Minicorbula* Habe, 1977 (p. 282), for a small-sized species. Subsequent authors have attempted to shoehorn every species into various subgenera, no matter how uncomfortable the fit. Efforts to make a meaningful arrangement of genera and subgenera will be fraught with inconsistencies until additional characters become available and are rationally evaluated. In light of this, elevating subgenera to genera, as many authors have done (including by Coan et al., 2000: 478–480), is premature.

Here, a conservative effort has been made to group similar species under some of the named subgenera and leaving several species in *Corbula*, s. l., but even these groupings should not be given much weight until a full-scale revision of the family is undertaken.

Grant & Gale (1931) placed *Corbula luteola* and *C. porcella* in *Corbula* (*Lentidium*), and the first assignment was followed by some other authors. The type species by monotypy of *Lentidium* Cristofori & Jan, 1832 (Descrizione, p. 9; Disposito, p. [ii]; Conchyliaterrastia, p. 8; Mantissa, p. 4), is *Tellina mediterranea* Costa, 1829 (pp. 14, 26–27, 131, pl. 1, fig. 6), which is small, thin, shiny, translucent, and shaped like a *Tellina*. It is sufficiently different from other corbulids that it has been placed in a separate subfamily, the Lentidiinae Vokes, 1945 (p. 23). No eastern Pacific species is similar.

Lamy (1941) placed *Corbula fragilis* and *C. luteola* in *Corbula* (*Corbulomya*). *Corbulomya* Nyst, 1845 (p. 59), has as its type species (subsequent designation of Herrmannsen, 1847: 308) *Corbula complanata* J. Sowerby, 1822 (p. 86, pl. 362, figs. 7, 8), from the upper Pliocene of England. This genus is now regarded as a synonym of *Lentidium* (Vokes, 1945: 23, 26; Glibert & van de Poel, 1966: 58; Keen, 1969b: 696).

The eastern Pacific Corbulidae include the following two species (or species complexes) of formidable morphological diversity, which cannot be fully resolved without new lines of evidence not available in the current study:

(1) *Corbula* (*Caryocorbula*) *nasuta* is by far the most common species in collections, and it occurs in enormous populations on soft-bottoms in shallow-water. Individuals of this species can attain a fairly large size, but most populations contain small individuals. Al-

though there is a wide range in morphologies, there is as yet no reliable evidence that more than one species is present, and specimens of intermediate morphologies can be found.

(2) *Corbula biradiata*, while not having as much morphological plasticity as *C. nasuta*, varies considerably with respect to the position of its beaks, the strength of its commarginal sculpture, and its color.

Corbulids are not only abundant, but there are many collection lots in alcohol or with dried animals. Thus, the group would be a prime candidate for biochemical genetic studies, not only to test for possible additional diversity at the species level but also to understand phylogenetic relationships in the family as a whole.

#### Subgenus (*Caryocorbula*) Gardner, 1926

*Caryocorbula* Gardner, 1926: 46

Type species (original designation): *Corbula alabamiensis* Lea, 1833 (reference below, under *C. nasuta* Discussion). Eocene, eastern United States.

*Serracorbula* Olsson, 1961: 433

Type species (original designation): *S. tumaca* Olsson, 1961, = *Corbula nasuta* G. B. Sowerby I, 1833 (references below)

Small to moderate in size, subequivalve, subequilateral, with a strong to weak ridge between central and posterior slopes. Sculpture of strong to weak commarginal ribs, similar on both valves. Specimens of some species with "marginal" ribs along the ventral and dorsal margins; these are further discussed below.

I include five eastern Pacific species in this subgenus. Other authors have placed additional species here as well.

Lamy (1941) placed *Corbula nasuta* in *Corbula* (*Cuneocorbula*). *Cuneocorbula* Cossmann, 1886 (p. 49 [reprint: 37]), has as its type species (subsequent designation by Dall, 1898: 836) *Corbula biangulata* Deshayes, 1857 (p. 231, pl. 13, figs. 19–23).<sup>2</sup> This species, from the Paleocene of France, is thin, elongate, and birostrate.

*Corbula* (*Caryocorbula*) *amethystina*  
(Olsson, 1961)  
Figures 1, 39

*Caryocorbula* (*Caryocorbula*) *amethystina*  
Olsson, 1961  
Olsson, 1961: 431, 548, pl. 75, fig. 1–1c;  
Keen, 1971: 262, 264, fig. 674 [*Corbula*  
(*Caryocorbula*)]

#### Type Materials & Localities

ANSP 218902, holotype, pair; length, 27.6 mm; height, 18.1 mm; width, 13.8 mm (Fig. 1). "Tortutilla" [? = Isla Tortolita, Panamá Province], Panamá (8.8°N); H. B. Johnson, 1958. In the plate explanation, Olsson gives the locality as [Isla] "Taboguilla," but both the text and label with the specimen say "Tortutilla". UMML 30.11391, paratype, right valve; Puerto Mensabé, Los Santos Province, Panamá. UMML 30.11368, paratype, left valve; San Carlos, Panamá Province, Panamá. UMML 30.11389, paratypes, right valve, left valve; San Carlos, Panamá Province, Panamá. UMML 30.11390, paratypes, 3 right valves, 2 left valves; El Lagartillo, Panamá Province, Panamá. UMML 30.11388, paratype, right valve; Isla Gibráleón, Archipiélago de las Perlas, Panamá. UMML 30.11326, paratype, left valve; Punta Cocos, Isla del Rey, Archipiélago de las Perlas, Panamá. UMML 30.11390, paratype, left valve; Puerto Callo, Manabí Province, Ecuador. UMML 30.11388, paratype, right valve; Santa Elena, Guayas Province, Ecuador.

#### Description

Ovate-trigonal, thick; right valve slightly larger than left; posterior end longer (beaks 37–43% from anterior end); anterior end rounded; posterior end pointed, slightly extended by a spout in some specimens; posterior slope set off from central slope by a moderately sharp ridge that extends to the ventral margin. Escutcheon defined by a low ridge.

Beaks with fine commarginal sculpture. Central slope with moderate commarginal ribs and much finer commarginal striae. Exterior color light to dark purple; interior color purple around margins, brown in some. Hinge plate broad; right valve with a large tooth; left valve with a broad, slightly projecting chondrophore and a small tooth. Posterior end of pallial line with small posterior extension (Fig. 39).

<sup>2</sup>Glibert & van de Poel (1966: 55) renamed this species *Cuneocorbula pelseneri* on the grounds that it was a junior homonym of "*Corbula biangulata* Sowerby, 1833," but there is no such senior homonym. They must have misread either *Corbula bicarinata* G. B. Sowerby I, 1833, or *C. biradiata* G. B. Sowerby I, 1833.



FIG. 1. *Corbula amythestina*, holotype; ANSP 218902; length, 27.6 mm. FIG. 2. *C. nasuta*. Lectotype of *C. nasuta*; BMNH 1966565/1; length, 17.6 mm.



Length to 30.8 mm (SBMNH 345487; Playas [de Villamil], Guayas Province, Ecuador).

#### Distribution

Mazatlán, Sinaloa (23.2°N) (UCMP E.8424; CAS 121790, 121793; LACM 152689, 152690, 63–11.78; SBMNH 126540), and La Paz, Baja California Sur (24.2°N) (CAS 121786; SBMNH 345503 ["Punta Coyote," probably one of the two in this vicinity]), México, to Playas [de Villamil], Guayas Province, Ecuador (2.6°S) (SBMNH 345487). It has been found living from the intertidal zone to 82 m (mean, 17.2 m;  $n = 27$ ), on sand bottoms. I have seen 67 eastern Pacific lots, including the types. A single lot labeled as having come from the western Atlantic at Islas Los Roques (as "Las Rochas Is."), Venezuela (BMSM 15008), seems improbable (R. Cipriani, e-mail, 30 Nov. 2000) and probably represents a labeling error.

#### Discussion

*Corbula amythestina* merits comparison with *C. dominicensis* Gabb, 1873b (p. 247), from the Miocene of the Dominican Republic (concerning the latter: Anderson, 1996: 14–15, pl. 1, figs. 9, 12, pl. 2, figs. 1, 2, 4, 5).

*Corbula (Caryocorbula) nasuta* G. B.  
Sowerby I, 1833  
Figures 2–7, 40

*Corbula nasuta* G. B. Sowerby I, 1833

G. B. Sowerby I, 1833: 35; Reeve, 1843: pl. 1, fig. 1; d'Orbigny, 1845: 571; Carpenter, 1857a: 183, 228, 300; 1864b: 537 [1872 reprint: 23]; Tryon, 1869: 65; Lamy, 1941: 233 [*Corbula (Cuneocorbula)*]; Hertlein & Strong, 1950: 240, 252, pl. 2, fig. 9 [*Aloidis (Caryocorbula)*]; Hertlein & Strong, 1955: 205–206; Soot-Ryen, 1957: 11; Keen, 1958: 209, fig. 527 [*Corbula (Caryocorbula)*]; Olsson, 1961: 429–430, 548, pl. 75, fig. 3–3e [*Caryocorbula (Caryocorbula)*]; Keen, 1971: 265–266, fig. 677 [*Corbula (Caryocorbula)*]; Gemmell et al., 1987: 59, figs. 72, 73 [as *Corbula cf. nasuta*]

*Corbula nuciformis* G. B. Sowerby I, 1833

G. B. Sowerby I, 1833: 35; Reeve, 1843: pl. 2, fig. 9; Carpenter, 1857a: 183, 300; 1864b: 537, 668 [1872 reprint: 23, 154];

Tryon, 1869: 65; Lamy, 1941: 234 [*Corbula (Cuneocorbula)*]; Olsson, 1961: 430–431, 548, 549, pl. 75, figs. 7, 8; pl. 76, fig. 7 [*Caryocorbula (Caryocorbula)*]; Keen, 1971: 265–266, fig. 678 [*Corbula (Caryocorbula)*]

#### First revision herein

[NON *Corbula nuciformis*, auctt., which = *C. obesa*]

Hertlein & Strong, 1950: 241, pl. 3, fig. 1 [*Aloidis (Caryocorbula)*]; Keen, 1958: 209, fig. 528 [*Corbula (Caryocorbula)*]

[not to be confused with *Corbulolumna nuciformis* Vokes, 1945: 9–11, pl. 2, figs. 5–8, from the Cretaceous of Lebanon.]

*Corbula fragilis* Hinds, 1843

Hinds, 1843: 56; Reeve, 1844: pl. 3, fig. 13; Hinds, 1845: 68, pl. 20, fig. 11; Carpenter, 1857a: 207, 300; Tryon, 1869: 64; Lamy, 1941: 240 [*Corbula (Corbulomya)*]; Hertlein & Strong, 1950: 243–244 [*Aloidis (Tenuicorbula)*]; Keen, 1958: 210, 211, fig. 537; Olsson, 1961: 430 [as a synonym of *Caryocorbula nasuta*]; Keen, 1966: 268, pl. 4, fig. 3

*Corbula alba* Philippi, 1846

Philippi, 1846: 19; Carpenter, 1857a: 224, 244; 1857b: 534, 547 [as a synonym of *Corbula bicarinata*]; Tryon, 1869: 63

*Corbula pustulosa* Carpenter, 1857

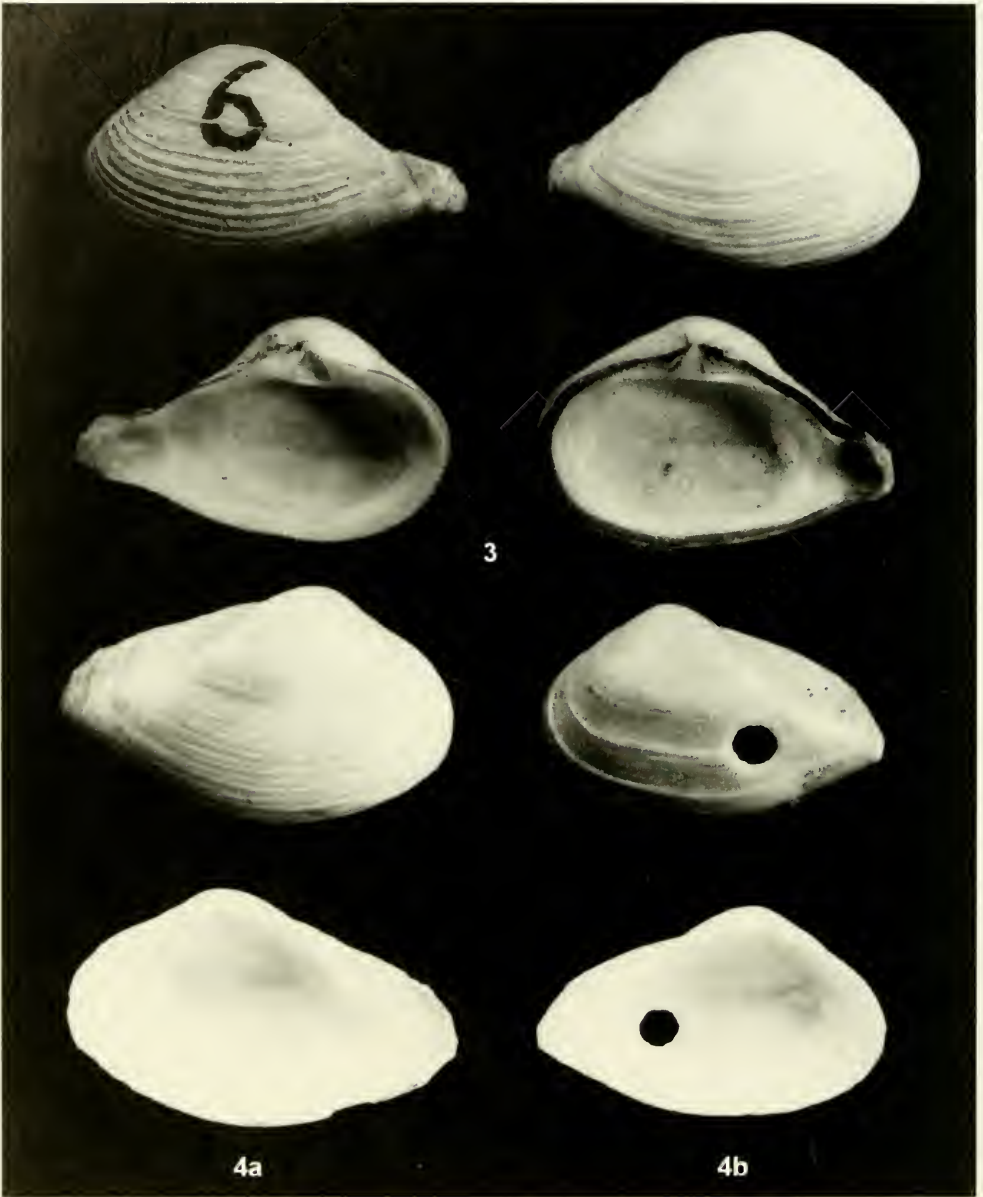
Carpenter, 1857a: 244, 300 [*nomen nudum*]; 1857b: 22–23; 1864a: 368 [1872 reprint: 204]; 1864b: 553 [1872 reprint: 39]; Tryon, 1869: 65; Lamy, 1941: 143; Hertlein & Strong, 1950: 240 [as a synonym of *Aloidis (Caryocorbula) nasuta*]; Palmer, 1951: 13; Brann, 1962: 29, pl. 4, fig. 32; Keen, 1968: 402, pl. 56, fig. 25 [as a synonym of *Corbula nasuta*]

*Serracorbula tumaca* Olsson, 1961

Olsson, 1961: 433, 549, pl. 76, fig. 4–4d; Keen, 1971: 268–269, fig. 690 [as *Corbula (Serracorbula)*]

#### Type Materials & Localities

*Corbula nasuta*—BMNH 1966565/1, **lecto-type here designated**, open pair, the specimen closest to the original length measurement; length, 17.6 mm; height, 11.5 mm; width, 12.0 mm (Fig. 2). BMNH 1966565/2–4, paralectotypes: closed pair, length, 18.4 mm; closed pair labeled "4", length, 16.0 mm; open pair, length 15.3 mm, perhaps the specimen figured by Reeve (1843)."Xipixipi" [Jipijapa; Puerto de Cayo], Manabí Province, Ecuador



FIGS. 3, 4. *Corbula nasuta*. FIG. 3. Lectotype of *C. nuciformis*; BMNH 1966566/1; length, 13.4 mm. FIG. 4a. Lectotype of *C. fragilis*; BMNH 1966234/1; length, 7.3 mm. FIG. 4b. Paralectotype of *C. fragilis*; BMNH 1966234/2; length, 6.4 mm.

(1.3°S); 10 fms. [18 m], sandy mud; Hugh Cuming. G. B. Sowerby I (1833) also reported some small specimens, tentatively assigned to this species, from the Golfo de Nicoya, Puntarenas Province, Costa Rica.

*Corbula nuciformis*—BMNH 1966566/1, lectotype here designated, open pair, la-

beled "6", probably the specimen figured by Reeve (1843); length, 13.4 mm; height, 8.4 mm; width, 9.4 mm (Fig. 3). ANSP 50875, possible paralectotypes, 2 small, closed pairs. "Real Llejos" [Río Realejo; Corinto], Chinandega Province, Nicaragua (12.5°N), 6 fms. [11 m], sandy mud; Hugh Cuming. G. B. Sowerby



I (1833) also cited fossil material from near Guayaquil, Guayas Province, Ecuador.

*Corbula fragilis*—1966234/1, **lectotype here designated**, right valve; length, 7.3 mm; height, 4.3 mm; width, 1.9 mm (Fig. 4a). BMNH 1966234/2, paralectotype, left valve; length, 6.4 mm (Fig. 4b). A larger specimen cited by Hinds (1843) is not in the BMNH. Veragua[s] Province, Panamá (approximately 7.7°N), 18 fms. [33 m]; Edward Belcher.

*Corbula alba*—Presumably lost. The original specimen measured 13.0 mm in length, 8.2 mm in height, and 7.6 mm in width. Mazatlán, Sinaloa, México (32.2°N); Kinderman.

*Corbula pustulosa*—BMNH 1857.6.4.77, lectotype (Keen, 1968: 402), closed pair mounted on a glass slide; length, 4.2 mm; height, 3.2 mm; width, approximately 2.0 mm (difficult to measure because of being glued to the slide) (Fig. 5). USNM 715647, paralectotype, left valve (glued to a glass slide); length, 3.4 mm. Mazatlán, Sinaloa, México (32.2°N); Frederick Reigen.

*Serracorbula tumaca*—ANSP 218948, **lectotype here designated**, right valve; length, 12.4 mm; height, 8.4 mm; width, 5.4 mm (Fig. 6a). Of the material that had been in the ANSP lot labeled "holotype," this valve comes closest to the holotype measurements in Olsson's text, but it does not match any of his illustrations labeled "holotype." Olsson's fig. 4, 4b, and 4c corresponds to a paralectotype pair measuring 12.0 mm in length (ANSP 405291) (Fig. 6b). His fig. 4d is a paralectotype left valve measuring 11.8 mm in length (also in ANSP 405291). The left valve shown in his fig. 4a was not present in the lot. Tumaco, Nariño Province, Colombia (1.8°N). The ANSP lot also contained a paralectotype right valve from San Miguel, Isla del Rey, Archipiélago de las Perlas, Panamá (now ANSP 405292). No type material was located in the Olsson collection in the UMML.

## Description

Ovate-elongate, heavy; right valve slightly larger than left; longer posteriorly to slightly longer anteriorly (beaks 34–51% from anterior end). Posterior end somewhat pointed ventrally, sometimes extended by a spout. Posterior slope set off by a well-defined ridge, often with a slight radial sulcus just anterior to it. Ventral margin sometimes growing medially to form an inflated, flattened ventral surface. Margins, particularly the ventral margin,

sometimes with "marginal"<sup>3</sup> ribs, resulting in a serrate edge. Escutcheon defined by a ridge, more evident in right valve.

Beaks relatively smooth, with fine, pustules. Sculpture on central and posterior slopes of closely spaced moderate commarginal ribs and fine, radially arrayed pustules.

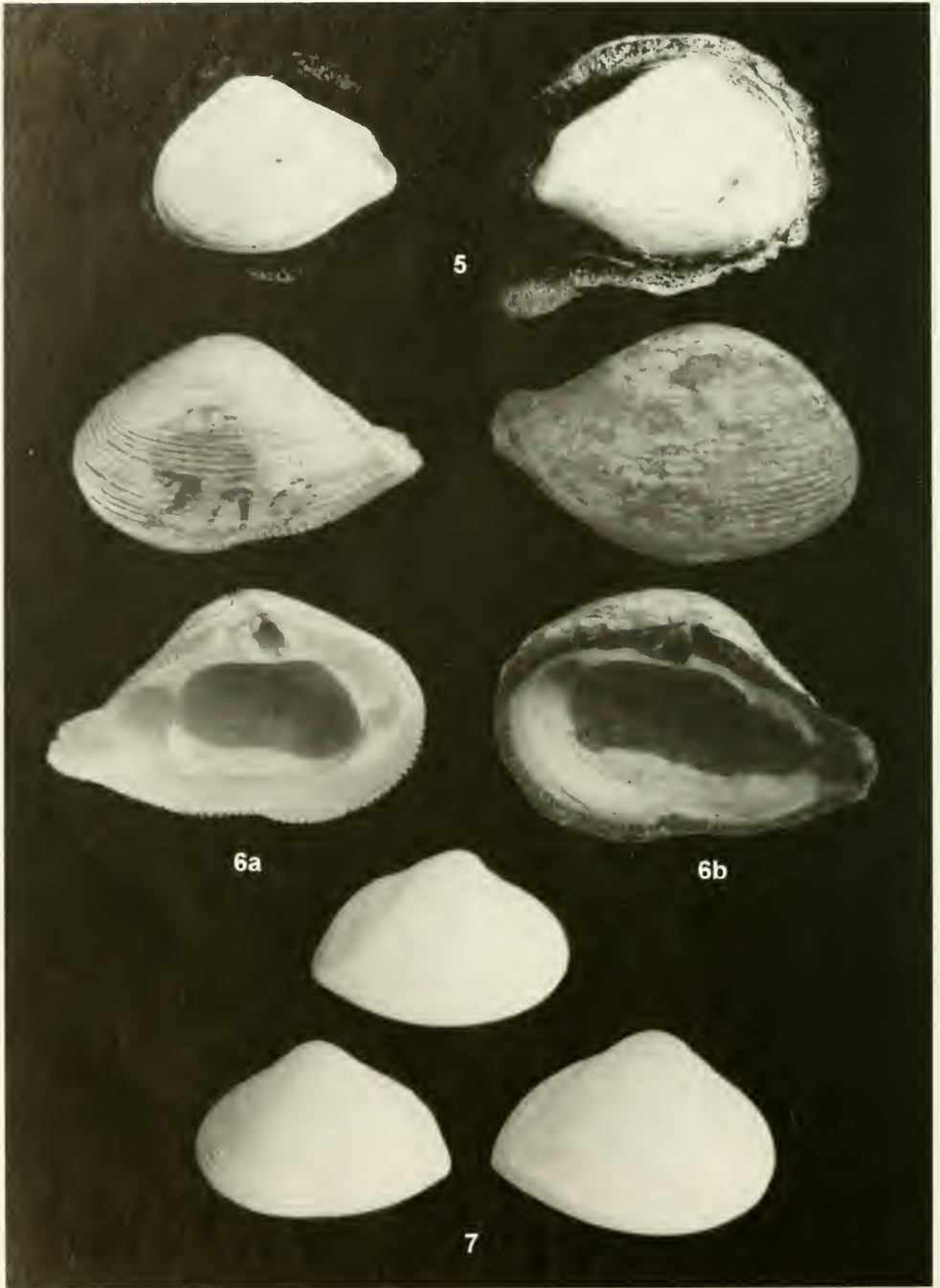
Periostracum tan. External color white; internal color white, but yellow or tan in some specimens. Hinge plate heavy; right valve with a large tooth; left valve with a broad chondrophore, projecting in some, less in others; tooth small (Fig. 40). Length to 18.4 mm (a paralectotype of *C. nasuta*).

## Distribution

Isla Natividad, Baja California Sur (27.9°N) (SBMNH 345488); Bahía Magdalena, Baja California Sur (24.5°N) (CAS 121538), into and throughout the Golfo de California to its head at Puerto Peñasco, Sonora (31.4°N) (UCMP E8431; CAS 115324, 121917, 121919, 122072; SBMNH 21350, 116514, 119426; USNM 212789, 707996; Skoglund Collection; and many other lots), México, to Callao, Lima Province, Perú (12.1°S) (LACM 35-152.1, 35-153.1, 35-177.2); Isla del Coco, Costa Rica (SBMNH 345489, 345490, 345491; LACM 38-180.2); Isla Santa Cruz, Islas Galápagos, Ecuador (LACM 38-193.13); from the intertidal zone to 152 m (mean, 28.7 m;  $n = 328$ ), on mud or sand. (A single valve with an indicated depth of 384 m—LACM 35-177.2—is probably the result of drift from shallower water.) I have seen 875 eastern Pacific lots, including the types. Two lots labeled as having come from "Monterey, California" (USNM 21480, 58346), probably represent labeling errors, and one of them may be the source of the Monterey record of *C. fragilis* by Dall (1921: 53) and Oldroyd (1925: 203).

This species has also been recorded in beds of Pleistocene age at Puerto Peñasco, Sonora (Hertlein & Emerson, 1956: 165), and at Bahía Magdalena, Baja California Sur (Jordan & Hertlein, 1936: 111, as "*C. porcella*" and as "*C. fragilis*"; CAS Loc. 754), México, in beds of Pliocene age of the Loreto Basin,

<sup>3</sup>These ribs appear along the outer ventral surface near the shell margins (Fig. 6a, b). Olsson (1961) referred only to "marginal serrations". They are not radial ribs, because they do not radiate from the beaks. I settled on the term "marginal ribs" because they run laterally along the shell margin.



FIGS. 5-7. *Corbula nasuta*. FIG. 5. Lectotype of *C. pustulosa*; BMNH 1857.6.4.77; length, 4.2 mm. FIG. 6a. Lectotype of *Serracorbula tumaca*; ANSP 218948; length, 12.4 mm. FIG. 6b. Paralectotype of *S. tumaca*; ANSP 405291; length, 12.0 mm. FIG. 7. SBMNH 345490; Bahía Chatham, Isla del Coco, Costa Rica; 46-69 m; largest specimen length, 5.0 mm.

Baja California Sur, México (Piazza & Robba, 1998: 238, 248, 260, as "*C. nuciformis*"), and in the middle to late Pliocene Canoa Formation at Punta Blanca, Manabí Province, Ecuador (Pilsbry & Olsson, 1941: 11, 75). G. B. Sowerby I (1833) cited fossil material of unknown age from Guayaquil, Guayas Province, Ecuador.

## Discussion

*Corbula nasuta* is the most variable of the eastern Pacific taxa. When small (< 10 mm), specimens are thin shelled, with conspicuous fine pustulose radial sculpture. This is the morphology named *C. fragilis*. As specimens grow, the ventral margin may soon become flattened, yielding the short, inflated morphology that was named *C. nuciformis* and *C. pustulosa*. The size at which material thickens and forms a flattened base varies greatly among populations, and this can occur in specimens as small as 5 mm. *Corbula nasuta* typically becomes rostrate posteriorly, and a short spout may be added in some specimens.

In some large specimens, marginal ribs may be developed at the margins, especially the ventral margin. This is the form that was named *Serracorbula tumaca*. The type lots of both *C. nasuta* and *C. nuciformis* also contain specimens with such ribs.

I believe that *Corbula alba* belongs here as a synonym in that Philippi's description speaks of the posterior slope being acute and subrostrate, and because the two European Mio-Pliocene species with which he compared *C. alba*—*C. revoluta* (Brocchi, 1814: 516, 685, pl. 12, fig. 6—originally described as *Tellina*) and the closely related *C. carinata* Dujardin, 1837 (p. 257)—are much more similar to *C. nasuta* than to *C. bicarinata*, with which it was previously synonymized.

Some material from the northwestern coast of South America is shorter, more rounded, without much of a posterior sulcus setting off the posterior end, and it has finer sculpture than material from further north. A similar morphology is seen in material from Isla del Coco, Costa Rica (lots cited in the Distribution), which is uniformly small, rounded, and smooth (Fig. 7). This might be regarded as a separable species or subspecies, but given the variability of this species (or species complex) as a whole, it is premature to bestow additional names.

*Corbula nasuta* is most similar to the later-

named western Atlantic *C. swiftiana* C. B. Adams, 1852c (pp. 236–237), which has been reported from Massachusetts to Argentina. Given the variability of these two taxa, I doubt that the two can be told apart on a morphological basis, and perhaps they should be synonymized until more evidence is available. Synonyms in the western Atlantic may include: *C. kjoeriana* C. B. Adams, 1852c (p. 237), *C. barrattiana* C. B. Adams, 1852c (pp. 237–238), *C. chittyana* C. B. Adams, 1852c (p. 238), *C. fulva* C. B. Adams, 1852c (pp. 240–241), *C. caribaea* d'Orbigny, 1853<sup>4</sup> (p. 284 [Spanish ed., p. 323], pl. 27, figs. 5–8), *C. lavalleana* d'Orbigny, 1853 (p. 284 [Spanish ed., p. 323], pl. 27, figs. 9–12), and *C. uruguayensis* Marshall, 1928 (p. 5, pl. 4, figs. 7–9). Records of *C. nasuta* from the western Atlantic, such as those of Dall (1889b: 70, pl. 2, fig. 6–6c, as *C. nasuta* "Say") and Haas (1953: 204), were presumably based on *C. swiftiana*.

Records of *C. nasuta* from Australia (Angas, 1867: 913, 1878: 869; Hedley, 1918: M31) were based on specimens of *C. coxi* Pilsbry, 1897 (pp. 363–364, pl. 9, figs. 1–3).

Dautzenberg (1912: 99) reported *Corbula nasuta* Sowerby from several localities in west Africa. This African species was also described as *C. lyrata* E. A. Smith, 1872 (p. 729, pl. 75, fig. 2), a junior homonym of *C. lyrata* J. de C. Sowerby, 1840 (expl. to pl. 21), and Smith's species was renamed *C. dautzenberg* Lamy, 1941 (pp. 235–236), the name currently in use.

*Corbula nasuta* Sowerby, 1833 (17 May), is not to be confused with *Corbula nasuta* Conrad, 1833 (3 Sept.) (p. 38; unpublished pl. 19, fig. 4 [not "pl. 20, fig. 2," as stated in text]), from the Middle Eocene Claiborne Formation of Alabama, for which the name *Corbula alabamiensis* Lea, 1833 (Dec.) (p. 45, pl. 1, fig. 12), is now used (Palmer & Brann, 1965: 74). *Corbula nasuta* Conrad was later reported by Conrad (1857: 161, pl. 19, fig. 4) from the Ter-

<sup>4</sup>Dall (1889b: 18), followed by Aguayo (1943: 38), maintained that the entire Atlas to d'Orbigny's monograph on the mollusks of Cuba appeared in 1842, with the French text on the bivalves appearing between 1847 and 1853. Aguayo also thought that the entire Spanish text might have appeared in 1845; Keen (1971: 1006) dated the Spanish text as 1846. However, there is no evidence that any of the bivalves were published, in text or plates, and in either edition, before 1853, when citations to the species begin to appear in other works.



tiary of western Texas, and this Texas material was later named *C. conradi* by Dall (1898: 842).<sup>5</sup>

Small specimens of this species commonly occur in shallow water with *C. marmorata*. These species may most easily be distinguished as follows:

	<i>nasuta</i>	<i>marmorata</i>
Posterior end	tapered, pointed posteriorly	subquadrate, pointed pos- terovertrally
Exterior color	white	mottled, with purplish blotches near beaks
Interior color	white	magenta, espe- cially around margins

The complex of *nasuta*-like taxa has been vastly overnamed in the Pliocene and Miocene of the western Atlantic region. A partial list of taxa that belong in this complex includes: *C. (Cuneocorbula) sarda* Dall, 1898 (pp. 847–848; 1900: pl. 36, fig. 14); *C. (C.) whitfieldi* Dall, 1898 (p. 849; 1900: pl. 36, fig. 18); *C. (Caryocorbula) whitfieldi stika* Gardner, 1928 (pp. 232–233, pl. 35, figs. 8, 9); and *C. (C.) whitfieldi boyntoni* Gardner, 1928 (p. 233, pl. 35, figs. 10–13), from the Miocene of Florida; *C. (Cuneocorbula) sericea* Dall, 1898 (pp. 848–849; 1900: pl. 36, fig. 8) [synonyms: *C. (C.) cercadica* Maury, 1917: 396–397 [= 232–233], pl. 65 [= 39], figs. 16, 17; *C. (C.) caimitica* Maury, 1917: 395 [= 233], pl. 65 [= 39], figs. 18, 19] (concerning: Anderson, 1996: 15–17, pl. 2, figs. 7–21); *C. (C.) helena* Maury, 1912 (p. 62, pl. 9, fig. 25) [synonyms: *C. (C.) smithiana* Maury, 1912: 63, pl. 9, figs. 29, 30; *C. (C.) caribaea pergrata* Maury, 1925: 255 [= 103], pl. 20, fig. 8; *C. (C.) daphnis* Maury, 1925: 256 [= 104], pl. 20, figs. 10–11] (concerning: Jung, 1969: 407–409, pl. 38, figs. 12, 13, pl. 39, figs. 1–9), from the Miocene and Pliocene of the Caribbean; *Caryocorbula (Caryocorbula) prenasuta* Olsson, 1964 (p. 70, pl. 9, fig. 10), from the Miocene of Ecuador; *C. oropendula dolicha* Woodring, 1982 (p. 712, pl. 119, figs. 4–6), from the Miocene of Panama; *Corbula (Cuneocorbula) swiftiana harrisii* Dall, 1898 (p.

855), from the Miocene of Texas; and *C. inaequalis* Say, 1824 (p. 153, pl. 13, fig. 2), from the Pliocene of Maryland and Virginia [synonym: *C. inaequalis mansfieldi* Richards, 1947: 32, pl. 11, figs. 27, 31] (concerning: Campbell, 1993: 48, pl. 21, fig. 191).

***Corbula (Caryocorbula) otra* Coan,  
new species  
Figures 8, 41**

*Corbula ovulata*, auctt., in part, non G. B. Sowerby I, 1833

G. B. Sowerby I, 1833: 35–36 [material cited from Mazatlán, México, and Corinto, Nicaragua]; Hanley, 1843: 47, 4 (pl. expl.), pl. 10, fig. 52; 1856: 344; Reeve, 1843 [material cited from Mazatlán, México, and Corinto, Nicaragua]; C. B. Adams, 1852a: 522–523 [1852b: 298–299] [in part; the large pair cited from Isla Taboga, Panamá]; Carpenter, 1857b: 23 [specimen cited from Mazatlán]; Lamy, 1941: 127–128; Hertlein & Strong, 1950: 241, 252, pl. 2, fig. 11 [*Aloidis (Caryocorbula)*]; Hertlein & Strong, 1955: 206; Keen, 1958: 209, fig. 530 [*Corbula (Caryocorbula)*]; Olsson, 1961: 428–429, 548, pl. 75, fig. 2c [*Caryocorbula (Caryocorbula)*]; Keen, 1971: 265, 266, fig. 680 [lower right fig. only] [*Corbula (Caryocorbula)*]

Type Material & Locality

SBMNH 345493, holotype, pair; length, 22.8 mm; height, 13.6 mm; width, 12.0 mm, including portion of dried soft parts (Figs. 8, 41). SBMNH 345494, paratypes; open pair, length, 23.3 mm; closed pair, length, 21.0 mm; right valve, length, 21.5 mm. Manzanillo, Colima, México (19.1°N, 104.3°W); 30–45 m; Carl & Laura Shy; ex Skoglund Collection.

Description

Ovate-elongate; heavy; right valve slightly larger than left; longer posteriorly (beaks at 40–43% from anterior end). Anterior end rounded; posterior end tapered, slightly upturned posteriorly, often extended by a short spout. Posterior slope set off by a rounded ridge, becoming less evident ventrally. Escutcheon weakly defined by a low ridge, most evident in right valve.

Beaks smooth; most of surface covered by well-spaced, rounded moderate commarginal

<sup>5</sup>*Corbula conradi* Dall is not the renaming of a homonym, as assumed by Boss et al. (1968: 88), but rather a new species based on Conrad's material (USNM 9899).

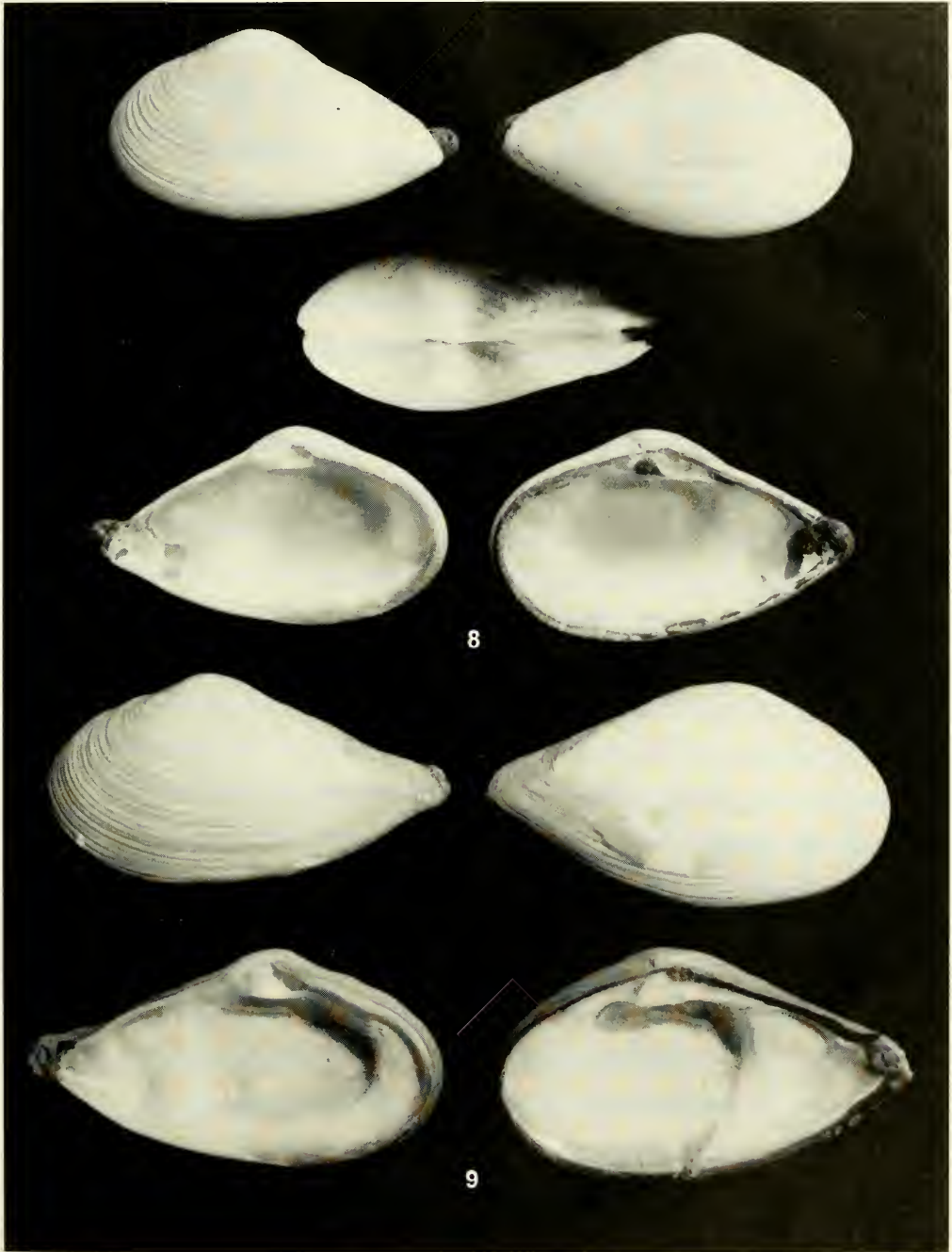


FIG. 8. *Corbula ota*, holotype; SBMNH 345493; length, 22.8 mm. FIG. 9. *C. ovulata*, lectotype; BMNH 1967946/1; length, 26.7 mm.

ribs and very fine commarginal striae. Posterior slope with much less conspicuous ribs. Ventral and dorsal margins with marginal ribs in some specimens, such as in the holotype.

Periostracum light tan. Exterior color white on anterior and posterior ends and ventrally, purple to pink medially; beaks white. Interior white to purple. Hinge plate heavy; right valve with large tooth; left valve with chondrophore not very extended and a small tooth. Posterior end of pallial line with short posterior extension (Fig. 41). Length to 26.1 mm (Bahía Chamela, Jalisco, México; Skoglund Collection).

#### Distribution

Isla Carmen, Baja California Sur (26.0°N) (CAS 121884), and Guaymas, Sonora (27.9°N) (UCMP E.8425, CAS 121883), México, to La Libertad, Guayas Province, Ecuador (2.2°S) (SBMNH 109827). A lot in the USNM 21479 labeled as "Monterey, California," is undoubtedly a labeling error. A few valves numbered with a locality in the Islas Galápagos, Ecuador, now isolated as CAS 121890, are thought to represent numbering errors on a few shells that had been a large lot from Corinto, Nicaragua. Recorded depths of live collected material are from the intertidal zone to 55 m (mean, 17.9 m;  $n = 31$ ), on mud or sand. I have seen 107 lots.

#### Etymology

The species name is the Spanish word for "other."

#### Discussion

This new species is closest to *C. ovulata*, and their distributions overlap from Costa Rica to Ecuador. *Corbula ovulata* is more elongate, even as a juvenile, more produced posteriorly, and it is always white in color. The radial rib between the central and posterior slope is more pronounced, and the commarginal sculpture is denser and more evenly distributed.

#### *Corbula (Caryocorbula) ovulata*

G. B. Sowerby I, 1833

Figures 9, 42

*Corbula ovulata*, G. B. Sowerby I, 1833

G. B. Sowerby I, 1833: 35–36; Hanley, 1843: 47 [in part; not the fig.]; Reeve,

1843: pl. 1, fig. 7 [in part]; d'Orbigny, 1845: 571–572; C. B. Adams, 1852a: 522–523 [1852b: 298–299] [in part]; Carpenter, 1857a: 183, 228, 244, 280, 300; 1857b: 23 [in part]; 1864a: 368 [1872 reprint: 204]; 1864b: 537, 668 [1872 reprint: 23, 154]; Tryon, 1869: 65; Lamy, 1941: 127–128 [in part]; Hertlein & Strong, 1950: 241 [*Aloidis (Caryocorbula)*] [in part; not the fig.]; Hertlein & Strong, 1955: 206; Keen, 1958: 209 [*Corbula (Caryocorbula)*] [in part; not the fig.]; Olsson, 1961: 428–429, 548; pl. 75, fig. 2-2b [*Caryocorbula (Caryocorbula)*] [in part; not fig. 2c]; Keen, 1971: 265–266, fig. 680 [*Corbula (Caryocorbula)*] [in part; not lower right fig.]

#### Type Material & Locality

BMNH 1967946/1, **lectotype here designated**, open pair, the largest specimen, that figured by Reeve (1843); length, 26.7 mm; height, 15.1 mm; width, 12.1 mm (Fig. 9). BMNH 1967946/2-3, paralectotypes, two other pairs: closed pair, length, 24.3 mm; open pair, length, 24.1 mm. "Caraccas" [Bahía de Caráques], Manabí Province, Ecuador (0.6°S). A collective depth of 7–17 fms. [13–31 m] was given for all the original material.

Five localities were originally mentioned. The two northernmost—Mazatlán, Sinaloa, México, and "Real Llejós" [= Río Realejos; Corinto], Chinendega Province, Nicaragua—specifically refer to the species ["beautiful pink color"] here described as *Corbula otra* and are not represented by material in the BMNH collection, nor is material present from the Golfo de Montijo, Veraguas Province, Panamá, or from the other cited Ecuadorian locality—"Xipixapi" [Jipijapa; Puerto de Cayo], Manabí Province. Without examining type material, Hertlein & Strong (1950: 241) "designated" the latter as the type locality, but this is now superceded by the locality of the lectotype designated here (ICZN Code, 1999: Art. 76.2).

#### Description

Ovate-elongate, heavy; right valve slightly larger than left; equilateral to longer posteriorly (40–50% from anterior end); anterior end rounded; posterior end produced, extended by a spout in large specimens. Posterior slope set off from central slope by a very low ridge



that disappears ventrally. Escutcheon well defined by a ridge.

Beaks smooth; most of surface with closely spaced, moderate commarginal ribs and very fine commarginal striae. Ventral margin with marginal ribs in some material. Escutcheon smooth.

Periostracum tan. Exterior white; interior with brown patches and brown marginal color in large specimens. Hinge plate heavy; right valve with a large tooth; left valve with a broad, not very projecting chondrophore and a small tooth. Posterior end of pallial line with posterior extension (Fig. 42). Length to 29.2 mm (Skoglund Collection; Playas, Guayas Province, Ecuador).

#### Distribution

Bahía Juanilla, Guanacaste Province, Costa Rica (10.9°N) (LACM 72-13.30), to Cabo Blanco, Piura Province, Perú (4.3°S) (CAS 121777), from the intertidal zone to 55 m (mean, 8.2 m;  $n = 13$ ), on sand bottoms. I have seen 58 lots, including the types.

Reported on the Pleistocene third terrace on the Peninsula de Santa Elena (Hoffstetter, 1948: 81) and, with question, as a subfossil at Laguna de Salinas (Hoffstetter, 1952: 44), both in Guayas Province, Ecuador. Also reported in the early Pliocene Jama Formation at Puerto Jama, Manabí Province, Ecuador (Pilsbry & Olsson, 1941: 11, 75), in the Pliocene at Río la Vaca and Río Blanca, Burica Peninsula, Puntarenas Province, Costa Rica (Olsson, 1942: 171, 172), and in the Miocene Tumbes Formation at Zorritos, Tumbes Province, Perú (Olsson, 1932: 140).

#### Discussion

See under *C. otra*.

*Corbula (Caryocorbula) porcella* Dall, 1916  
Figures 10, 43

*Corbula porcella* Dall, 1916

Dall, 1916a: 41 [*nomen nudum*]; Dall, 1916b: 415–416; Oldroyd, 1925: 204; Grant & Gale, 1931: 422 [*Corbula (Lentidium)*]; Lamy, 1941: 242 [as *C. "porcellio"*]; Hertlein & Strong, 1950: 242, 252, pl. 2, figs. 13, 15 [*Aloidis (Caryocorbula)*]; Keen, 1958: 210–211, fig. 531 [*Corbula (Caryocorbula)*]; Olsson, 1961: 430, 549, pl. 76, fig. 8 [*Caryocorbula (Caryocor-*

*bula)*]; Keen, 1971: 265–266, fig. 681 [*Corbula (Caryocorbula)*]; Coan et al., 2000: 478, pl. 102 [*Caryocorbula Corbula fragilis* Hinds, *auctt., non* Hinds, 1843 Dickerson, 1922: 563; Grant & Gale, 1931: 422 [*Corbula (Lentidium)*]

#### Type Material & Locality

USNM 97039, **lectotype here designated**, open pair; length, 7.9 mm; height, 5.2 mm; width, 4.9 mm (Fig. 10). USNM 880652, paralectotypes, 1 closed pair, 6 right valves, 8 left valves, and assorted fragments. USFC Stn. 2838, off the east side of Isla Cedros, Baja California, México (28.2°N, 115.2°W), 44 fms. [99 m], green mud; May 5, 1888.

#### Description

Shell ovate-subquadrate, of moderate thickness for size; right valve slightly more inflated than left; beaks closer to anterior end (32–34% from anterior end). Anterior end rounded. Posterior end almost vertically truncate. Posterior slope separated from central slope by a fairly strong radial ridge. Escutcheon sharply defined by a ridge.

Beaks smooth. Central slope with moderate, irregular commarginal ribs, lamellar on posterior slope; posterior end also with radial rows of pustules in many specimens.

Color white exteriorly and interiorly. Hinge plate broad; right valve with a narrow tooth; left valve a narrow, non-projecting chondrophore and a small tooth (Fig. 43). Length to 10.2 mm (MCZ 260684; S of Laguna San Ignacio, Baja California Sur).

#### Distribution & Habitat

Esteros Bay, San Luis Obispo County, California (35.4°N) (USNM 207636), to Punta Magdalena, Baja California Sur, México (24.6°N) (LACM 71-13.5), in 27 to 210 m (mean, 80.3 m;  $n = 55$ ), on mud and sand. I have seen 68 lots, including the types.

The record of *C. porcella* from Bahía Balena, Puntarenas Province, Costa Rica, by Hertlein & Strong (1950: 242) was based on specimens of *C. nasuta* (CAS 121941).

Also recorded in the late Pleistocene Miller-ton Formation at Tomales Bay, Marin County, California (Dickerson, 1922: 563, as "*C. fragilis*"—CAS Loc. 561; Valentine, 1961: 390, as "*C. fragilis*"; R. G. Johnson, 1962: 115–120; J.



FIG. 10. *Corbula porcella*, lectotype; USNM 97039; length, 7.9 mm. FIG. 11. *C. esmeralda*. FIG. 11a. Lectotype; ANSP 218903; length, 20.6 mm. FIG. 11b. Paralectotype; ANSP 403198; length, 21.9 mm.

E. Johnson, 1987: 116, as both *C. porcella* and "*C. fragilis*"). The record of this species in the Pleistocene at Bahía Magdalena, Baja California Sur, México (Loc. 754; Jordan, 1936: 111), was based instead on specimens of *C. nasuta*.

#### Discussion

*Corbula procella* may be distinguished from *C. luteola*, which is sympatric but in shallower water, in that the latter is more elongate and longer anteriorly, is frequently colored, has finer sculpture, is less inflated, has a less pronounced rib separating the central slope from the posterior slope, and has a less sharply defined escutcheon.

Hertlein & Strong (1950), followed by Soot-Ryen (1957:11),<sup>6</sup> Keen (1958, 1971), and Olsson (1961), suggested a relationship of *C. porcella* to the Panamic *C. obesa* Hinds, 1843. However, *C. obesa* is very distinct, attaining a larger size, being very inflated, having a proportionately more inflated right valve, having radial ribs on its umbones, in lacking an escutcheon, in being colored interiorly, and in having a heavier periostracum.

Specimens of the highly variable *C. nasuta* account for Panamic records of *C. porcella*. They differ as follows:

<i>C. nasuta</i>	<i>C. porcella</i>
more pointed posteroventral corner, often set off by a shallow radial sulcus just anterior to it	even, truncate posterior end
radial ridge fairly sharp all the way to ventral margin	radial ridge becoming indistinct near ventral margin
tinted yellow to brown escutcheon indistinct	white escutcheon defined by a ridge
sometime with a posterior spout	never with a posterior spout

#### Subgenus (*Hexacorbula*) Olsson, 1932

*Hexacorbula* Olsson, 1932: 140

Type species (original designation): *Corbula hexacyma* Brown & Pilsbry, 1913, = *C. gatunensis* Toulou, 1909 (references in

Discussion below). Middle Miocene, Panamá.

Medium-sized, heavy, ovate to ovate-elongate, subequivalve, subequilateral; sculpture of strong commarginal undulations.

Woodring (1982: 713) and Anderson (1996: 12) suggested that *Hexacorbula* is very similar in sculpture to *Bothrocorbula* Gabb, 1873a (p. 274, pl. 10, fig. 3, 3a); its type species, by monotypy, is *Corbula viminea* Guppy, 1866a (pp. 293, 295, pl. 18, fig. 11), from the middle Miocene of Jamaica and the Dominican Republic. *Bothrocorbula* differs from *Hexacorbula* in having a lunular pit.

*Corbula (Hexacorbula) esmeralda*  
(Olsson, 1961)  
Figures 11, 44

*Caryocorbula (Hexacorbula) esmeralda* Olsson, 1961  
Olsson, 1961: 432–433, 549, pl. 76, fig. 3-3c; Keen, 1971: 266–267, fig. 683  
[*Corbula (Hexacorbula)*]

#### Type Material & Locality

ANSP 218903, **lectotype here designated**, right valve, the specimen shown in Olsson's fig. 3a, c; length, 20.6 mm; height, 12.4 mm; width, 5.0 mm (Fig. 11a). ANSP 403198, paralectotypes—left valve, shown in Olsson's fig. 3b, length, 21.9 mm; left valve, shown in Olsson's fig. 3; length, 20.6 mm (similar to holotype in size and shape, but they are not a pair) (Fig. 11b); right valve, not figured in Olsson (1961), length, 20.3 mm. UMML 30.11326, paralectotypes, 3 right valves, 9 left valves. Esmeraldas, Esmeraldas Province, Ecuador (1.0°N); 20 ft. [5 m]; Axel A. Olsson, 1958.

Olsson (1961) illustrated an unmatched pair of valves as the "holotype", necessitating a lectotype selection.

#### Description

Shell ovate-elongate, thin in small specimens to very thick in large specimens; subequivalve; longer posteriorly (beaks at 33–39% from anterior end). Central slope with a broad radial sulcus. Posterior slope set off from central slope by a relatively sharp ridge. Escutcheon set off by a ridge.

Beaks relatively smooth, with fine commarginal ribs and still finer radial rows of pustules.

<sup>6</sup>Oddly, Soot-Ryen (1957) made *C. obesa* Hinds, 1843, a junior synonym of *C. porcella* Dall, 1916b, in reporting the latter from Panamá. His specimen was probably one of the variable *C. nasuta*.



Most of surface with broad commarginal undulations and finer commarginal ribs. Posterior slope with only fine commarginal sculpture.

Color white exteriorly and interiorly. Right valve with a large tooth; left valve with a broad chondrophore, which is not very projecting, and a small tooth (Fig. 44). Length to 22.5 mm (2.5 km S of river at Esmeraldas; Skoglund Collection).

#### Distribution

Esmeraldas, Esmeraldas Province (1.0°N) (type locality), to Chone, Bahía de Caráquez, Manabí Province (0.6°S) (USNM 709895), Ecuador, in 5–43 m (mean, 23.8; n = 4); no bottom types have been recorded. I have seen only 6 lots, including the types.

#### Discussion

*Corbula esmeralda* differs from the middle Miocene *C. (H.) gatunensis* Toulà, 1909 (p. 733, pl. 27, fig. 12), in being more elongate and in having its posterior end less set off by a sulcus. In addition to *C. hexacyma* Brown & Pilsbry, 1913 (p. 518, pl. 26, fig. 4), Woodring (1982: 714) listed *C. (Caryocorbula) buenavistana* F. Hodson, in F. Hodson & H. Hodson, 1931 (p. 24, pl. 8, fig. 6, pl. 12, figs. 8–13), from the Miocene of Venezuela as a synonym of *H. gatunensis*.

*Corbula (H.) cruziana* Olsson, 1932 (p. 141, pl. 3, fig. 5, pl. 4, fig. 9), from the early Miocene of Perú and Panamá is apparently the oldest member of this subgenus.

Subgenus (*Juliacorbula*)  
Olsson & Harbison, 1953

*Juliacorbula* Olsson & Harbison, 1953: 148–149

Type species (original designation): *Corbula cubaniana* d'Orbigny, 1853; = *C. knoxiana* C. B. Adams, 1852c; = *C. aequivalvis* Philippi, 1836 (references in Discussion below). Recent, western Atlantic.

Shell small to medium in size, heavy, subequivalve; beaks just posterior to midline; posterior end truncate; with a strong ridge between central and posterior slopes and another outlining the escutcheon. Sculpture of strong commarginal ribs in both valves.

After saying that their new genus contained "several" species, Olsson & Harbison (1953)

referred only three to it: the type species, *C. scutata* Gardner, 1944 (reference below), and the eastern Pacific *C. biradiata*; the latter was perhaps an error for *C. bicarinata*, which is very similar if not identical to the type species.

*Corbula (Juliacorbula) bicarinata*  
G. B. Sowerby I, 1833  
Figures 12, 13, 45

*Corbula bicarinata* G. B. Sowerby I, 1833

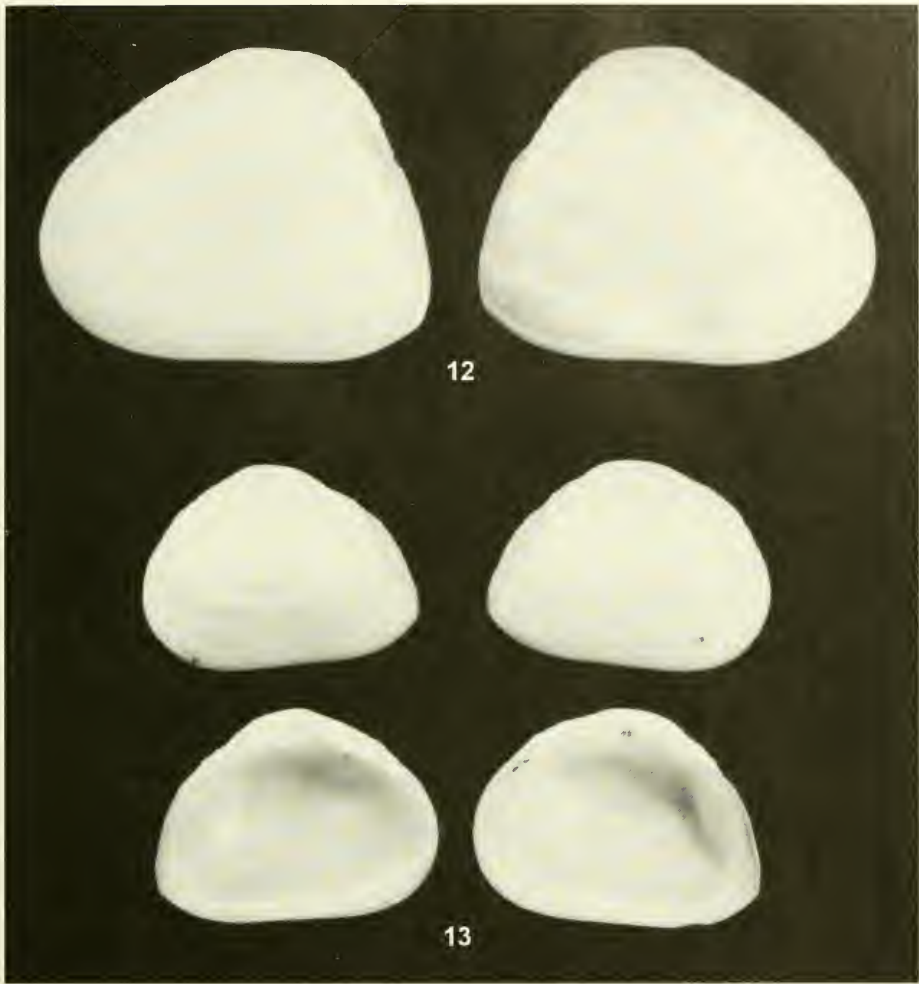
G. B. Sowerby I, 1833: 35; Hanley, 1843: 46, 6, pl. 12, fig. 31; 1856: 344; Reeve, 1844: pl. 3, fig. 23; d'Orbigny, 1845: 571; C. B. Adams, 1852a: 521 [1852b: 297]; Carpenter, 1857a: 183, 224, 228, 244, 280, 281, 300; 1857b: 21–22, 547; 1864a: 368 [1872 reprint: 204]; 1864b: 537 [1872 reprint: 23]; Tryon, 1869: 63; Lamy, 1941: 128–129; Hertlein & Strong, 1950: 238 [*Aloidis (Caryocorbula)*]; Keen, 1958: 208–209, fig. 523 [*Corbula (Caryocorbula)*]; Olsson, 1961: 436, 548, pl. 75, fig. 6–6b [*Juliacorbula*]; Keen, 1971: 266–268, fig. 684 [*Corbula (Juliacorbula)*]; Gemmell et al., 1987: 60

#### Type Material & Locality

BMNH 1966567/1, **lectotype here designated**, closed pair, the specimen figured by Reeve (1844); length, 10.6 mm; height, 8.5 mm; width, 6.6 mm (Fig. 12). BMNH 1966567/2–3, paralectotypes, 2 open pairs, lengths, 10.9, 10.5 mm. BMNH 1907.12.30.102, paralectotype, open pair, length 9.6 mm. Four localities in "Columbiae Occidentalis" [West Colombia] were given by G. B. Sowerby I—Panamá; "Real Llejós" [= Río Realejos; Corinto], Chinendega Province, Nicaragua; and "Caraccas" [Bahía Caráquez], Manabí Province, Ecuador; and Santa Elena, Guayas Province, Ecuador. Neither of the two lots in the BMNH collection has a specific locality, so the **type locality is here clarified** (ICZN Code, Recommendation 76a) as being Playa Kobbe, Panamá Province, Panamá (8.9°N), where the species is common (Skoglund Collection). A collective depth for the original material was given as 7–17 fms. [13–31 m], in sandy mud; Hugh Cuming.

#### Description

Ovate-subquadrate, moderately heavy; right valve slightly larger than left; posterior



FIGS. 12, 13. *Corbula bicarinata*. FIG. 12. Lectotype; BMNH 1966567/1; length, 10.6 mm. FIG. 13. CAS 120689; San Felipe, Baja California, México; length, 11.2 mm.

end longer (beaks at 38–40% from anterior end). Anterior end rounded; posterior end abruptly truncate. Posterior slope set off from central slope by a sharp ridge that becomes somewhat more rounded ventrally. Escutcheon set off by a similarly sharp ridge.

Beaks relatively smooth. Most of surface with moderate, rounded commarginal ribs, which continue onto posterior slope, and very fine radial striae. Escutcheon with fine commarginal ribs.

Periostracum light tan. White exteriorly; interior white to yellowish. Hinge plate narrow; right valve with a large tooth; left valve with a narrow chondrophore and a very inconspicuous tooth (Figs. 13, 45). Length to 13.0 mm

(Bahía Cholla, Puerto Peñasco, Sonora, México; Skoglund Collection).

#### Distribution

Head of the Golfo de California at Puerto Peñasco, Sonora, México (31.4°N) (Skoglund Collection; UCMP B.6008, E.8416, E.8431; LACM 60-11.33, 62-22.28, 63-56.38; SBMNH 113654), south to Zorritos, Tumbes Province, Perú (3.7°S) (UMML 30.11424); Isla Santa María, Islas Galápagos, Ecuador (LACM 32-2.4); from the intertidal zone on undersides of rocks to 110 m, in rubble (mean, 12.4 m; n = 61). I have seen 257 lots, including the types.

This species has been reported in the Pleis-

tocene at Bahía Santa Inez and Isla Carmen (Hertlein, 1957: 63), and in the Pliocene on Isla Carmen (Emerson & Hertlein, 1964: 341), Baja California Sur, México.

### Discussion

Carpenter (1857b: 547) and some other authors have synonymized *C. alba* Philippi, 1846, with this species. However, Philippi's description, together with shapes of the European fossil species with which he compared it, indicate that *C. alba* should instead be regarded as a synonym of *C. nasuta* (see Discussion under the latter).

Olsson (1961) suggested that *C. ira* Dall, 1908, described from Panamá, might be a synonym. Although superficially similar in shape, *C. ira* is longer and narrower posteriorly, there is no rib defining the escutcheon, and the commarginal ribs are fewer and much more prominent.

This species is similar to the western Atlantic type species of the subgenus, *C. aequivalvis* Philippi, 1836 (pp. 227–228, pl. 7, fig. 4), which has been reported from Florida to Panamá. Synonyms of *C. aequivalvis* include *C. knoxiana* C. B. Adams, 1852c (pp. 238–239), and *C. cubaniana* d'Orbigny, 1853 (p. 283 [Spanish ed., p. 322], pl. 26, figs. 51–54). *Corbula aequivalvis* seems to have finer commarginal sculpture than *C. bicarinata* (based on comparison with CAS 130494; Salinas Papaya, near Ensenada, southwest coast, Puerto Rico). *Corbula aequivalvis* was discussed by Jung (1969: 410–411, pl. 39, figs. 11–15) and by Anderson (1996: 17–18, pl. 2, figs. 22–26), who compared it with closely related fossil taxa, including *C. knoxiana fossilis* Pilsbry, 1922 (pp. 427, 435, pl. 46, fig. 14), from the Miocene of the Dominican Republic; *C. aequivalvis stainforthi* Rutsch, 1942 (p. 124–125, pl. 3, figs. 8, 9), from the Miocene of Trinidad; and *C. scutata* Gardner, 1944 (pp. 140–141, pl. 23, figs. 16, 30–32), from the Plio-Pleistocene of Florida and North Carolina.

Subgenus (*Panamicorbula*) Pilsbry, 1932

*Panamicorbula* Pilsbry, 1932: 105

Type species (original designation): *Potamomya inflata* C. B. Adams, 1852a; = *Corbula ventricosa* A. Adams & Reeve, 1850 (references below); tropical eastern Pacific, in mangrove swamps.

Shell large, thin in most material to thick in

largest specimens; subequivalve; beaks just anterior to midline; left valve with submarginal marginal ridges; with fine commarginal sculpture; chondrophore broad, conspicuously divided.

C. B. Adams (1852a, b) described his three synonymous taxa in the genus *Potamomya* J. de C. Sowerby, 1835 (p. 241). Its type species, by subsequent designation of Keen (1969b: 698), is *Mya plana* J. Sowerby, 1814 (pp. 173–174, pl. 76, fig. 2), from the Eocene and Oligocene of Europe. *Potamomya* is now considered to be a synonym of *Erodona* Bosc, 1801, ex Daudin ms (vol. 2:329–330, pl. 6, fig. 2) (Keen, 1969b: 698). *Erodona*, placed in its own family, the Erodonidae, within the Myoidea, is still living in brackish waters on the east coasts of Central and South America. It has a projecting chondrophore in the left valve similar to that of *Mya*. Tryon (1869) placed *Potamomya aequalis* in *Corbula* (Azara). Azara d'Orbigny, 1842 (p. 161, pl. 7), is an objective synonym of *Erodona* (Vokes, 1945: 26; Keen, 1969b: 698).

*Corbula (Panamicorbula) ventricosa*

A. Adams & Reeve, 1850

Figures 14–19, 46

*Corbula ventricosa* A. Adams & Reeve, 1850  
A. Adams & Reeve, 1850: 83, pl. 13, fig. 12; Carpenter, 1857a: 284, 300; Tryon, 1869: 66

NOT *C. ventricosa* A. Adams & Reeve, *auctt.*  
[= *C. colimensis* Coan, n. sp.]  
Hertlein & Strong, 1950: 242–243, 251, pl. 2, figs. 3, 4; Keen, 1958: 210, 211, fig. 532; Olsson, 1961: 428, 549, pl. 76, fig. 9; Keen, 1971: 266–267, fig. 682

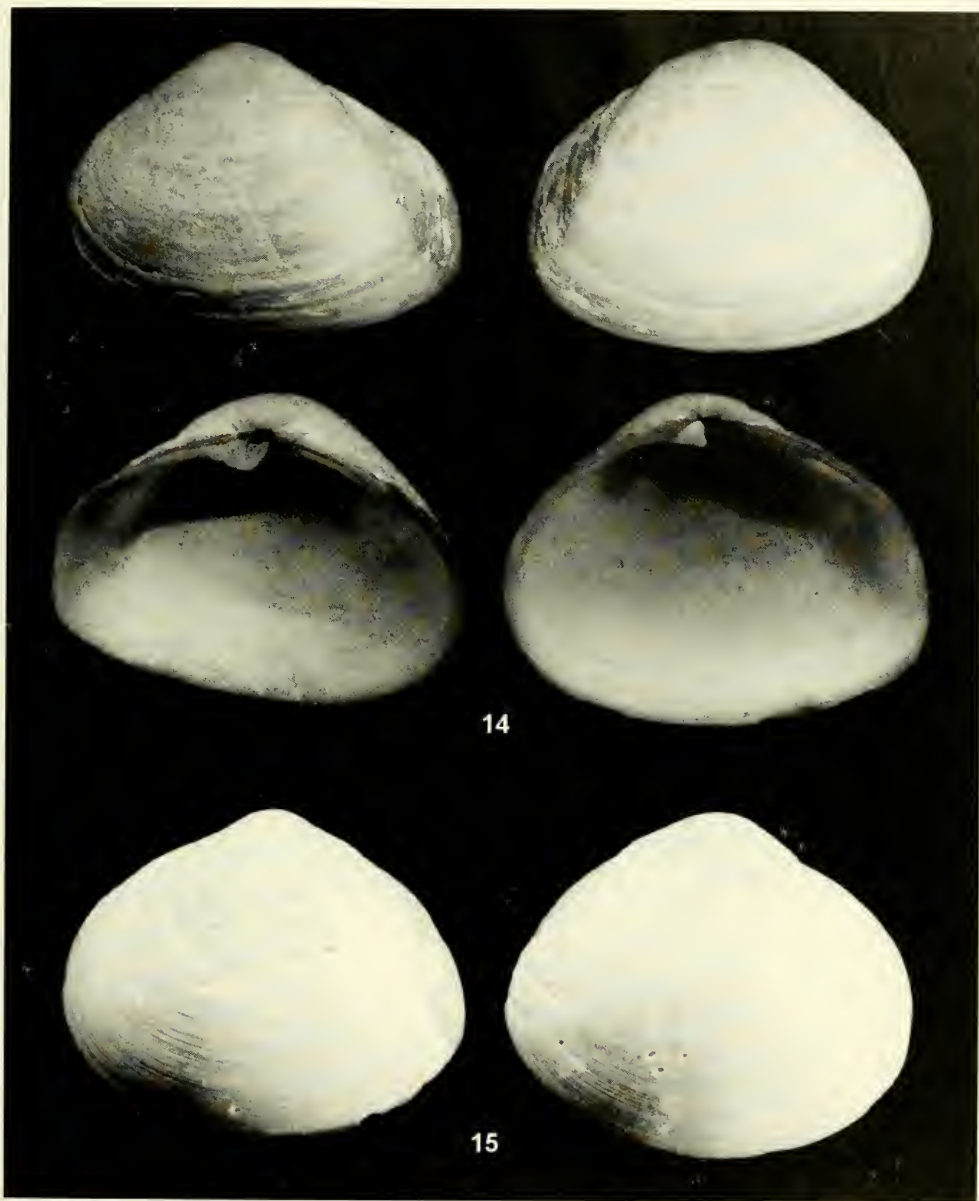
*Potamomya aequalis* C. B. Adams, 1852

C. B. Adams, 1852a: 519–520, 547–548 [1852b: 295–296, 323–324]; Carpenter, 1857a: 280, 300; 1864a: 363 [1872 reprint: 204]; Tryon, 1869: 67 [*Corbula* (Azara)]; Turner, 1956: 28, 128, pl. 19, figs. 5, 6 [*Potamomya*]; Keen, 1958: 210–211, fig. 533 [*Corbula* (*Panamicorbula*)]

*Potamomya inflata* C. B. Adams, 1852

C. B. Adams, 1852a: 520, 548 [1852b: 296, 324]; Carpenter, 1857a: 280, 300; 1864a: 363 [1872 reprint: 204] [as a junior synonym of *P. aequalis*]; Tryon, 1869: 67 [as a junior synonym of *C. aequalis*]; Pilsbry, 1932: 105 [*Corbula* (*Panamicorbula*)]; Vokes, 1945: 9, 11–12, pl. 2, figs. 1–4; Turner, 1956: 56, 126, pl. 17, figs. 12, 13 [*Potamomya*]; Keen,





FIGS. 14, 15. *Corbula ventricosa*. FIG. 14. Lectotype of *C. ventricosa*; BMNH 1967980/1; length, 22.0 mm. FIG. 15. Holotype of *Potamomya aequalis*; MCZ 186325; length, 19.4 mm.

1958: 210-211, fig. 535 [*Corbula (Panamicorbula)*]; Olsson, 1961: 434-435, 549, pl. 76, fig. 1-1c [*Panamicorbula*]; Keen, 1971: 268-269, fig. 689 [*Corbula (Panamicorbula)*]

*Potamomya trigonalis* C. B. Adams, 1852  
C. B. Adams, 1852a: 520, 548 [1852b:

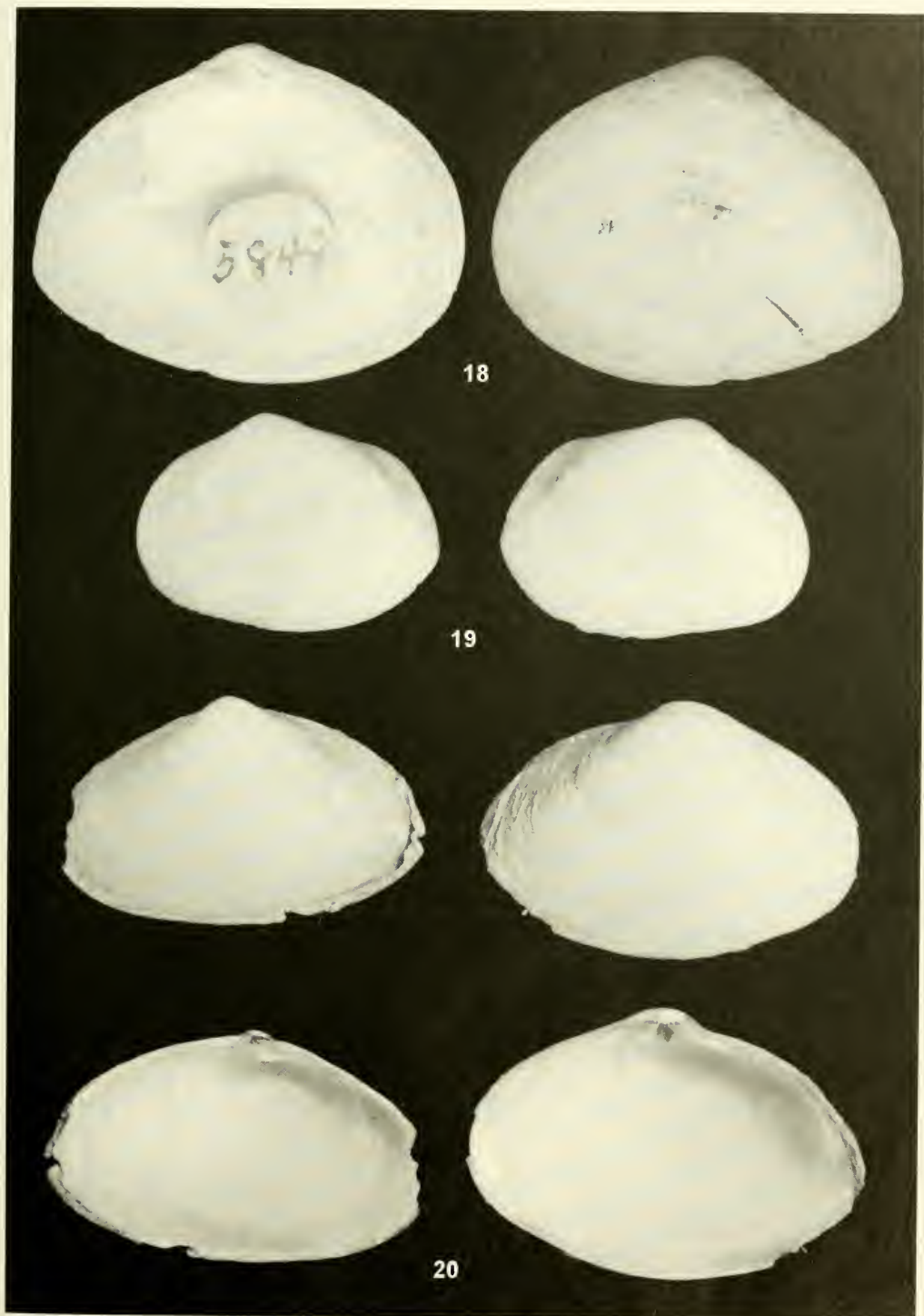
296, 324]; Carpenter, 1857a: 280, 300; 1864b: 363 [1872 reprint: 204] [as probable synonym of *P. aequalis*]; Tryon, 1869: 67 [as probable synonym of *Corbula aequalis*]; Turner, 1956: 93, 128 [*Potamomya*; as "*triagonalis*"], pl. 18, figs. 3, 4; Hoffstetter, 1952: 44, fig. 10 [*Pana-*



FIGS. 16, 17. *Corbula ventricosa*. FIG. 16. Lectotype of *Potamomya inflata*; MCZ 186315; length, 17.2 mm. FIG. 17. Lectotype of *P. trigonalis*; MCZ 186314; length, 23.8 mm.

*micorbula*]; Keen, 1958: 210–211, fig. 536 [*Corbula* (*Panamicorbula*)]  
*Corbula macdonaldi* Dall, 1912  
 Dall, 1912: 3; Dall, 1925: 15, pl. 17, figs. 1, 3 [catalogue number misquoted as

214358]; Olsson, 1961: 435 [as a synonym of *P. inflata*]  
*Panamicorbula cylindrica* Morrison, 1946  
 Morrison, 1946: 47, pl. 1, figs. 15, 17;  
 Keen, 1958: 210–211, fig. 534 [*Corbula*



FIGS. 18, 19. *Corbula ventricosa*. FIG. 18. Lectotype of *Corbula macdonaldi*; USNM 214353; length, 20.7 mm. FIG. 19. Holotype of *Panamicorbula cylindrica*; USNM 542186; length, 13.3 mm. FIG. 20. *Corbula amurensis*; CAS 089104; Martinez, Contra Costa County, California; length, 16.4 mm.



(*Panamicorbula*); Olsson, 1961: 435, 549, pl. 76, fig. 2, 2a [*Panamicorbula*]; Keen, 1971: 267–268, fig. 688 [*Corbula* (*Panamicorbula*)]

?*Corbula ustulata* Reeve, *auctt.*, *non* Reeve, 1844

Menke, 1847: 191; Carpenter, 1857a: 236; 1857b: 539

[*non* Reeve, 1844—reference in Discussion of next species]

#### Type Materials & Localities

*Corbula ventricosa*—BMNH 1967980/1, **lectotype here designated**, pair, the larger of two specimens, probably that figured by A. Adams & Reeve (1850); length, 22.0 mm; height, 16.8 mm; width, 13.6 mm (Fig. 14). BMNH 1967980/2, paralectotype, pair; length, 16.0 mm. “China Sea,” but **type locality here clarified** as the mangrove swamp at Paitilla, near Panamá City, Panamá Province, Panamá (9.0°N), where this species is known to occur (ANSP 155409).

*Potamomya aequalis*—MCZ 186325, holotype, pair; length, 19.4 mm; height, 16.5 mm; width, 10.2 mm (Fig. 15). Mangrove thicket, 2.5 miles [6.5 km] E of Panamá City, Panamá Province, Panamá (9.0°N); soft mud; C. B. Adams; 27 Nov. 1850–2 Jan. 1851.

*Potamomya inflata*—MCZ 186315, lectotype (Turner, 1956: 126), pair; length, 17.2 mm; height, 13.8 mm; width, 12.4 mm (Fig. 16). MCZ 186316, paralectotypes, 2 pairs. Same locality as *P. aequalis*.

*Potamomya trigonalis*—MCZ 186314, lectotype (Turner, 1956: 128), pair; length, 23.8 mm; height, 19.8 mm; width, 13.6 mm (Fig. 17). There are no paralectotypes in the MCZ. Same locality as *P. aequalis*.

*Corbula macdonaldi*—USNM 214353, **lectotype here designated**, the specimen figured by Dall (1925), left valve; length, 20.5 mm; height, 16.5 mm; width, 5.7 mm (Fig. 18). USNM 517479, paralectotype, right valve; length, 22.7 mm; and pair; length, 18.6 mm. “Loc. 5848; Pleistocene muck beds at Colon,” but label says “Miraflores Locks,” and Olsson (1961: 435) says “near Panama City,” Panamá Province, Panamá (9.0°N).

*Panamicorbula cylindrica*—USNM 542186, holotype, pair; length, 13.3 mm; height, 9.3 mm; width, 6.3 mm (Fig. 19). USNM 542187, paratypes: pair, length, 12.5 mm; right valve, length, 20.6 mm; broken right valve, length, approximately 21.2 mm; left valve, length, 19.3 mm. Río Marina mangrove swamp, Isla

San José, Archipiélago de las Perlas, Panamá (8.3°N); J. P. E. Morrison, 19 February 1944.

#### Description

Shell variable in shape, from ovate to trigonal, from thin- to thick-shelled; right valve slightly larger than left. Posterior end slightly longer (beaks 46% from anterior end). Anterior end rounded; posterior end obliquely subtruncate. Posterior slope set off from central slope by a low ridge, more pronounced in some specimens than in others. Escutcheon present in most specimens, set off by a slight ridge and a change in sculpture.

Anterior and posterior slopes of juvenile portion of unworn specimens with fine, regular commarginal ribs. Central and posterior slopes of larger specimens with fine, irregular commarginal sculpture and fine radial striae.

Periostracum brown to greenish, generally eroded away. White exteriorly and interiorly. Right valve with a large, triangular tooth and elongate submarginal ridges resembling lateral teeth situated well away from cardinal tooth; left valve with a large, projecting, divided chondrophore, having a moderate tooth on its posterior end; anteroventral hinge margin swollen into a small tooth medially. Pallial sinus absent (Fig. 46). Length to 35.0 mm (USNM 612203; Indian kitchen midden at Valdivia, Guayas Province, Ecuador).

#### Distribution

Medano Blanco, N of Topolobampo, Sinaloa, México (25.7°N) (Skoglund Collection), to Puerto Pizarro, Tumbes Province, Perú (3.5°S) (SBMNH 127876; UMML 30.11329, 11338). All living material has been collected from intertidal mudflats, generally in mangrove swamps. I have seen 78 lots, including the types of the various synonyms.

Parker's (1964: 162) west Mexican offshore records of *C. ventricosa* were based on specimens of *C. ira* (MCZ 260660, 260668), *C. nasuta* (MCZ 253667), and *C. porcella* (MCZ 260013, 260679, 260684).

This species was recorded as a subfossil at Laguna de Salinas, Guayas Province, Ecuador (Hoffstetter, 1952: 44, fig. 10, as “*Panamicorbula trigonalis*”).

Anderson (1996: 18–19, pl. 3, figs. 1–10) described *C. (P.) canae* from the upper Miocene Cercado Formation of the Dominican Republic. It is more rostrate and acuminate than the Recent species. She also discussed

one other possible new species from the same formation.

#### Discussion

Carpenter (1857a: 284, 300) first suggested that *Corbula ventricosa* came from the eastern Pacific. Hertlein & Strong (1950) also discussed the likelihood that the type material of *C. ventricosa* actually came from the Panamic Province, rather than the "China Sea," as originally indicated.<sup>7</sup> This lot did indeed come from the eastern Pacific, but it is not the species Hertlein & Strong thought.

Given the fact that C. B. Adams described three synonymous taxa from a single station, subsequent workers might have exercised more caution in proposing additional names without a better understanding of the variability of this species of *Corbula* (*Panamicorbula*). Although material of this species remains uncommon in most collections, because few workers have collected in mangrove swamps, abundant specimens from single stations at the Instituto Nacional de Biodiversidad (INBio) in Costa Rica clearly demonstrate that only a single taxon is present. The largest specimens tend to become trigonal. Specimens in which the ventral margin turns medially at a smaller size become inflated and more cylindrical.

#### Subgenus (*Potamocorbula*) Habe, 1955

*Potamocorbula* Habe, 1955: 272

Type species (original designation): *Corbula amurensis* Schrenck, 1861. Recent, northwestern Pacific.

Small sized, thin, subequivalve, smooth. Left valve with a more prominent radial ridge than the right valve. Left valve with a projecting chondrophore.

*Corbula* (*Potamocorbula*) *amurensis*  
Schrenck, 1861  
Figures 20, 47

*Corbula amurensis* Schrenck, 1861

Schrenck, 1861: columns 412–413;  
Schrenck, 1867: 584–586, pl. 25, figs.

<sup>7</sup>Although the *Samarang* did not stop in the eastern Pacific, the earlier *Sulphurex* expedition, on which Edward Belcher also served, did so and was probably the source of the eastern Pacific material mixed into the *Samarang* collection. This confusion is discussed by Carpenter (1857a: 224; 1864b: 534) and Hertlein & Strong (1950: 241).

5–8; Lamy, 1941: 247–248 [as *Corbula* (*Erodona*)]; Oyama, 1980: 116, pl. 55, figs. 6, 8, 10, 13 [as *Potamocorbula*]; Scarlato, 1981: 392–393, pl. figs. 415–417, text fig. 14; Zhuang & Cai, 1983: 65, fig. 12; Coan et al., 2000: 479–480, pl. 102.

*Corbula amplexa* A. Adams, 1862  
A. Adams, 1862: 223–224

*Corbula frequens* Yokoyama, 1922

Yokoyama, 1922: 123, pl. 6, figs. 16, 17

*Corbula pustulosa* Yokoyama, 1922 [non Carpenter, 1857]

Yokoyama, 1922: 123–124, pl. 6, fig. 18 [non Carpenter, 1857b: 22–23]

*Corbula sematensis* Yokoyama, 1922

Yokoyama, 1922: 124–125, pl. 6, fig. 19 [not fig. 20, which is a *Poromya* (Oyama, 1980: 120)]

*Corbula vladivostokensis* Bartsch, 1929

Bartsch, 1929: 133, pl. 2, figs. 1–7

*Corbula amurensis takatuayamaensis* Ando, 1965

Ando, 1965: 209, fig. 28

#### Type Materials & Localities

Under study in a separate project by another worker.

#### Description

Ovate, thin; right valve decidedly larger than left valve; beaks anterior to midline (approximately 41% from posterior end); anterior end sharply rounded; posterior end sharply rounded. Posterior end not set off from central slope in right valve, but set off by an angle in left valve. Escutcheon not evident.

Beaks smooth; rest of surface with low, irregular commarginal ribs. Periostracum tan. Shell white exteriorly and interiorly (Fig. 20).

Hinge plate narrow; right valve with a narrow tooth, attached to shell wall below hinge-line; left valve with a long, projecting chondrophore that is conspicuously divided, and with a very small tooth on its posterior end; anteroventral hinge margin swollen into a low tooth medially. Pallial line with a small sinus (Fig. 47). Length to 19.7 mm (CAS 121534; Carquinez Strait, San Francisco Bay, Contra Costa County, California).

#### Distribution

This introduced species is thus far found only in San Francisco Bay, California, its ecol-

ogy there discussed by Carlton et al. (1990), Nichols et al. (1990), and Duda (1994). It occurs from the intertidal zone to 8 m, on mud, sand or clay.

### Discussion

Another worker in a separate project is attempting to understand the taxonomy of the Asian species attributed to this subgenus. *Corbula laevis* Hinds, 1843 (p. 59), and *C. usutulata* Reeve, 1844 (pl. 4, fig. 25), are earlier names for members of this species complex. Resolution of this group will require access not only to the type material of the nominal species but also suites of specimens from several Asian localities to fully understand variability and distributions. Material of the San Francisco Bay import shows significant variability in shape and thickness. For example, CAS 121534 contains specimens that are ovate, subtrigonal, and ovate-elongate.

A comparison between *C. (Potamocorbula) amurensis* and *C. (Panamocorbula) ventricosa* is instructive because they both inhabit brackish waters:

<i>C. amurensis</i>	<i>C. ventricosa</i>
inequivalve	subequivalve
ovate, ovate-elongate, to subtrigonal	subquadrate
smooth, with fine posterior radials in right valve	stronger commarginal sculpture
length to 20 mm	length to 35 mm
has a small pallial sinus division between central and posterior slopes evident only in left valve	pallial sinus not evident division between central and posterior slopes in both valves
no lateral ridges on hinge	lateral ridges in right valve
tooth in right valve seated deeply under hinge plate	tooth less deeply seated
chondrophore very projecting	less projecting

### Subgenus (*Tenuicorbula*) Olsson, 1932

*Tenuicorbula* Olsson, 1932: 141

Type species (original designation): *Corbula tenuis* G. B. Sowerby I, 1833 (reference below). Recent, eastern Pacific.

Thin, subequivalve, longer posteriorly. With a strong keel separating posterior and central slopes and another keel defining a lunule. Posterior end truncate. Sculpture of fine,

raised commarginal ribs, strongest on posterior slope.

### *Corbula (Tenuicorbula) tenuis*

G. B. Sowerby I, 1833

Figs. 21, 22, 48

### *Corbula tenuis* G. B. Sowerby I, 1833

G. B. Sowerby I, 1833: 36; Hanley, 1843: 47; Reeve, 1843: pl. 2, fig. 13; C. B. Adams, 1852a: 523–524 [1852b: 299–300]; Carpenter, 1857a: 183, 228, 244, 280, 300; 1864a: 363 [1872 reprint: 204]; 1864b: 537 [1872 reprint: 23]; Tryon, 1869: 66; Lamy, 1941: 143–144; Vokes, 1945: 9, 14–15, pl. 2, figs. 10, 11; Keen, 1958: 211, fig. 538 [*Corbula (Tenuicorbula)*]; Olsson, 1961: 433–434, 550, pl. 77, fig. 3, 3a [*Tenuicorbula*]; Keen, 1971: 268–270, fig. 691 [*Corbula (Tenuicorbula)*]

### *Corbula glypta* Li, 1930

Li, 1930: 264, pl. 5, fig. 38, 38a; Pilsbry, 1931: 431 [as a synonym of *C. tenuis*]

### Type Materials & Localities

*Corbula tenuis*—BMNH 1966563, holotype, pair; length, 22.8 mm; height, 12.1 mm; width, 10.2 mm (Fig. 21). Bay of [Golfo de] Montijo, Veraguas Province, Panamá (7.7°N); 12 fms. [22 m]; Hugh Cuming.

*Corbula glypta*—AMNH 268094 [formerly Columbia University 22098], holotype, pair; length, 23.9 mm; height, 13.4 mm; width, 10.6 mm (Fig. 22). Mouth of Río Grande near La Boca, Panamá Province, Panamá (8.9°N); 10–40 ft. [3–12 m]; D. F. MacDonald, 1907. As "Miocene," but actually Recent (Pilsbry, 1931: 428, 431).

### Description

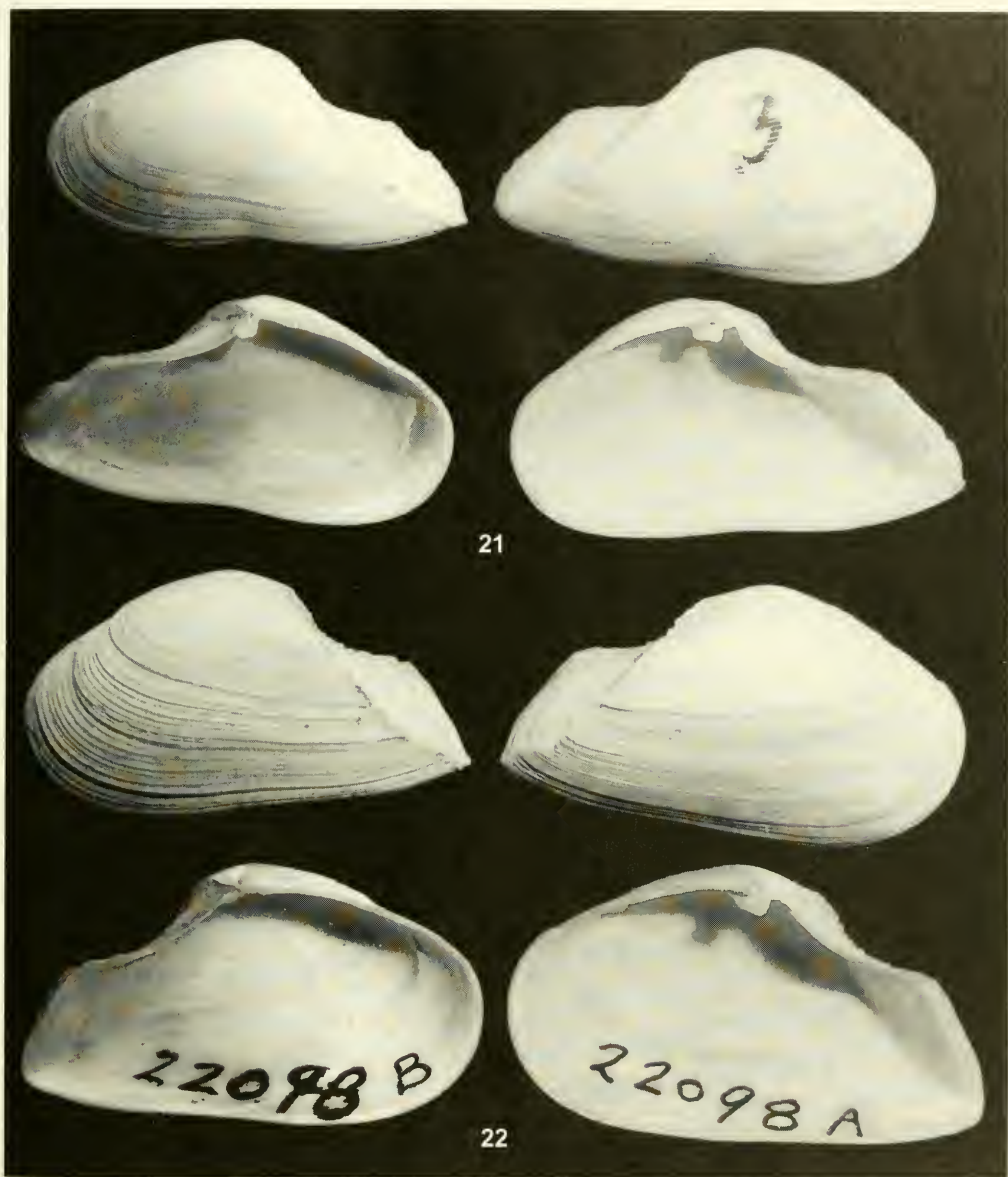
Shell elongate-subquadrate, thin, subequivalve; longer posteriorly (beaks at 40% from anterior end). Posterior end slightly tapered ventrally, truncate, sharply turned dorsally. Posterior slope set off from central slope by a carina. Escutcheon well defined by a sharp angle.

Beaks, central and posterior slopes with fine, dense commarginal ribs, strongest on posterior slope. Escutcheon much smoother.

Periostracum tan; white exteriorly and interiorly.

Right valve with a long, narrow tooth. Left valve with a projecting chondrophore; tooth





FIGS. 21, 22. *Corbula tenuis*. FIG. 21. Holotype of *C. tenuis*; BMNH 1966563; length, 22.8 mm. FIG. 22. Holotype of *C. glypta*; AMNH 268094; length, 23.9 mm.

not evident (Fig. 48). Length to 24.5 mm (Venado Beach, Panamá Province, Panamá; Skoglund Collection).

#### Distribution

Southeastern coast of Isla Tiburon, Sonora, México (28.9°N) (MCZ 319592), to Zorritos,

Tumbes Province, Perú (3.7°S) (UMML 30.11308, 11358, 11359, 11395, 11396, 11397, 11401), from the intertidal zone to 73 m (mean 12.9 m;  $n = 8$ ), on mud or sand. I have seen 30 lots, including the types.

Although Olsson (1932) mentioned a specimen from an old collection at Cornell University labeled as having come from Mazatlán,

Sinaloa, México, no specimens from north of Panamá have been collected in recent years other than the single specimen from the central Golfo de California in the MCZ cited here as the northern record (MCZ 319592).<sup>8</sup> Another specimen in the MCZ (319593) from an old collection is labeled has having come from "Margarita Bay, California," but there is no such place in California or Baja California, and this specimen may instead have come from Panamá. The record by DuShane (1962: 44) of *C. tenuis* from Puertecitos, Baja California, México, cannot be verified, because the specimen has not been located in the AMNH (J. Cordero, e-mail, 17 January 2001), the present location of the bulk of the DuShane collection.

This species has also been recorded on the Pleistocene third terrace, Peninsula de Santa Elena, Guayas Province, Ecuador (Hoffstetter, 1948: 81).

#### Discussion

*Corbula tenuis lupina* Olsson (1932: 143, pl. 14, figs. 7, 10), described from the Miocene Tumbes Formation at Quebrada Tucillal, Zorritos, Tumbes Province, Perú, was said to differ in being heavier, more narrowly elongate, and more coarsely sculptured. Jung (1965: 477, 620, pl. 62, figs. 8, 9) subsequently reported this subspecies from upper middle Miocene beds on the Paraguaná Peninsula of Venezuela, and he described the similar *Tenuicorbula melajoensis* from the late Miocene of Trinidad (Jung, 1969: 413–414, pl. 40, figs. 7–9); it was said to differ in having heavier sculpture. These fossil taxa merit comparison with *C. acutirostra* Spieker, 1922 (pp. 176–177, pl. 10, figs. 18, 19), described from the late Miocene Zorritos Formation of Perú.

Subgenus (*Varicorbula*) Grant & Gale, 1931

*Varicorbula* Grant & Gale, 1931: 420, footnote 1

Type species (original designation): *Tellina gibba* Olivi, 1792: 101. Recent, Mediterranean.

Shell of medium size, very inequivalve, with right valve larger, higher, more inflated and more rostrate. Right valve with pronounced commarginal sculpture; left valve with subdued commarginal sculpture and often with sparse radial ribs.

#### *Corbula (Varicorbula) grovesi*

Coan, new species

Figures 23, 49

#### Type Materials & Locality

LACM 2891, holotype, pair; length, 11.0 mm; height, 10.1 mm; width, 6.7 mm (Figs. 23, 50). LACM 2892, paratype, pair; length, 11.0 mm; height, 9.0 mm; width, 6.0 mm. Sal Si Puedes Basin, S end of Isla San Lorenzo, Baja California Sur, México (28.7°N, 113.0°W), in 732 m (LACM 67–135).

#### Description

Trigonal-ovate; right valve much larger than left; left valve fitting inside right valve, leaving a wide margin; subequilateral (beaks at 48% from anterior end). Anterior end rounded; posterior end narrowed, subtruncate, without a radial rib between the central and posterior slopes. Escutcheon present, but not defined by a rib.

Beaks smooth. Right valve with dense, closely set commarginal ribs. Left valve with 5–6 faint radial ribs; otherwise without sculpture.

Periostracum very thin. White externally; internally white to yellowish. Hinge plate broad; right valve with a prominent tooth; left valve with a large, vertically projecting chondrophore and a prominent, elongate tooth (Fig. 49). Length to 11.0 mm (holotype and paratype).

#### Distribution

Thus far known from only the type lot containing two pairs.

#### Etymology

This species is named for Lindsey T. Groves of the Natural History Museum of Los

<sup>8</sup>The voucher collection in the MCZ from Parker's (1964) study of the benthic fauna of the west Mexican coast was incomplete, and the labels with the remaining specimens do not always correspond to the publication. For example, the single specimen that now constitutes the northern record of this species was not cited in the report, and the only other extant Parker voucher lot labeled *C. tenuis* (his station 1) contained a mixture of *C. nasuta* (MCZ 253549) and *C. biradiata* (MCZ 320412).

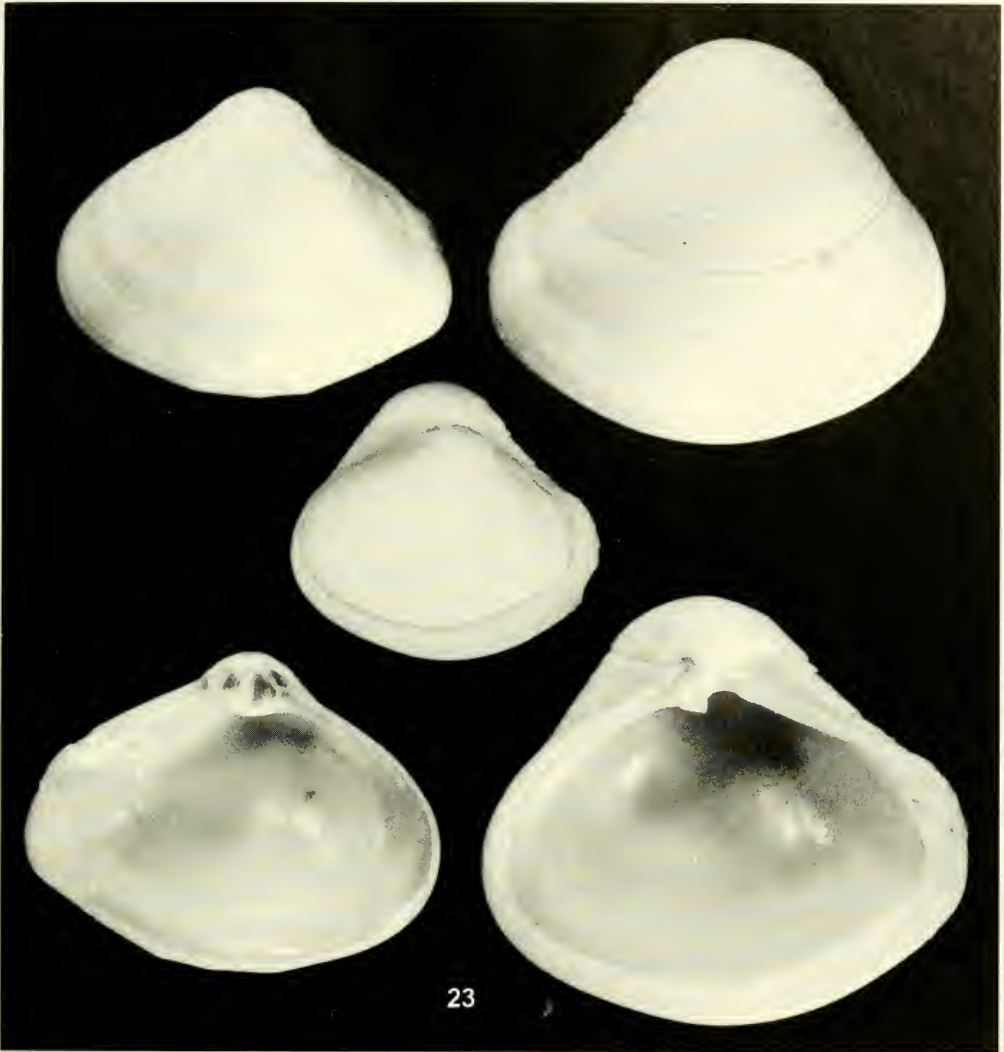


FIG. 23. *Corbula grovesi*, holotype; LACM 2891; length, 11.0 mm.

Angeles County, who has helped with this and many other projects.

#### Discussion

A similar western Atlantic Recent species is *C. operculata* Philippi, 1848 (p. 13), which occurs from North Carolina to Brazil. Synonyms of *C. operculata* include *C. krebsiana* C. B. Adams, 1852c (p. 234), *C. disparilis* d'Orbigny, 1853 (p. 283 [Spanish ed., p. 322], pl. 27, figs. 1-4), and *C. philippii* E. A. Smith, 1885 (p. 33, pl. 7, fig. 4-4b [not "pl. 8," as stated in text]). A commensal foraminiferan of

*C. operculata* was discussed by Bock & Moore (1968). *Corbula caloosae* Dall, 1898 (p. 853), 1900 (pl. 36, fig. 16), from the Plio-Pleistocene Caloosahatchee Formation of Florida, merits close comparison with *C. operculata*. The two Recent species differ as follows (based on a comparison with BMSM 15009; W of Cape Romano, Collier County, Florida; and BMSM 15011; Boca Grande, Lee County, Florida):

*grovesi*  
rounded posteriorly  
fine sculpture in left  
valve

*operculata*  
truncate posteriorly  
heavier sculpture in left  
valve



periostracum inconspicuous, transparent	periostracum shiny, light tan
right valve smooth, with fine radial rays	right valve with moderate commarginal sculpture and still finer radial rays
beaks less prominent	beaks prominent

Of Recent eastern Pacific species, *C. grovesi* is closest to *C. obesa*, differing in having a thin, transparent periostracum, being more inequivalve, in lacking radial ribs on the beaks, in having a smoother left valve with faint radial ribs, and in having a proportionately broader hinge plate in the left valve with larger teeth.

*Corbula grovesi* differs from the European type species of the subgenus *Varicorbula*—*C. gibba*—in being more triangular, less truncate posteriorly, and white in color.

There are two Pliocene species of *Corbula* (*Varicorbula*) in western North America. *Corbula gibbiformis* Grant & Gale, 1931 (pp. 420–421, 920, pl. 19, figs. 4–6), was described from the early Pliocene upper Etchegoin Formation (near lower boundary of San Joaquin Formation) at Southern California Gas Company Well 1–4 (Sec. 4, T. 28 S., R. 23 E.; approximately 35.5°N, 119.5°W), Kern County, California, at a depth of 3,951–3,952 feet. Examination of the holotype of *C. gibbiformis* (SDMNH 172, right valve; length, about 13 mm; height, about 13 mm) demonstrates that it is very different from *C. grovesi*, with heavy sculpture, bulbous, projecting beaks, and more prominent radial sculpture in the left valve. This Pliocene species is also reported from the late Pliocene San Joaquin Formation, Kettleman Hills, Kings County (Grant & Gale, 1931; Woodring, 1938: 55–56, pl. 6, figs. 8, 9; Woodring et al., 1941: opposite p. 78), the Niguel Formation, Orange County (Vedder, 1960: 326), and the San Diego Formation, San Diego County (Hertlein & Grant, 1972: 323–324, pl. 57, figs. 3, 4), California, and northwestern Baja California (Rowland, 1972:29, as *C. "gibbiformis"* (Sowerby, 1833)), and from the middle Pliocene Pico [and/or Saugus] Formations, Ventura County (Watts, in Grant & Gale, 1931; Woodring et al., in Winterer & Durham, 1962: 304–305), the Santa "Clara" [Clarita] Valley, "Ventura" [Los Angeles] County (Grant & Gale, 1931), and the East Coyote field, USGS Loc. 13873, Los Angeles Basin, Los Angeles County (Woodring, 1938; USNM 496103), California.

*Corbula* (*Varicorbula*) *granti* Olsson, 1942 (p. 197 [=45], 238 [=86], pl. 15 [=2], figs. 8, 9),

was described from the Pliocene Charco Azul Formation, Quebrada Peñitas, Burica Peninsula, Costa Rica. The type material (PRI 5505, 5506) is now missing (W. Allmon, e-mail, 11 August 2000). It has a more rostrate posterior end and heavier sculpture in the right valve than *C. grovesi*, and it has no radial sculpture on the left valve.

The Pliocene species merit further comparison with several other species from New World Pliocene, Miocene, and Oligocene strata, including *Corbula chowanensis* Bailey, 1977 (pp. 129–130), from the Pliocene of North Carolina, and *C. caloosae* Dall, 1898 (p. 853; 1900: pl. 36, fig. 16), from the Pliocene of Florida. *Corbula bradleyi* Nelson, 1870 (p. 200), from the Miocene Tumbes Formation at Zorritos, Tumbes Province, Perú, illustrated and discussed by Speiker (1922: 171–172, 196, pl. 10, figs. 13, 14), was subsequently tentatively identified from the Pliocene Charco Azul Formation at Quebrada Melissa, Burica Peninsula, Panamá (Olsson, 1942: 197–198). Other taxa include: *Corbula chipolana* Gardner, 1928 (p. 229, pl. 34, figs. 13–17); *C. chipolana carolina* Richards, 1977 (p. 33, pl. 11, figs. 34, 35); *C. waltonensis* Gardner, 1928 (p. 229, pl. 34, figs. 18–22), and *C. waltonensis rubisiniiana* Mansfield, 1932 (pp. 156–157, pl. 34, figs. 2–4), from the Miocene of Florida; *C. sanctidominici* Maury, 1925 (pp. 98–99, pl. 19, fig. 2), from the upper Miocene of the Dominican Republic; *C. vieta* Guppy, 1866b (pp. 580–581, 590, pl. 26, fig. 8), and *C. islatrinitalis* Maury, 1925 (p. 101, pl. 19, figs. 8–10), from the Miocene of Trinidad; *C. heterogena* Dall, 1898, ex Guppy ms (p. 850; 1900: pl. 36, fig. 15), from the Miocene of Panamá; *C. carrizalana* F. Hodson, in F. Hodson & H. Hodson, 1931 (p. 23–24, pl. 10, figs. 4, 6–9), from the Miocene of Venezuela; *C. prenuicia* Speiker, 1922 (p. 172, pl. 10, fig. 12), from the Miocene of Perú, and *C. zuliana* F. Hodson, in F. Hodson & H. Hodson, 1931 (pp. 22–23, pl. 10, figs. 1–3, 5), from the upper Oligocene of Venezuela. (For a discussion of some of these species: Woodring, 1982: 715–717; Anderson, 1996: 20–22). It is likely that there are fewer species than there are names.

*Corbula* (*Varicorbula*) *obesa* Hinds, 1843  
Figures 24, 25, 50

*Corbula obesa* Hinds, 1843

Hinds, 1843: 57 [1844 reprint: 230];  
Reeve, 1844: pl. 5, fig. 38 [in part; text but



FIGS. 24, 25. *Corbula obesa*. FIG. 24. Neotype of *C. obesa*; SBMNH 345495; length, 12.7 mm. FIG. 25. Figure of *C. obesa* from Hinds (1845).

not fig., which = *C. nasuta*]; Hinds, 1845: 68, pl. 20, fig. 12; C. B. Adams, 1852a: 522 [1852b: 298]; Carpenter, 1857a: 207, 280, 300; 1864a: 368 [1872 reprint: 204]; 1864b: 537, 668 [1872 reprint: 23, 154]; Tryon, 1869: 65; Oldroyd, 1925: 202 [in part]; Lamy, 1941: 133; Keen, 1958: 209, fig. 529 [*Corbula (Caryocorbula)*]; Keen, 1966: 268; Keen, 1971: 265–266, fig. 679

*Corbula nuciformis* G. B. Sowerby I, *auctt.*, non G. B. Sowerby I, 1833  
Hertlein & Strong, 1950: 241, 251, pl. 2, fig. 1; Keen, 1958: 209, fig. 528

#### Type Materials & Localities

*Corbula obesa*—SBMNH 345495, **neotype here designated**, pair; length, 12.7 mm; height, 11.0 mm; width, 9.0 mm, with dried soft parts (Figs. 24, 50). Mazatlán, Sinaloa, México (23.2°N, 106.4°W); 91–128 m; Donald R. Shasky, October 3, 1961; ex Skoglund Collection. (Other material from this station in the Skoglund and museum collections has no type status.) Two localities were originally provided for this species—San Blas, Nayarit, México (21.5°N), and Veragua[s] Province, Panamá (approximately 7.7°N); the collective

depth distribution originally given was 22–33 fms. [38–60 m], on mud; Edward Belcher. No material from either station has been located in the BMNH collection.

Workers have guessed about the identity of this species. Reeve (1844) illustrated a specimen of *C. nasuta* as *C. obesa*. Hertlein & Strong (1950), followed by Keen (1958), figured the present species as *C. nuciformis*, which is here regarded as a synonym of *C. nasuta*. Keen (1958, 1971) speculated on a possible relationship between *C. porcella* and *C. obesa*, but they are not very similar (see Discussion under *C. porcella*). A neotype is therefore necessary to stabilize nomenclature.

Hinds' description and subsequent figure (Fig. 25) are in accord with the neotype here designated, which is about twice as large as the originally measured specimen. Mazatlán is approximately 225 km north of San Blas, but this species occurs still further north.

#### Description

Shell ovate, very inflated, rotund; right valve much more inflated than left; equilateral (beaks at about 50% from anterior end). Posterior end narrow, subtruncate, only slightly extended by a spout. Posterior slope set off from central slope by a broadly rounded ridge. Escutcheon not evident.

Beaks of both valves with commarginal and radial ribs. Right valve with heavy commarginal sculpture; left valve with much finer commarginal sculpture. Periostracum heavy, light brown. Exterior surface white; interior surface white, suffused light brown; adductor muscle scars and pallial line stained brown in some. Right valve with a large tooth; left valve with a narrow, non-projecting chondrophore and a projecting ridge on its posterior end (Fig. 50). Length to 12.7 mm (neotype).

#### Distribution

Isla Espíritu Santo, Baja California Sur (25.5°N) (CAS 121638; LACM 60-6.27; SBMNH 996; Skoglund Collection), and Mazatlán, Sinaloa (23.2°N) (SBMNH 129866, 21358, 21362), México, to near Isla Coiba, Veraguas Province, Panamá (7.4°N) (Kaiser Collection); from 14–205 m depth (mean, 100.9 m;  $n = 33$ ), on mud bottoms. There is a lot in the CAS labeled as having been collected on Isla Cedros, Baja California

(28.2°N) (CAS 121638), presumably in beach drift. This locality requires further verification. I have seen 38 lots.

The record of *C. obesa* from Santa Catalina Island, California (Dall, 1921: 53), was based on specimens of *C. nasuta* (USNM 199001), and also these were probably from Isla Santa Catalina in the southern Golfo de California, a labeling error that has resulted in other mistaken Californian records of Panamic taxa.

#### Discussion

*Corbula granti* Olsson, 1942, from the Pliocene of Costa Rica, may be a synonym of *C. obesa* (reference in Discussion of *C. grovesi*). Olsson's material was admittedly worn, and the radial sculpture on the beaks may not have been visible. Short of rediscovery of the now-missing type material, topotypic specimens would be required to make a convincing case.

This species has some resemblance to *C. patagonica* d'Orbigny, 1845 (p. 570; 1847: pl. 82, figs. 18–22), which occurs from Brazil to Argentina. *Corbula patagonica* attains a larger size, has a narrower, more produced posterior end, and has less bulbous beaks that lack the prominent radial sculpture present on those of *C. obesa*. *Corbula patagonica* also has sparse radial ribs on its right valve.

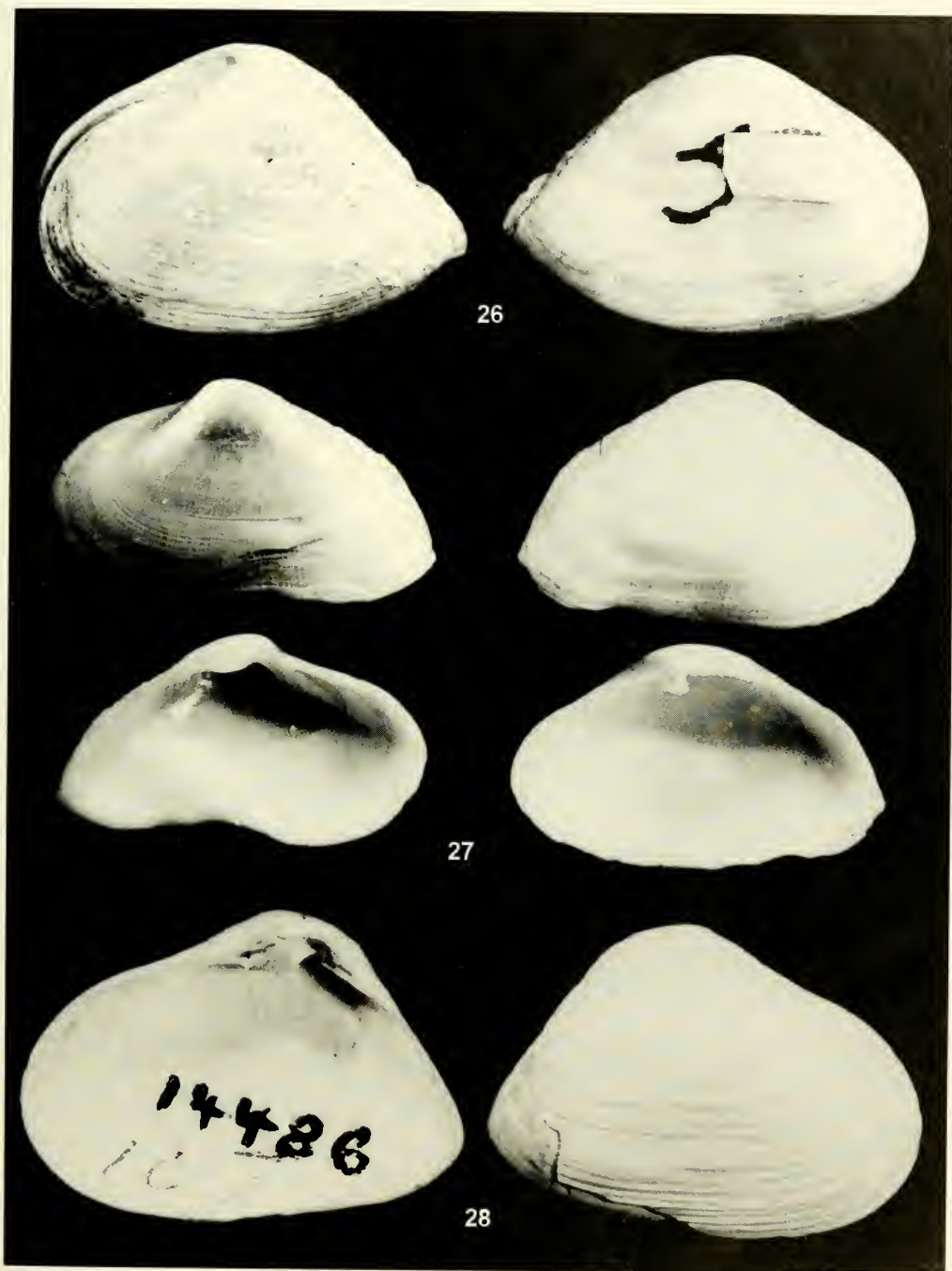
#### *Corbula, s.l.*

I am hesitant to place any of the following species in named subgenera. Much more work must be done to demonstrate true lineages within this family.

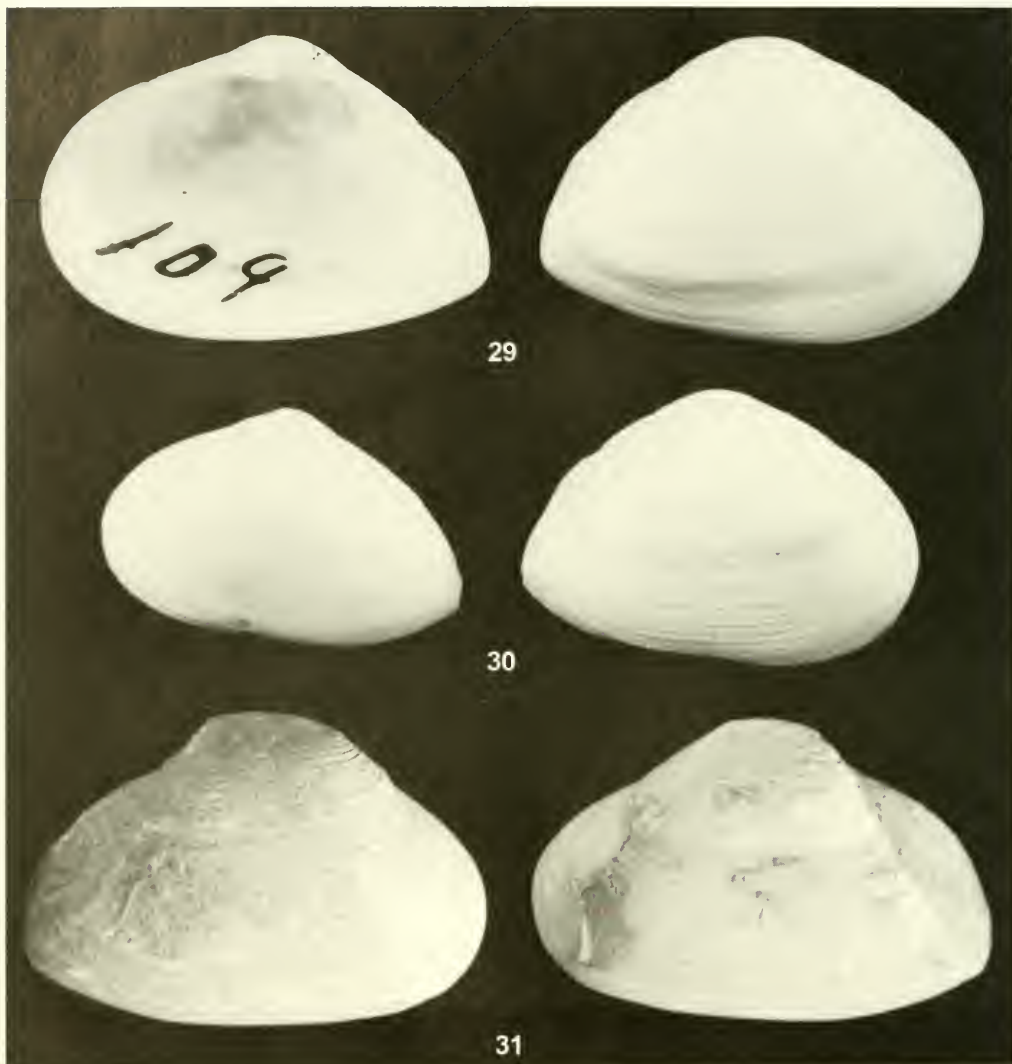
*Corbula biradiata* G. B. Sowerby I, 1833  
Fig. 26–31, 51

*Corbula biradiata* G. B. Sowerby I, 1833  
G. B. Sowerby I, 1833: 35; Hanley, 1843: 47, 4, pl. 10, fig. 51; 1856: 344; Reeve, 1843: pl. 1, fig. 3; d'Orbigny, 1845: 571; C. B. Adams, 1852a: 521–522 [1852b: 297–298]; Carpenter, 1857a: 183, 244, 280, 300; 1857b: 22; 1864a: 368, 369 [1872 reprint: 204, 205]; 1864b: 534, 537, 553, 637 [1872 reprint: 20, 23, 39, 123]; Tryon, 1869: 63; Lamy, 1941: 134; Hertlein & Strong, 1950: 238 [*Aloidis* (*Caryocorbula*)]; Keen, 1958: 208–209,





FIGS. 26-28. *Corbula biradiata*. FIG. 26. Lectotype of *C. biradiata*; BMNH 1966564/1; length, 16.2 mm. FIG. 27. Holotype of *C. rubra*; MCZ 186313; length, 12.5 mm. FIG. 28. Holotype of *C. ecuabula*; ANSP 14486; length, 16.3 mm.



FIGS. 29–31. *Corbula biradiata*. FIG. 29. Holotype of *Juliacorbula elenensis*; ANSP 218913; length, 17.0 mm. FIG. 30. Paratypes of *J. elenensis*; UMML 30.11384; lengths, 11.5 mm, 9.4 mm. FIG. 31. LACM 34-318.2; Isla La Plata, Manabí Province, Ecuador; 13–18 m; length, 12.3 mm.

fig. 524 [poor redrawing of Reeve's figure] [*Corbula (Caryocorbula)*]; Olsson, 1961: 437, 548, pl. 75, figs. 6–6b [*Juliacorbula*]; Keen, 1971: 267–268, fig. 685 [*Corbula (Juliacorbula)*]

*Corbula rubra* C. B. Adams, 1852

C. B. Adams, 1852a: 523, 548 [1852b: 299, 324]; Carpenter, 1857a: 280, 300; 1864a: 363 [1872 reprint: 204] [as a synonym of *C. biradiata*]; 1864b: 553 [1872

reprint: 39]; Turner, 1956: 82–83, 126, pl. 17, figs. 8, 9

*Corbula polychroma* Gould & Carpenter, 1857: 198–199; Carpenter, 1857a: 226, 228, 300; 1864a: 31 [1872 reprint: 205] [as a synonym of *C. biradiata*]; Carpenter, 1864b: 534, 553 [1872 reprint: 20, 39]; Palmer, 1958: 117; 1963: 318; R. I. Johnson, 1964: 129

*Corbula ecuabula* Pilsbry & Olsson, 1941

Pilsbry & Olsson, 1941: 75, 78, pl. 12, figs. 3–5; Olsson, 1961: 437 [*Juliacorbula*]

*Juliacorbula elenensis* Olsson, 1961

Olsson, 1961: 438, 550, pl. 77, fig. 5;

Keen, 1971: 267, 268, fig. 686 [*Corbula* (*Juliacorbula*)]

#### Type Materials & Localities

*Corbula biradiata*—BMNH 1966564/1, **lectotype here designated**, closed pair, numbered “5” on shell, possibly the originally measured specimen and that figured by Reeve (1843); length, 16.2 mm; height, 11.1 mm; width, 8.7 mm (Fig. 26). BMNH 1966564/2, paralectotype, open pair, length 15.2 mm. BMNH 1966564/3, paralectotype, closed pair; length, 14.7 mm; BMNH 1966564/4, open pair; length, 14.1 mm. [Golfo de] Chiriquí, Veraguas Province, Panamá (8.0°N); Hugh Cuming. BMNH 1907.12.30.118, paralectotype, open pair, that figured by Hanley (1843); length, 9.5 mm. “Bay of Caraccas” [Bahía de Caráquez], Manabí Province, Ecuador; Hugh Cuming. A collective habitat of 3–6 fms. [5–11 m], on mud and sand, was given for this species.

*Corbula rubra*—MCZ 186313, holotype, pair; length, 12.5 mm; height, 4.6 mm; width, 3.6 mm (Fig. 27). Panamá, presumably near Panamá City, Panamá Province (about 9.0°N), Panamá; C. B. Adams, 27 Nov. 1850–2 Jan. 1851.

*Corbula polychroma*—Not located. The originally cited Gould collection specimens, stated to have come from Santa Barbara, California, might be expected to be either in the MCZ or the USNM, but they have not been located. Carpenter (1864a:31) later said that these specimens probably instead came from either Acapulco, México, or Panamá. Specimens were also originally cited from the Cuming Collection obtained from the Golfo de California, and these might be expected in the BMNH, but they have not been located. The originally stated measurements were: length, 13.4 mm; height, 6.8 mm; width, 9.4 mm (height and width were probably reversed).

*Corbula ecuabula*—ANSP 14486, holotype, right valve; length, 16.3 mm; height, 11.5 mm; width, 4.2 mm (Fig. 28). ANSP 78998, paratype, left valve; length, 11.2 mm. Punta Blanca, Manabí Province, Ecuador (1.1°S); Canoa Formation, middle to late Pliocene. UMML 30.11455, paratypes, 1 right valve, 2 left valves; Puerto Callo, Manabí Province, Ecuador (1.3°S); Recent.

*Juliacorbula elenensis*—ANSP 218913, holotype, right valve; length, 17.0 mm; height, 12.0 mm; width, 4.4 mm (Fig. 29). UMML 30.11341, paratypes, 5 right valves, 1 left valve; [Salinas], Santa Elena Peninsula, Guayas Province, Ecuador (2.2°S). UMML 30.11384, paratypes, 5 right valves, 1 left valve (Fig. 30); Puerto Callo, Manabí Province, Ecuador (1.3°S). UMML 30.11456, paratype, 1 right valve; Zorritos, Tumbes Province, Perú (3.7°S)

#### Description

Ovate-elongate, thin to moderately heavy; right valve slightly larger than left; posterior end usually longer (beaks at 41–48% from anterior end), but anterior end slightly longer in some specimens (beaks at 54–55% from anterior end). Anterior end rounded; posterior end narrowed, obliquely subtruncate, extended by a small spout in some specimens; bluntly subtruncate in some specimens. Posterior slope set off from central slope by a fairly sharp ridge that continues to ventral margin. Escutcheon well defined by a ridge.

Beaks, central and posterior slopes with moderate commarginal ribs and very fine radial striae. Some material with only fine commarginal striae. Escutcheon smooth.

Exterior light tan to orange, with light radial color bands about a third of the way to ends in small specimens; ends purple. Interior reddish-brown to purple, particularly around margins, but some material nearly colorless. Hinge plate broad; right valve with a large tooth; left valve with a narrow chondrophore and a conspicuous tooth (Fig. 51). Length to 20.8 mm (Búcaro, Los Santos Province, Panamá; UMML 30.11442).

#### Distribution

El Solita, Laguna Ojo de Liebre [Scammons], Baja California (27.8°N) (SBMNH 31519); Bahía San Luis Gonzaga, Baja California (29.8°N) (LACM 40-36.5), and Isla San Jorge, Sonora (31.0°N) (Skoglund Collection), México, to Punta Peña Mala, Piura Province, Perú (4.2°S) (UMML 30.11449); Isla Santa Cruz (LACM 38-193.14) and Isla San Cristóbal (LACM 34-43.22), Islas Galápagos, Ecuador; from the intertidal zone to 57 m (mean, 7.3 m; n = 86), on mud or sand. I have seen 248 lots, including the types of the various synonyms.



This species is reported in beds of Pleistocene age at Puerto Libertad, Sonora, México (Stump, 1975: 182, 186, 193, 195), and from the Pleistocene Armuelles Formation, Burica Peninsula, Chiriquí Province, Panamá (Olsson, 1942: 162). It is also recorded from the middle to late Pliocene Canoa Formation at Punta Blanca, Manabí Province, Ecuador (Pilsbry & Olsson, 1941: 11, 75, as both *C. biradiata* and *C. ecuabula*; UMML 30.11380).

Rutten (1931: 661) reported but did not figure this species (as "cf.") from the Quaternary of Surinam, based on an unpublished thesis, a record that requires further verification.

## Discussion

I have come to the conclusion that *C. ecuabula* is inseparable from *C. biradiata*. The key feature of *Corbula ecuabula*, which Pilsbry & Olsson (1941) and Olsson (1961) also reported from the Recent fauna, was that it is significantly longer anteriorly. Olsson described the beaks of *C. ecuabula* as being in the "posterior third", but even in his type material, the beaks are only 4–5% behind the midline. Occasional specimens may be found throughout the distribution of *C. biradiata* that have a slightly longer anterior end.

I then concluded that *Juliacorbula elenensis* is also a synonym. This species was based on beach-drift material that is light in color, rounded, and with even commarginal sculpture. I have found similar material from the Golfo de California (LACM 78-30.12, from Bahía San Carlos, Sonora, and LACM 79-111.14, from Bahía de los Angeles, Baja California), and a specimen from Esmeraldas, Ecuador (UMML 30.11321), came to light with subdued sculpture in the left valve and "elenensis"-like sculpture in the right valve. An offshore specimen from Isla La Plata, Manabí Province, Ecuador (LACM 34-318.8), is thin, white, and almost equilateral (Fig. 31).

In the fossil fauna, this *Corbula biradiata* merits comparison with *C. (Caryocorbula) urumacoensis* F. Hodson, in F. Hodson & H. Hodson, 1931 (pp. 25–26, pl. 12, figs. 1–7), and *C. (C.) democraciana* F. Hodson, in F. Hodson & H. Hodson, 1931 (pp. 26–27, pl. 11, figs. 1–6), both described from the middle Miocene of Venezuela, and perhaps to *C. (C.) retusa* Gardner, 1944 (p. 140, pl. 23, figs. 33, 34) [synonym: *C. (C.) conradi* Gardner, 1944: 139–140, pl. 23, figs. 27, 28, *non* Dall, 1898], from the Pliocene of Virginia and North Car-

olina (concerning *C. retusa*: Campbell, 1993: 47–48, pl. 21, fig. 190).

## *Corbula colimensis* Coan, new species Figures 32, 52

*Corbula ventricosa* A. Adams & Reeve, *auctt.*, *non* A. Adams & Reeve, 1850  
Hertlein & Strong, 1950: 242–243, pl. 2, figs. 3, 4 [*Aloidis (Caryocorbula)*]; Keen, 1958: 210–211, fig. 532 [*Corbula (Caryocorbula)*]; Olsson, 1961: 428, 549, pl. 76, fig. 9 [*Caryocorbula (Caryocorbula)*]; Keen, 1971: 266–267, fig. 682 [*Corbula (Caryocorbula)*]

## Type Material & Locality

SBMNH 345496, holotype, pair; length, 13.7 mm; height, 9.5 mm; width, 7.7 mm (Figs. 32, 52). SBMNH 345497, paratypes, 3 closed pairs; lengths, 14.0 mm, 13.4 mm, 3.1 mm. Las Ventanas, Manzanillo, Colima, México (19.0°N, 104.3°W), 42 m; Carl & Laury Shy, 1969–1970; *ex* Skoglund Collection

## Description

Shell ovate, thin to moderate in thickness; right valve slightly larger than left; posterior end longer (beaks at 32% from anterior end). Posterior end subtruncate, extended by a short spout in some specimens; posterior slope set off from central slope by a rounded ridge. Escutcheon faint, set off by a slight ridge in right valve.

Beaks with fine commarginal ribs; most of surface with moderate commarginal ribs. Periostracum light brown. Shell white exteriorly and interiorly. Hinge plate of moderate thickness; right valve with a large tooth; left valve with a chondrophore of medium width, which is not very projecting, and a moderate tooth. Pallial sinus with a somewhat sharp bend posteriorly (Fig. 53). Length to 14.0 mm (a paratype).

## Distribution

Los Corchos, Nayarit (21.7°N) (MCZ 260451), to Bahía Tangola Tangola, Oaxaca (15.8°N) (LACM 34-240.5), México, in 29–112 m (mean, 55.9 m; n = 7), on mud bottoms. This species is thus far known from 8 lots. The lot cited by Hertlein & Strong (1950) from off

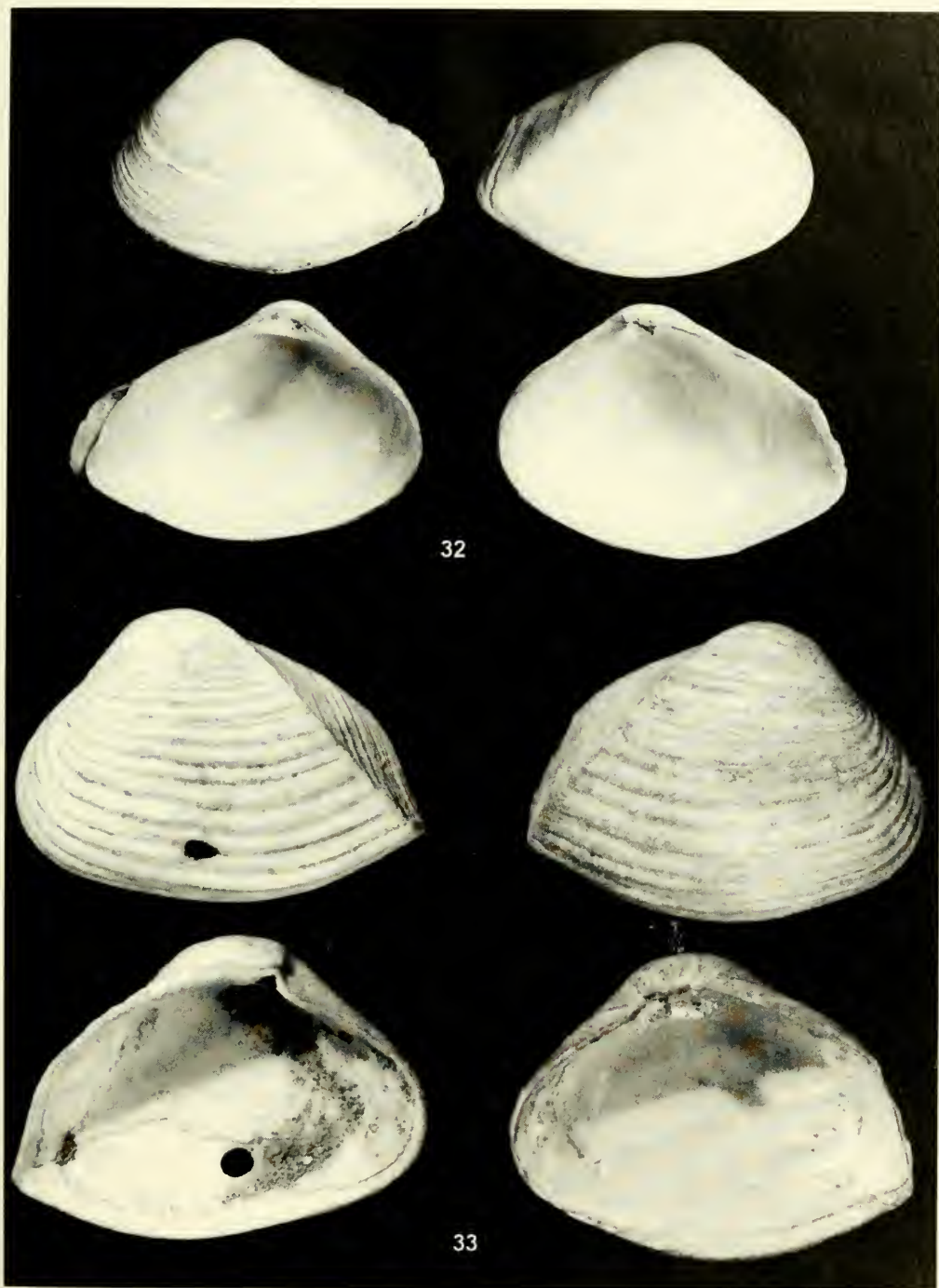


FIG. 32. *Corbula colimensis*, holotype; SBMNH 345496; length, 13.7 mm. FIG. 33. *C. ira*, lectotype; USNM 122944; length, 11.4 mm.

Bahía Tangola Tangola has not been located in the CAS or AMNH.

### Etymology

This species is named for the Mexican state of Colima.

### Discussion

*Corbula colimensis* is most similar in size, shape, and color to *C. obesa*, but the new species is equivalve, thinner, and less inflated, and it has no radial sculpture.

*Corbula ira* Dall, 1908  
Figures 33, 53

### *Corbula (Cuneocorbula) ira* Dall, 1908

Dall, 1908: 423; Lamy, 1941: 233–234; Keen, 1958: 210 [as a synonym of *C. ventricosa*]; Olsson, 1961: 436, 549, pl. 76, fig. 5 [*Juliacorbula*]; Keen, 1971: 267–268, fig. 687 [*Corbula (Juliacorbula)*]

### Type Material & Locality

USNM 122944, **lectotype here designated**, right valve; length, 11.4 mm; height, 8.6 mm; width, 3.0 mm (Fig. 33). USNM 880651, paralectotypes, 1 left valve, length, 11.8 mm (close in size to lectotype, but they are not a pair); right valve, length, 11.0 mm. *Albatross* Stn. 3355; Dall (1908), followed by other authors, reported this as “Gulf of Panamá,” but the log and map (Townsend, 1901: 412) place this station at 7.2°N, 80.9°W, just off Punta Mariato, Peninsula de Azuero, Veraguas Province, Panamá; 182 fms. [333 m], mud; Feb. 23, 1891.

### Description

Ovate-subquadrate, moderately heavy; right valve slightly larger than left; beaks closer to anterior end (beaks at 30–34% from anterior end). Ventral surface sometimes flattened. Anterior end sharply rounded. Posterior end tapered, obliquely truncate. Posterior slope set off from central slope by a sharp ridge that runs almost to ventral margin. Escutcheon defined by a ridge.

Beaks relatively smooth. Central slope with strong, rounded, shingle-like commarginal ribs and very fine radial ribs. Posterior slope with finer commarginal ribs.

Periostracum tan. Exterior white; interior white, sometimes suffused with purple or brown. Hinge plate broad; right valve with a large tooth; left valve with a very small chondrophore and a small tooth (Fig. 53). Length to 13.6 mm (USNM 810921; Cabo Lobos, Sonora, México).

### Distribution & Habitat

Cabo Lobos, Sonora (29.9°N) (USNM 212797; MCZ 260668), and Bahía San Luis Gonzaga, Baja California (29.8°N) (LACM 37-199.10, 40-36.6), México, to Callao, Lima Province, Perú (12.1°S) (LACM 35-153.2, 35-177.3); Isla del Coco, Costa Rica (SBMNH 345530), from 15 to 388 m (mean, 98.4 m; n = 60), on sand and mud. I have seen 85 lots, including the types.

### Discussion

This species can be distinguished from *C. marmorata* of similar size in being more quadrate and elongate, more truncate posteriorly, with a stronger radial rib, and commarginal ribs that are higher and narrower. It may also become ventrally flattened, as in *C. nasuta*, which is never true of *C. marmorata*.

*Corbula luteola* Carpenter, 1864  
Figures 34, 35, 54

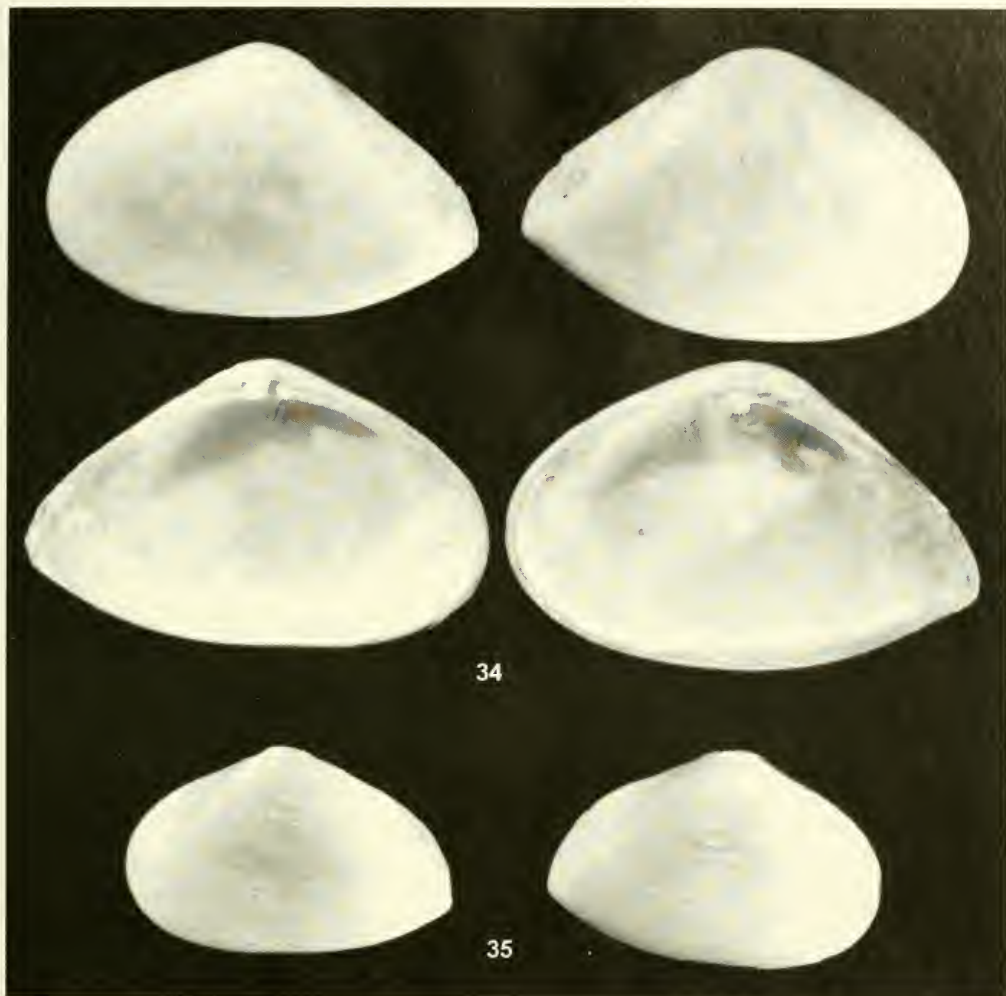
### *Corbula luteola* Carpenter, 1864

Carpenter, 1864b: 611, 637 [1872 reprint: 97, 123]; 1865: 207; Tryon, 1869: 65; Arnold, 1903: 181, pl. 17, fig. 11 [a poor figure]; Oldroyd, 1925: 203; Grant & Gale, 1931: 421–422, 920, pl. 19, figs. 2, 7 [*Corbula (Lentidium)*]; Lamy, 1941: 240–241 [*Corbula (Corbuloyma)*]; Hertlein & Strong, 1950: 239 [*Aloidis (Caryocorbula)*]; Keen, 1958: 209 [in part; not fig. 525, which = *C. marmorata*] [*Corbula (Caryocorbula)*]; Palmer, 1958: 117–118, 340, pl. 15, fig. 13–18 [*Corbula (Lentidium)*]; Keen, 1971: 264 [in part; not fig. 675, which = *C. marmorata*] [*Corbula (Caryocorbula)*]; Hertlein & Grant, 1972: 324–325, pl. 55, figs. 1, 2, 5, 6, 15 [*Corbula (Lentidium)*]; Coan et al., 2000: 479, pl. 102 [*Juliacorbula*]

*Corbula luteola rosea* Williamson, 1905, *non* T. Brown, 1843 (or earlier), *non* Reeve, 1844

Williamson, 1905: 120; Coan, 1989: 298





FIGS. 34, 35. *Corbula luteola*. FIG. 34. Lectotype of *C. luteola*; USNM 14897; length, 10.2 mm. FIG. 35. Holotype of *C. luteola rosea*; LACM 1421; length, 7.0 mm.

[as a synonym of *C. luteola*] [*non Corbula rosea* T. Brown, 1843 (or earlier): 105, pl. 42, fig. 6; *non Corbula rosea* Reeve, 1844: pl. 5, fig. 26]

#### Type Materials & Localities

*Corbula luteola*—USNM 14897, **lectotype here designated**, the largest pair, closest to Carpenter's (1865) measurement; length, 10.2 mm; height, 6.8 mm; width, 4.5 mm (Fig. 34). USNM 880650, paralectotypes: pair, length, 8.4 mm (the specimen figured by Palmer, 1958); right valve, length, 8.3 mm; left valve, length 5.9 mm; pair, length, 5.7 mm.

San Pedro, Los Angeles County, California (33.7°N); James G. Cooper. (Evidently, at some point in the past, USNM 15668 had been combined into this lot, because this number is written on the back of the label.) USNM 73457, paralectotypes, 1 right valve, 1 left valve; San Diego, San Diego County, California (32.7°N); James G. Cooper. Lots in other collections from Cooper material are not types, because they were not studied by Carpenter.

*Corbula luteola rosea* Williamson—LACM 1421, holotype, pair; length, 7.0 mm; height 4.6 mm; width, 2.3 mm (Fig. 35). Terminal Island, San Pedro, California (33.7°N); on an

anemone in a rock pool on the old breakwater; Martha Burton Williamson. The original description specified a single valve, but what is in the type lot is a matched pair of valves.

### Description

Shell ovate, solid; right valve slightly larger than left; posterior end longer (approximately 42–48% from anterior end). Posterior end vertically truncate. Posterior slope set off from central slope by a rounded ridge that becomes obsolete ventrally. Escutcheon evident but not sharply defined.

Beaks, central and posterior slopes with fine commarginal sculpture.

Exterior white or pink, sometimes with purple patches on either side of beaks. Interior white or tan. Hinge plate relatively narrow; right valve with a triangular tooth; left valve with relatively broad chondrophore and a small tooth (Fig. 54). Length to 10V.2 mm (holotype; CAS 121848; Point Loma, San Diego County, California).

### Distribution

Monterey, Monterey County, California, U.S.A. (36.7°N) (CAS 121792), possibly a result of larval settlement in an El Niño year; Topanga Creek, Los Angeles County, California (33.7°N) (LACM 68-192.21), south to Bahía Magdalena, Baja California Sur (CAS 121791; USNM 217823; Skoglund Collection); from the intertidal zone to 80 m (mean, 16.1 m;  $n = 47$ ), in rubble. I have seen 157 Recent lots, including the types.

Records of this species from the Golfo de California were based on misidentified *C. marmorata*, or, in the case of Parker (1964: 161), *C. nasuta* (MCZ 253667, 259948, 260263) and *C. ira* (MCZ 260703).

This species has been widely reported as a fossil in California and Baja California. In the late Pleistocene, there are records from terraces on Santa Rosa Island, Channel Islands, Santa Barbara County (A. G. Smith, in Orr, 1960: 1117, A. G. Smith, 1968: 22); Playa del Rey (Willett, 1937: 391), the Baldwin Hills (B. L. Burch, 1947: 9), terraces in the Palos Verdes Hills (Chace, 1966: 169; Marincovich, 1976: 20), San Pedro (DeLong, 1941: opposite p. 244; Valentine, 1961: 375, 376, 377), Huntington Beach (Valentine, 1959: 54), Los Angeles County; Newport Bay, Orange County (Kanakoff & Emerson, 1959: 22); San

Diego, San Diego County (Dall, 1878a: 11, 1878b: 27; Emerson & Chace, 1959: 338; Valentine, 1961: 357; Valentine & Meade, 1961: 10; Kern et al., 1971: 333), California; northwestern Baja California (Valentine, 1957: 297; Valentine & Rowland, 1969: 518); Bahía San Quintín (Dall, in Orcutt, 1921: 24; Jordan, 1926: 245; Manger, 1934: 293), Baja California; Laguna San Ignacio (Hertlein, 1934: 64), Bahía San Bartolomé [Turtle Bay] (Emerson, 1980: 72; Emerson et al., 1981: 111), and Bahía Magdalena (Jordan, 1936: 111), Baja California Sur. Records of this species from the Pleistocene of the southern Golfo de California (Durham, 1950) were based on specimens of *C. marmorata* (see under the latter).

It has been recorded in strata of early Pleistocene age in Santa Monica (Woodring, in Hoots, 1931: 121; Valentine, 1956: 196; Rodda, 1957: 2484) and San Pedro (DeLong, 1941: opposite p. 244), Los Angeles County, California.

Cooper, in Watts (1897: 79) and Woodring, in Hoots (1931: 116) reported this species from late Pliocene strata in Los Angeles County, and Hertlein & Grant (1972: see synonymy) reported it from the late Pliocene San Diego Formation, San Diego County, California. There is a record in the early Pliocene Towsley Formation of Los Angeles County, California (Woodring, in Winterer & Durham, 1962: 304–305).

There are also records from the late Miocene Santa Margarita Formation (Gale, in Preston, 1931: 15) of central California, the late Miocene Castaic Formation of southern California (Stanton, 1966: 23), from the early to middle Miocene Temblor Formation (Adegoke, 1969: 153) of central California, and from the Miocene Isidro Formation near Bahía Magdalena, Baja California Sur (Beal, 1948: 66).

### Discussion

This species is most similar to *C. marmorata*, which accounts for Panamic records of *C. luteola*. The two differ as follows:

<i>C. luteola</i>	<i>C. marmorata</i>
oval	pointed posteroventrally
larger (to 10.2 mm)	smaller (to 8.2 mm)
beaks closer to midline	longer posteriorly
solid color	mottled color
without a medial sulcus	with a medial sulcus
radial ridge becomes	radial ridge strong to
obscure ventrally	ventral margin
chondrophore larger	chondrophore smaller

hinge plate narrower at same size	wider hinge plate
finer, sharper sculpture	heavier, more undulating sculpture
beaks sculptured	beaks less sculptured

For comparison with the sympatric *C. porcella*, see under the latter.

Of the western Atlantic taxa, *C. luteola* is most similar to *C. contracta* Say, 1822 (p. 312), differing from it in being more inflated, having a much more prominent ridge between the central and posterior slopes, and having more lamellar sculpture, which extends onto the beaks.

*Corbula marmorata* Hinds, 1843  
Figures 36, 37, 55

*Corbula marmorata* Hinds, 1843

Hinds, 1843: 58 [1844 reprint: 231]; Reeve, 1844: pl. 5, fig. 39; Hinds, 1845: 69, pl. 20, fig. 13; Carpenter, 1857a: 207, 300; Tryon, 1869: 65; Lamy, 1941: 133–134; Hertlein & Strong, 1950: 239–240, 252, pl. 2, fig. 17 [*Aloidis* (*Caryocorbula*)]; Keen, 1958: 209, fig. 526 [*Corbula* (*Caryocorbula*)]; Olsson, 1961: 431–432, 548, pl. 75, fig. 5 [*Caryocorbula* (*Caryocorbula*)]; Keen, 1966: 268 [*Corbula*]; Keen, 1971: 264–265, fig. 676 [*Corbula* (*Caryocorbula*)]; Gemmell et al., 1987: 58–59 [*Corbula*]

*Corbula luteola* Carpenter, *auctt.*, non Carpenter, 1864

Durham, 1950: 94, 170, pl. 25, figs. 15, 16; Keen, 1958: 209, fig. 525 [Panamic records and the fig.]; Keen, 1971: 265, fig. 675 [Panamic records and the fig.]

Type Material & Locality

Not located in the BMNH collection (Keen, 1966). The description and Hinds' subsequent figure, however, are sufficiently clear and unambiguous that a neotype is not required. A copy of the figure from Hinds (1845) is given here (Fig. 36). The originally measured specimen was 4.2 mm in length, 2.8 mm in height, and 2.1 mm in width. Veragua[s] Province, Panamá (approximately 7.7°N); 26 fms. [48 m], mud; Edward Belcher.

Description

Shell ovate-subquadrate, moderately heavy for size; right valve slightly larger than left; beaks in anterior third of shell (beaks

28–36% from anterior end). Anterior end rounded. Shallow medial radial sulcus present. Posterior end truncate, pointed posteroventrally. Posterior slope set off from central slope by a radial ridge that runs to ventral margin. Escutcheon evident, narrow, strongest in right valve.

Beaks relatively smooth; central slope with moderate, undulating commarginal ribs. Sculpture more lamellar on posterior slope. Exterior white, brown, or red, mottled with magenta or white, and with a magenta patch anterior to beaks. Interior magenta, particularly around margins. Right valve with a triangular tooth; ligament under valve margin. Left valve with a narrow chondrophore; tooth small (Figs. 37, 55). Length to 8.2 mm (Bahía Cholla, Sonora, México; Skoglund Collection).

Distribution

Bahía Magdalena, Baja California Sur (24.6°N) (CAS 121641; LACM 67-70.26), and throughout the Golfo de California to its head at Puerto Peñasco, Sonora (31.4°N) (UCMP E.8419; CAS 121646; Skoglund Collection), México, south to Callao, Lima Province, Perú (12.1°S) (LACM 35-153.3). This species also occurs in the western Atlantic, where specimens are sometimes labeled as *C. blandiana* C. B. Adams, 1852, which is a synonym of *C. dietziana* C. B. Adams, 1852 (see Discussion under *C. speciosa*), as *C. barrattiana* C. B. Adams, 1852, a synonym of *C. swiftiana* C. B. Adams, 1852 (see Discussion under *C. nasuta*), or *C. contracta* Say, 1822 (p. 312), a distinct, uncolored, more inflated, more heavily sculptured species that occurs as far north as New England. *Corbula marmorata* occurs from the intertidal zone to 137 m (mean, 19.9 m; n = 115), in rubble and on the undersides of rocks. I have seen 299 eastern Pacific lots.

The record of this species from the Galapagos Islands (Kaiser, 1997: 25) was based on a specimen of *C. bicarinata* (LACM 34-43).

Also present in the Pleistocene at Bahía Santa Inez, Baja California Sur, México (Durham, 1950: 94, as "*C. luteola*").

Discussion

*Corbula marmorata* sometimes occurs at the same stations as *C. speciosa*. Small specimens of the latter are similar to *C. marmorata* in having a mottled color pattern and a purple patch in front of the beaks. In specimens of





FIGS. 36, 37. *Corbula marmorata*. FIG. 36. Figure of *C. marmorata* from Hinds (1845). FIG. 37. SBMNH 345499; Bahía Cholla, Sonora, México; length, 6.8 mm. FIG. 38. *C. speciosa*, lectotype; BMNH 1967945/1; length, 19.7 mm.

similar size, *C. speciosa* is more elongate; longer, broader, and more truncate posteriorly; has a stronger rib separating the central from the posterior slope; has a more pronounced medial radial sulcus; and the posterodorsal margin is more elevated and flange-like.

Species that are possibly ancestral to *C. marmorata* include: *C. engonata burnsii* Dall, 1898 (p. 847), *C. (Caryocorbula) franci* Gardner, 1928 (pp. 231–232, pl. 35, figs. 1–4), *C. (C.) wakullensis* Gardner, 1928 (p. 232, pl. 35, figs. 5, 6), and *C. barrattiana leonensis* Mansfield, 1932 (p. 160, pl. 33, figs. 1, 3), from the Miocene of Florida, and *C. cuneata* Say, 1824 (pp. 152–153, pl. 13, fig. 3), from the Pliocene of Maryland and Virginia.

*Corbula speciosa* G. B. Sowerby I, 1833  
Figures 38, 56

*Corbula radiata* G. B. Sowerby I, 1833, *non*  
Deshayes, 1824  
G. B. Sowerby I, 1833: 36; Hanley, 1843:  
47  
[*non* Deshayes, 1824: 58–59, pl. 9, figs.  
11, 12<sup>9</sup>]

*Corbula speciosa* Reeve, 1843  
Reeve, 1843 (Aug.): pl. 1, fig. 6; Hinds,  
1843 (Nov.): 57 [1844 reprint: 230];  
Hinds, 1845: 68–69, pl. 20, figs. 7, 8;  
Carpenter, 1857a: 207, 300; Tryon, 1869:  
66; Lamy, 1941: 133; Hertlein & Strong,  
1950: 237 [*Aloidis (Aloidis)*]; Keen, 1958:  
208–209, fig. 522 [*Corbula (Corbula)*];  
Olsson, 1961: 438–439, 550, pl. 77, fig.  
7–7c [*Varicorbula*]; Keen, 1971: 269–  
270, fig. 692 [*Corbula (Varicorbula)*]

#### Type Materials & Localities

*Corbula radiata*—Not located in the BMNH. The original measurements were: length, 8.9 mm; height, 6.3 mm; width, 4.3 mm. Acapulco, Guerrero, México (16.9°N); Hugh Cuming.

*Corbula speciosa*—BMNH 1967945/1, **lectotype here designated**, the largest specimen and closest to Reeve's figure; length, 19.7 mm; height, 15.4 mm; width, 11.6 mm (Fig. 38). BMNH 1967945/2, paralectotype, left valve; length, 18.4 mm. BMNH 1967945/3, paralectotype, left valve; length, 15.3 mm. Golfo de Nicoya, Costa Rica (approximately 9.9°N); Edward Belcher. BMNH 1879.2.26.91,

pair; length, 17.8 mm. Panamá, 6 fms. [11 m], mud; Edward Belcher. The latter seems to be the specimen figured in Hinds (1845), but material from Panamá was not mentioned by Reeve (1843), who made the name available three months before Hinds.

#### Description

Shell subtrigonal as an adult, heavy; right valve much larger than left, very inflated. Posterior end truncate. Posterior slope set off from central slope by a rounded ridge. Escutcheon apparent in some specimens only.

Juvenile shell set off by a remarkable change in growth direction, shape, sculpture, and color. Subquadrate juvenile shell flattened, with commarginal undulations, a medial radial sulcus, fine radial ribs, and a mottled color pattern.

Right valve of adult with commarginal undulations; left valve with finer, lamellar, somewhat oblique sculpture. Exterior color of reddish-brown radial ribs. Periostracum light to dark brown. Interior white to yellowish, with red ribs visible ventrally. Right valve with a large tooth; left valve with a small, non-projecting chondrophore, with the ligament confined to a small area medial to a large posterior cardinal (Fig. 56). Length to 20.6 mm (Bahía Tenacatita, Jalisco, México; LACM 34-146.14).

#### Distribution

San Felipe, Baja California (31.0°N) (LACM 40-279.3), and Isla Tiburon, Sonora (LACM 36-80.45) (28.7°N), México, to Punta Utria, Choco Province, Colombia (6.0°N) (LACM 35-63.18, 35-170.7); Isla Socorro, Islas Revilagigedo, México (LACM 34-5.17; Kaiser collection); from the intertidal zone to 125 m (mean, 40.2 m; n = 98), on sand or gravel, or in rubble. I have seen 137 lots, including the types.

This species has been reported in late Miocene deposits of the Imperial Formation in Riverside County, California (Powell, 1988: 16).

#### Discussion

This species is very similar and perhaps identical to the later-named western Atlantic *C. dietziana* C. B. Adams, 1852c (pp. 235–236), which occurs from North Carolina to Brazil. Synonyms of *C. dietziana* include *C.*

<sup>9</sup>Not in Brocchi (1814), as Reeve (1843) claimed. Deshayes' species is a *Cardiomya*.

*blandiana* C. B. Adams, 1852c (pp. 234–235), and *C. cymella* Dall, 1881 (p. 115) (based on comparison with BMSM 15012; Boca Grande, Lee County, Florida).

Small specimens of *Corbula speciosa* can be distinguished from *C. ira*, with which it sometimes occurs, by its more quadrate outline, longer posterior end, mottled color, less prominent sculpture, and medial radial sulcus.

Some authors have placed this species in the subgenus *Varicorbula* because it is inequivalve, but I think that this allocation is premature. *Corbula speciosa* differs from other species of *Varicorbula* in having a highly differentiated juvenile shell. Indeed, in several respects small specimens of *C. speciosa* are closest to *C. marmorata* (for a comparison, see Discussion under *C. marmorata*).

#### ADDITIONAL NOTES & RECORDS

*Corbula altirostris* Li, 1930 (pp. 263–264, pl. 5, fig. 37), supposedly from an offshore outcrop of the Miocene Gatun Formation in the Bay of Panamá, was based on a Recent specimen of the mactrid *Mulinia pallida* (Broderip & Sowerby, 1829: 360, as *Mactra*) (Pilsbry, 1931: 431).

Carpenter (1857a: 300; 1860: 2) listed a *Corbula bovinei*, without authorship, from Central America. This is a *nomen nudum*.

The record of "*Corbula cf. collazica* Maury," 1920 (pp. 44–45, pl. 6, figs. 10, 11), supposedly from an offshore outcrop of the Gatun Formation in the Bay of Panamá (Li, 1930: 263, pl. 5, fig. 36, 36a), was actually based on a Recent specimen of *Corbula ovulata*, according to Pilsbry (1931: 431).

*Corbula gibbosa* Broderip & Sowerby, 1829 (p. 361), from the Arctic coast of Alaska, is a probable synonym of *Mya truncata* Linnaeus, 1758 (p. 670) (Coan et al., 2000: 471).

*Corbula kelseyi* Dall, 1916b (p. 416; Dall, 1916a: 41, *nomen nudum*), was based on a worn specimen of *Cumingia californica* Conrad, 1837: 234 (Coan & Scott, 1991; Coan et al., 2000: 437, 478).

The record of "*Corbula cf. swiftiana* C. B. Adams," 1852c (pp. 236–237), supposedly from an offshore outcrop of the Gatun Formation in the Bay of Panamá (Li, 1930: 264, pl. 5, fig. 39), was based on a Recent specimen of the mactrid *Mulinia pallida* (Broderip & Sowerby, 1829) (Pilsbry, 1931: 431).

*Corbula tenuis* Moody, 1916 (pp. 59, 62, pl. 2, fig. 4a, 4b), *non* G. B. Sowerby I, 1833, = *C. binominata* Hanna, 1924 (p. 163), from the

Pliocene Fernando Formation in downtown Los Angeles, California [holotype: UCMP 11087; Loc. 3030], is not a corbulid. Although broken and partially sediment- and glue-filled, the holotype seems to be a poromyid, closest and probably identical to the Recent *Dermatomya mactrioides* (Dall, 1889a: 448, as *Poromya (Dermatomya)*); Coan et al. (2000: 572) treated this *Dermatomya*. *Corbula binominata* was also later recorded from the Pliocene of the Los Angeles Basin by Soper & Grant (1932: 1060).

#### NOTE ADDED IN PROOF

A paper has recently appeared that sheds new light on the western Atlantic species of *Corbula (Varicorbula)* (Mikkelsen & Bieler, 2001). Using *Varicorbula* as a full genus, they adopt the traditional early dates of d'Orbigny's species of *Corbula*, with the result that *V. disparalis* (d'Orbigny, 1842) is regarded as the valid name for the species closest to *Corbula (Varicorbula) grovesi* named here. A synonym that I had not noted, *Corbula limatula* Conrad, 1846 (p. 25, pl. 1, fig. 2), would be the valid name if the dates of d'Orbigny are as late as I now think. They regard *Corbula operculata* Philippi, 1848, the name I used for this species, as a *nomen dubium*, because of the absence of type material. Clearly, reaching a definitive conclusion about the dates of the all-important d'Orbigny work should be a high priority for workers on the western Atlantic fauna.

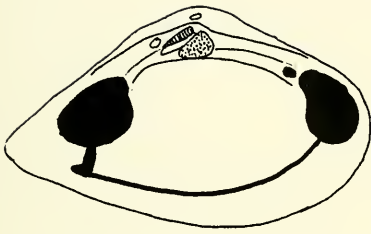
CONRAD, T. A., 1846, Descriptions of new species of fossil and Recent shells and corals. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 3(1): 19–27, pl. 1

MIKKELSEN, P. M. & R. BIELER, 2001, *Varicorbula* (Bivalvia: Corbulidae) of the western Atlantic: taxonomy, anatomy, life habits, and distribution. *The Veliger*, 44(3): 271–293

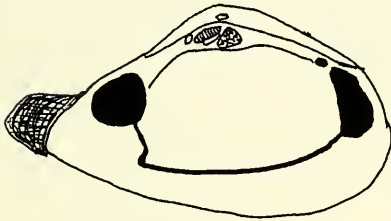
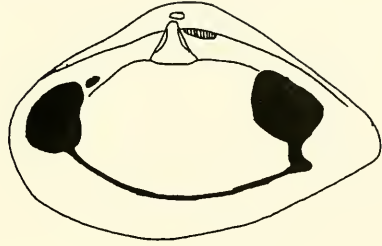
#### ACKNOWLEDGMENTS

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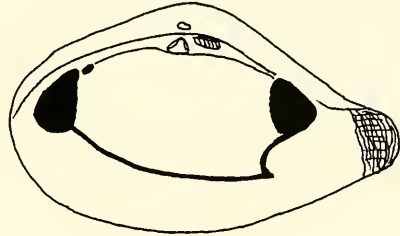




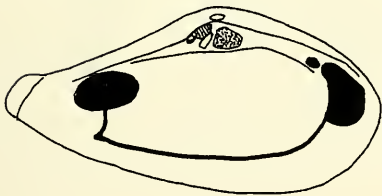
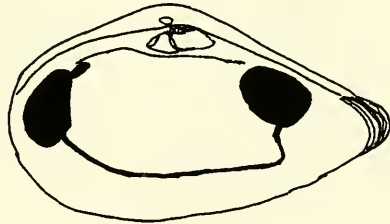
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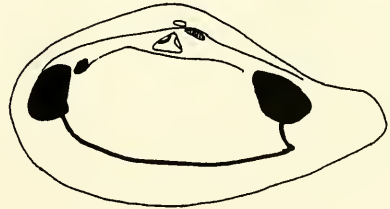
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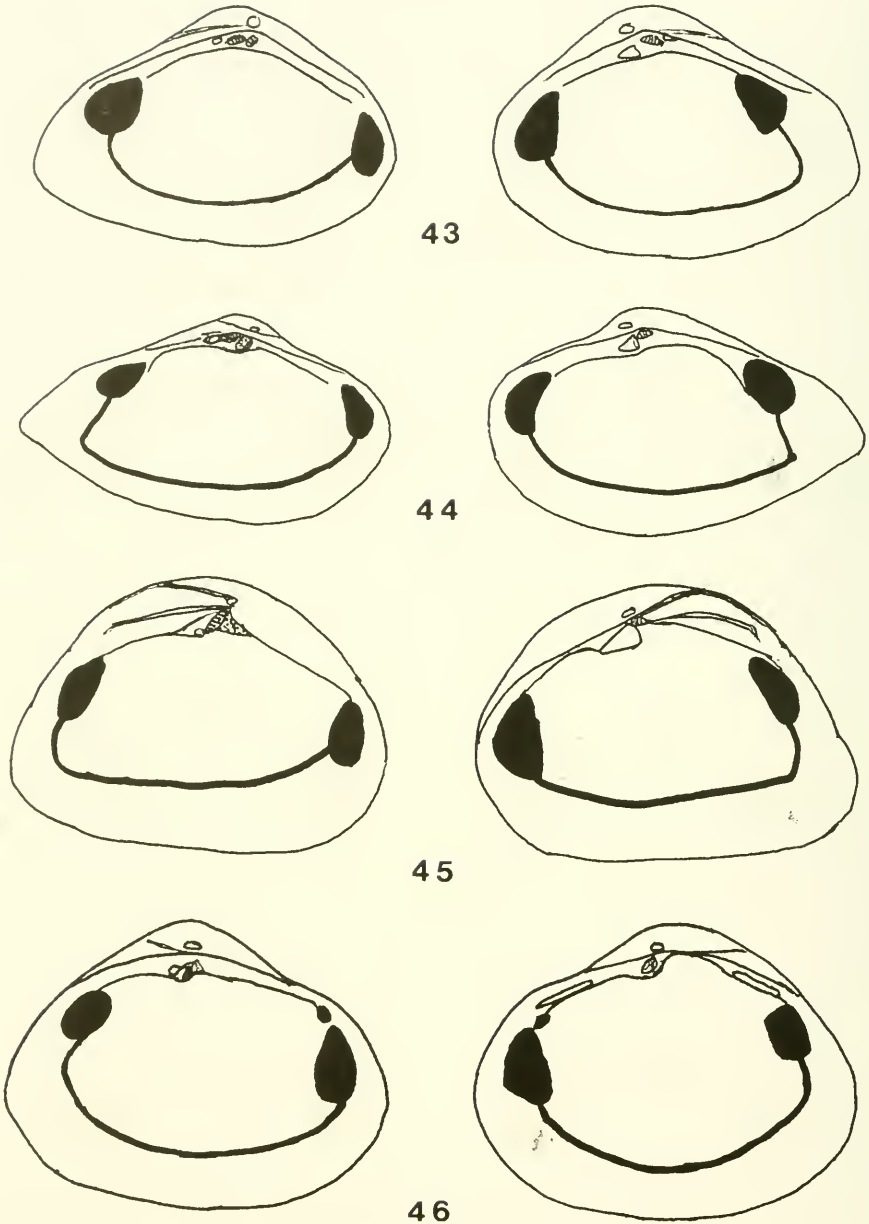
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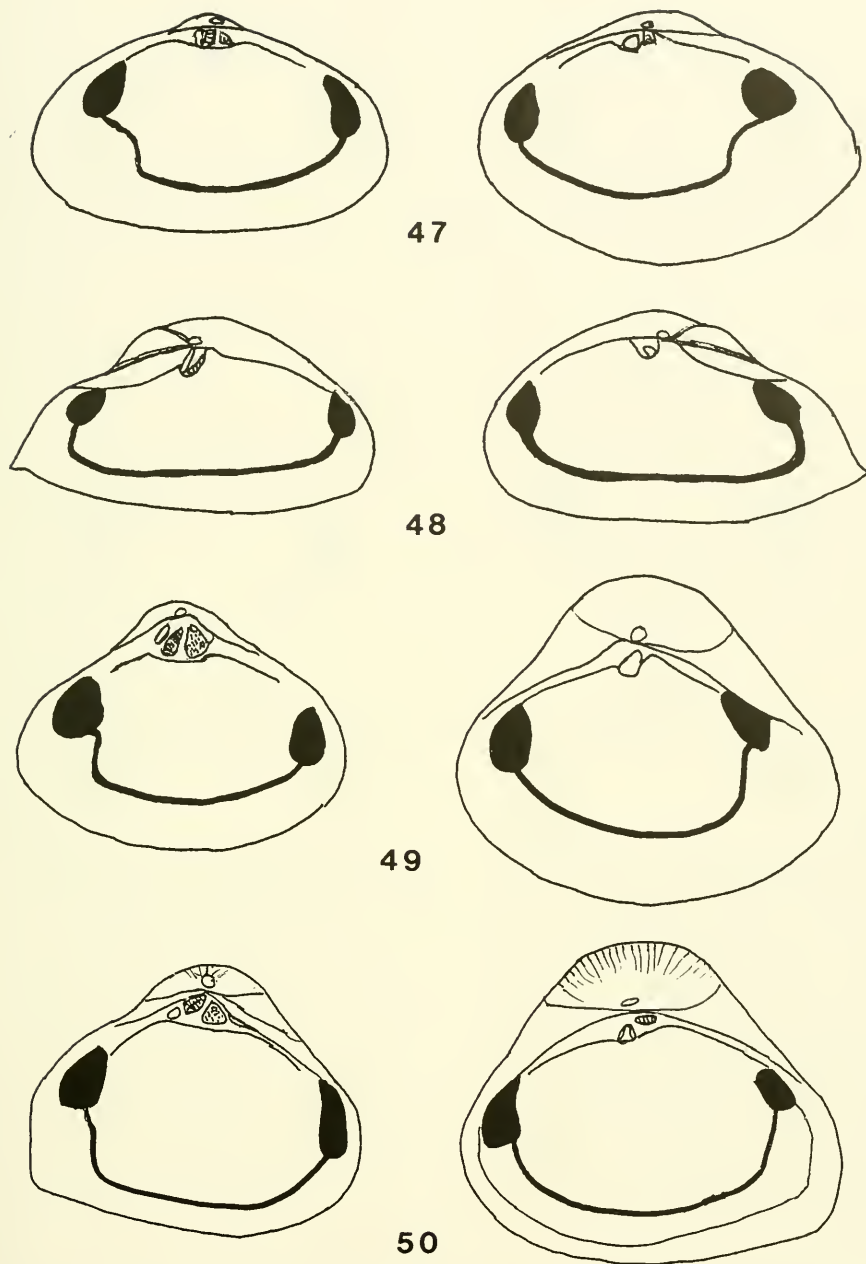
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FIGS. 39–42. Diagrammatic interior views of eastern Pacific species of *Corbula*, showing hinge, pallial sinus, and adductor scars of right and left valves. Stippling in left valve indicates socket for tooth of right valve. Cross-hatching indicates areas of ligament attachment on chondrophore of left valve and visible areas of attachment on hinge margin of right valve. FIG. 39. *C. amethystina*; SBMNH 345487; Playas de Villamil, Guayas, Ecuador; trawled; length, 30.8 mm. FIG. 40. *C. nasuta*; SBMNH 345492, between Santa Cruz and Platinitos, Nayarit, México; 6–18 m; length, 15.9 mm. FIG. 41. *C. otra*, new species; SBMNH 345493, holotype; Manzanillo, Colima, México; 30–45 m; length, 22.8 mm. FIG. 42. *C. ovulata*; SBMNH 345498; Playas de Villamil, Guayas, Ecuador; trawled; length, 29.2 mm.

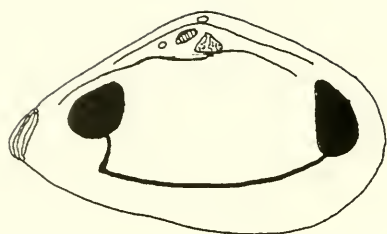


FIGS. 43–46. Diagrammatic interior views of eastern Pacific species of *Corbula*, showing hinge, pallial sinus, and adductor scars of right and left valves. FIG. 43. *C. porcella*; CAS 142446; E end of Isla Cedros, Baja California, México; 82 m; unpaired valves: right valve, 7.4 mm; left valve, 7.2 mm. FIG. 44. *C. esmeralda*; ANSP 218903, 403198, lectotype and paralectotype; Esmeraldas, Esmeraldas, Ecuador; lengths, 20.6 mm. FIG. 45. *C. bicarinata*; CAS 120689; San Felipe, Baja California, México; length, 11.2 mm. FIG. 46. *C. ventricosa*; CAS 120699; Panamá; length, 15.3 mm.

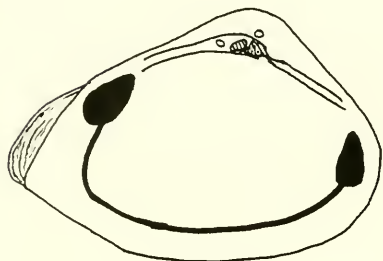
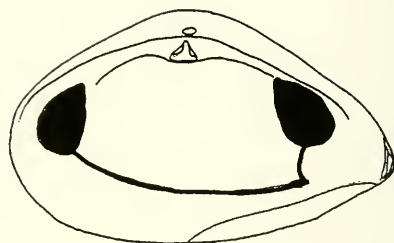


FIGS. 47–50. Diagrammatic interior views of eastern Pacific species of *Corbula*, showing hinge, pallial sinus, and adductor scars of right and left valves. FIG. 47. *C. amurensis*; CAS 089104; Martinez, Contra Costa County, California; length, 16.4 mm. FIG. 48. *C. tenuis*; CAS 120702; Isla Taboga, Panamá, Panamá; length, 19.1 mm. FIG. 49. *C. grovesi*; LACM 2891, holotype; S end of Isla San Lorenzo, Baja California Sur, México; 732 m; length, 11.0 mm. FIG. 50. *C. obesa*; SBMNH 345495, neotype; Mazatlán, Sinaloa, México; length, 12.7 mm.

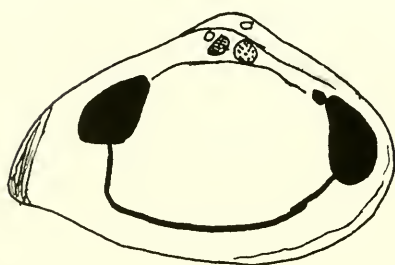
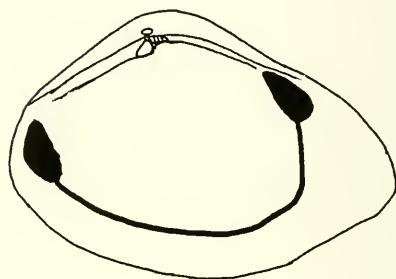




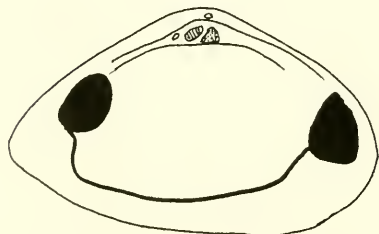
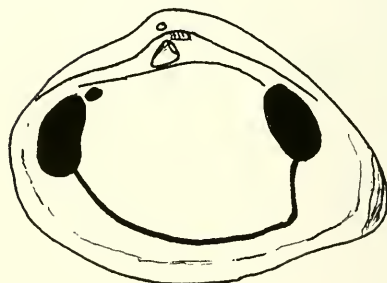
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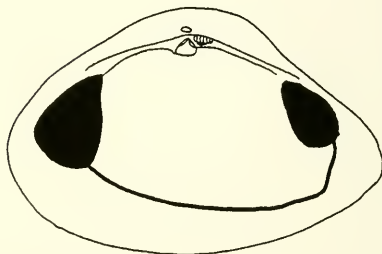
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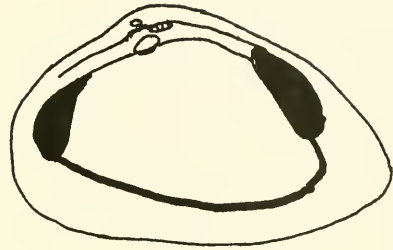
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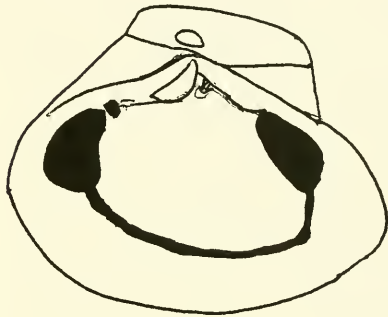
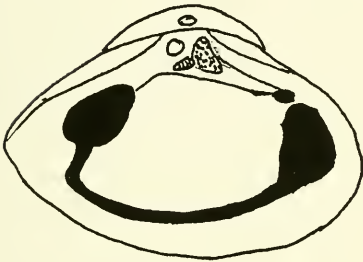
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FIGS. 51–54. Diagrammatic interior views of eastern Pacific species of *Corbula*, showing hinge, pallial sinus, and adductor scars of right and left valves. FIG. 51. *C. biradiata*; SBMNH 345500; Playa Kobbe, Panamá, Panamá; length, 16.8 mm. FIG. 52. *C. colimensis*, new species; SBMNH 345496, holotype; Las Ventanas, Manzanillo, México; length, 13.7 mm. FIG. 53. *C. ira*; SBMNH 345501; Bahía Carazal, Colima, México; 75 m; length, 11.4 mm. FIG. 54. *C. luteola*; CAS 120696; Arch Rock, Corona del Mar, Orange County, California; length, 10.4 mm.



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FIGS. 55, 56. Diagrammatic interior views of eastern Pacific species of *Corbula*, showing hinge, pallial sinus, and adductor scars of right and left valves. FIG. 55. *C. marmorata*; CAS 120688; Mazatlán, Sinaloa, México; length, 5.8 mm. FIG. 56. *C. speciosa*; CAS 120695; Bahía Santa Inez, Baja California Sur, México; 55–64 m; length, 17.5 mm

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#### LITERATURE CITED

- ADAMKEWICZ, S. L., M. G. HARASEWYCH, J. BLAKE, D. SAUDEK & C. J. BULT, 1997, A molecular phylogeny of the bivalve mollusks. *Molecular Biology and Evolution*, 14(6): 619–629.  
 ADAMS, A, 1862, On some new species of acephalous Mollusca from the Sea of Japan. *Annals and Magazine of Natural History*, (3)9(51): 223–230.

- ADAMS, A. & L. A. REEVE, 1848–1850, Mollusca. x + 87 pp., 24 pls., in: A. ADAMS, ed., *The zoology of the voyage of H. M. S. Samarang, under the command of Captain Sir Edward Belcher, . . . during the years 1843–1846*. London (Reeve, Benham & Reeve) [pp. 1–24, pls. 1–9, November 1848; pp. 25–44, pls. 10–13, May 1850; pp. 45–87, i–x, pls. 14–24, August 1850].
- ADAMS, C. B., 1852a, Catalogue of shells collected at Panama, with notes on synonymy, station and habitat, . . . . *Annals of the Lyceum of Natural History of New York*, 5: 229–549 [reprinted: C. B. Adams (1852b)].
- ADAMS, C. B., 1852b, *Catalogue of shells collected at Panama, with notes on their synonymy, station, and geographical distribution*. New York (Craighead), viii + 344 pp.
- ADAMS, C. B., 1852c, Descriptions of new species of *Corbula* from Jamaica. *Contributions to Conchology*, 1(12): 233–241.
- ADEGOKE, O. S., 1969, Stratigraphy and paleontology of the marine Neogene formations of the Coalinga region, California. *University of California, Publications in Geological Sciences*, 80: 269 pp., 13 pls., 3 maps in pocket.
- AGUAYO, C. G., 1943, Centenario de los "Moluscos" de d'Orbigny en la obra de la Sagra. *Revista de la Sociedad Malacologica "Carlos de la Torre"*, 1(1): 37–40, pl. 1.
- ANDERSON, L. C., 1992, Naticid gastropod predation on corbulid bivalves: effects of physical factors, morphological features, and statistical artifacts. *Palaos* 7(6): 602–620.
- ANDERSON, L. C., 1994, Paleoenvironmental control of species distributions and intraspecific variability in Neogene Corbulidae (Bivalvia: Myacea) of the Dominican Republic. *Journal of Paleontology*, 68(3): 460–473.
- ANDERSON, L. C., 1996, Neogene paleontology in the northern Dominican Republic. 16. The family Corbulidae (Mollusca: Bivalvia). *Bulletins of American Paleontology*, 110(351): 1–34, pls. 1–3.
- ANDERSON, L. C., 2001, Temporal and geographic size trends in Neogene Corbulidae (Bivalvia) of tropical America: using environmental sensitivity to decipher causes of morphologic trends. *Palaeoecology, Palaeoclimatology, Palaeoecology*, 166(1/2): 101–120.
- ANDO, Y., 1965, [Molluscan fossils from the western part of Kobe, Hyogo Prefecture, Japan] [in Japanese]. *Kyoto, Nipon Kobutsu Shuminokai, Chigaku Kenkyu*, Special Vol.: 206–241.
- ANGAS, G. F., 1867, A list of species of marine Mollusca found in Port Jackson Harbour, New South Wales, and on the adjacent coasts, with notes on their habitats etc. *Proceedings of the Zoological Society of London*, for 1867(2): 912–935.
- ANGAS, G. F., 1878, A list of additional species of marine Mollusca to be included in the fauna of the province of South Australia; with notes on their habitats and local distribution. *Proceedings of the Zoological Society of London*, for 1878(4): 864–871.
- ARNOLD, R., 1903, The paleontology and stratigraphy of the marine Pliocene and Pleistocene of San Pedro, California. *Memoirs of the California Academy of Sciences*, 3: 420 pp., 37 pls. [published simultaneously as: Stanford University, *Contributions to Biology from the Hopkins Seaside Laboratory*, 31].
- BACESCO, M.; H. DUMITRESCO, V. MANEA, F. PÓR & R. MAYER, 1957, Les sables a *Corbulomya (Aloidis) maeotica* Mil.—Base trophique de premier ordre pour les poissons de la Mer Noire. Aspect hivernal de la biocénose à *Corbulomya* des eaux Roumaines. *Travaux du Museum d'Histoire Naturelle "Grigore Antipa"*, 1: 305–374, fold-out table and fig.
- BAILEY, R. H., 1977, *Varicorbula chowanensis*, a new species (Bivalvia: Myacea) from the Pliocene of North Carolina. *The Nautilus* 91(4): 128–130.
- BARTSCH, P., 1929, Report upon the collection of marine mollusks made by Professor Dr. K. Derjugin in the Gulf of Peter the Great. *Leningrad, Gosudarstvennyi Gidrologicheskii Institut, Issledovaniia Morei SSSR*, 10: 129–140, pls. 1–4.
- BEAL, C. H., 1948, Reconnaissance of the geology and oil possibilities of Baja California, Mexico. *Memoir of the Geological Society of America*, 31: x + 138 pp., 11 pls.
- BOCK, W. D. & D. R. MOORE, 1968, A commensal relationship between a foraminifer and a bivalve mollusk. *Gulf Research Reports* [Ocean Springs, Mississippi], 2(3): 273–279, pl. 1.
- BOSC, L. A. G., 1801, Histoire naturelle de coquilles, contenant leur description, les moeurs des animaux qui les habitent et leurs usages, avec figures dessinées d'après nature. In: C. L. L. de BUFFON, *Histoire naturelle de Buffon, classée . . . d'après le systeme de Linné . . .* Paris (Déterville) (1: 343 pp.; 2: 330 pp., pls. 1–15, 1 fold-out table; 3: 292 pp., pls. 16–28; 4: 280 pp., pls. 29–36; 5: 255 + [1] + [10] pp., pls. 37–44).
- BOSS, K. J., J. ROSEWATER & F. A. RUHOFF, 1968, The zoological taxa of William Healey Dall. *Bulletin of the United States National Museum*, 287: 427 pp.
- BRANN, D. C., 1962, *Illustrations to "Catalogue of the Collection of Mazatlan Shells" by Philip Carpenter*. Ithaca, New York (Paleontological Research Institution). 111 pp., 60 pls.
- BROCCHI, G. B., 1814, *Conchiologia fossile subapennina con osservazioni sugli geologiche sugli appennini e sul suolo adiacente*. Milano (Stamperia Reale). (1: pp. 1–56 + i–lxxx + 1–240; 2: pp. 241–712, pls. 1–16).
- BRODERIP, W. J. & B. B. SOWERBY I, 1829, Observations on new or interesting Mollusca contained, for the most part, in the Museum of the Zoological Society. *Zoological Journal*, 4(15): 359–376, pl. 9.
- BROWN, A. P. & H. A. PILSBRY, 1913, Fauna of the Gatun Formation, Isthmus of Panama, II. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 64 [for 1912]: 500–519, pls. 22–26.



- BROWN, T., 1843 [1837–1844], *Illustrations of the Recent conchology of Great Britain and Ireland, with the description and localities of all the species, marine, land, and freshwater*. London (Smith, Elder & Co.) & Edinburgh, xiii + 144 + 1 pp., 59 pls. [printed in as-yet undated parts, and reissued in 1844].
- BRUGUIÈRE, J.-G.; J. B. P. A. de M. de LAMARCK & B. de SAINT-VINCENT, 1797 [1791–1827], *Tableau encyclopédique et méthodique des trois règnes de la nature. Vers, coquilles, mollusques, et polypiers*. Paris (Agasse), viii + 180 + 16 pp., 488 pls. [pls. 190–286, 1797, by Bruguière].
- BURCH, B. L., 1947, Comparison of the molluscs of three Pleistocene beds with the Recent fauna of Los Angeles County, California. *Minutes of the Conchological Club of Southern California*, 73: 1–18 [charts referred to on p. 18 never published].
- BURCH, J. Q., 1960, Notes on the taxonomy of pelecypod genus *Corbula*. *The Veliger*, 1(2): 33–34.
- CAMPBELL, L. D., 1993, Pliocene molluscs from the Yorktown and Chowan River formations in Virginia. *Virginia Division of Mineral Resources Publication*, 127: vii + 259 pp., 43 pls.
- CARLTON, J. T., J. K. THOMPSON, L. E. SCHEMEL & F. H. NICHOLS, 1990, Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam *Potamocorbula amurensis*. I. Introduction and dispersal. *Marine Ecology—Progress Series*, 66: 81–94.
- CARPENTER, P. P., 1857a, Report on the present state of our knowledge with regard to the Mollusca of the west coast of North America. *Report of the British Association for the Advancement of Science*, 26[for 1856]: 159–368 + 4, pls. 6–9.
- CARPENTER, P. P., 1857b, *Catalogue of the collection of Mazatlan Shells, in the British Museum: collected by Frederick Reigen.*: London (British Museum), xii + 552 pp. [some copies as i–iv + ix–xvii] [also published simultaneously as *Catalogue of the Reigen Collection of Mazatlan Mollusca, in the British Museum*. Warrington (Oberlin Press), viii + xii + 552 pp.] [reprinted: Paleontological Research Institution, 1967].
- CARPENTER, P. P., 1860, Checklists of the shells of North America. No. 2(b). West Coast: Mexican and Panamic Province. *Smithsonian Institution Miscellaneous Collections*, 2(128): 13 pp.
- CARPENTER, P. P., 1864a, Review of Prof. C. B. Adams's 'Catalogue of the Shells of Panama' from the type specimens. *Proceedings of the Zoological Society of London*, for 1863(3): 339–369 [reprinted in Carpenter, 1872: 173–205].
- CARPENTER, P. P., 1864b, Supplementary report on the present state of our knowledge with regard to the Mollusca of the west coast of North America. *Report of the British Association for the Advancement of Science*, 33[for 1863]: 517–686 [reprinted: Carpenter, 1872: 1–172].
- CARPENTER, P. P., 1865 [1864–1866], Descriptions of new marine shells from the coast of California. Parts I–III. *Proceedings of the California Academy of Sciences*, 3: I: 155–159 (July 1864); II: 175–176 (December 1864); 177 (January 1865); III: 207–208 (post-4 September 1865); 209–224 (February 1866).
- CARPENTER, P. P., 1872, The mollusks of western North America. Embracing the second report made to the British Association on this subject, with other papers; reprinted by permission, with a general index. *Smithsonian Miscellaneous Collections*, 10(252): xii + 325 + 13–121.
- CHACE, E. P., 1966, Pleistocene Mollusca from the second terrace at San Pedro, California. *Transactions of the San Diego Society of Natural History*, 14(13): 169–172
- COAN, E. V., 1989, The malacological papers and taxa of Martha Burton Woodhead Williamson, 1843–1922, and the Isaac Lea Chapter of the Agassiz Association. *The Veliger*, 32(3): 296–301.
- COAN, E. V. & P. H. SCOTT, 1991, *Corbula kelseyi* unmasked: a *Cumingia* (Bivalvia). *The Veliger*, 34(4): 366.
- COAN, E. V. & C. SKOGLUND, 2001, Family Corbulidae. Pp. 82–85, in C. SKOGLUND, Panamic Province molluscan literature. Additions and changes from 1971 to 2000. I. Bivalvia. *The Festivus*, Suppl.: 119 pp.
- COAN, E. V., P. VALENTICH SCOTT & F. R. BERNARD, 2000, Bivalve seashells of western North America. Marine bivalve mollusks from Arctic Alaska to Baja California. *Santa Barbara Museum of Natural History, Monographs*, 2: viii + 764 pp.
- CONRAD, T. A., 1833 [1832–1837]. *Fossil shells of the Tertiary formations of North America, illustrated by figures drawn on stone, from nature*. Philadelphia (Dobson), viii + 9–46, 29–56 pp., 18 pls., 1 map [1(3): 29–38, September 1833] [reprinted by Harris, 1893, which was reprinted in 1963].
- CONRAD, T. A., 1857, Descriptions of Cretaceous and Tertiary fossils, in W. H. EMORY, *Report of the United States and Mexican Boundary Survey* [U. S. 34<sup>th</sup> Congress, 1<sup>st</sup> Session, Senate Executive Document 108 and House Executive Document 135], vol. 1(2): 141–174, pls. 1–21.
- COSSMANN, A. E. M., 1886, Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris. Premier fascicule. *Annales de la Société Malacologique de Belgique*, 21[(4)1]: 15–186, pls. 1–8 [reprint: 174 pp., 8 pls.].
- COSTA, O. G., 1829, *Catalogo sistematico e ragionato de' Testacei delle due Sicilie*. Napoli (Minerva), 8 + cxxvii pp., 2 pls.
- CRISTOFORI, G. & G. JAN, 1832, *Catalogus in IV. sectiones divisus rerum naturalium in museo exstantium Josephi de Cristophori et Georgii Jan . . . complectens abumbrationem oryctognosiae et geognosiae atque prodrumum faunae et florum Italiae superioris*, Sect. II—Conchilologia. Parma (Carmignani). This is a complex, multi-part work, of which only relevant sections are cited here. The parts are inconsistently numbered or unnumbered. *Descrizione dei generi degli animali per*

- servire d'introduzione al prodormo delle fauna dell'Italia superiore compreso nei cataloghi del Museo di Storia Naturale*. . . . vi + 10 pp. (March); Pars 1a. *Conspectus methodicus molluscorum*. Fasc. lus. *Testacea terrestria et fluviatilia*. *Dispositio methodica generum*. . . . —[ii] pp. *Conchylia terrestria et fluviatilia*. . . . —8 pp. *Mantissa in secundam partem catalogi testaceorum existantium in collectione quam possident de-Cristofori et Jan*. . . . —4 pp. (April)
- DALL, W. H., 1878a, Fossil mollusks from Later Tertiaries in California. *Proceedings of the United States National Museum*, 1(8): 10–16
- DALL, W. H., 1878b, Distribution of California Tertiary fossils. *Proceedings of the United States National Museum*, 1(8): 26–30
- DALL, W. H., 1881, Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of México, and in the Caribbean Sea, 1877–79, by the United States Coast Guard Steamer “Blake,”. . . . XV. Preliminary report on the Mollusca. Harvard College [University], *Bulletin of the Museum of Comparative Zoology*, 9(2): 33–144
- DALL, W. H., 1889a, Report on the Mollusca. Part II.—Gastropoda and Scaphopoda. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78) and in the Caribbean Sea (1979–80), by the U. S. Coast Survey steamer “Blake,” Lieut.-Commander C. D. Sigsbee, U.S.N., and Commander J. R. Bartlett, U.S.N., commanding. XXIX. Harvard College [University], *Bulletin of the Museum of Comparative Zoology*, 18: 492 pp., pls. 10–40
- DALL, W. H., 1889b, A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the south-eastern coast of the United States, with illustrations of many of the species. *Bulletin of the United States National Museum*, 37: 221 pp., 74 pls. [reprinted, 1903, 221 pp., 95 pls.]
- DALL, W. H., 1898, Contributions to the Tertiary fauna of Florida, with especial reference to the siliceous beds of Tampa and the Pliocene beds of the Caloosahatchie River, including in many cases a complete revision of the generic groups treated of and their American species. Part IV. I. Prionodesmacea. II. Teleodesmacea: *Teredo* to *Ervilia*. *Transactions of the Wagner Free Institute of Science of Philadelphia*, 3(4): viii + 571–947, pls. 23–35 [pl. 36, with the corbulids, published in Dall (1900)]
- DALL, W. H., 1900, Contributions to the Tertiary fauna of Florida, with especial reference to the siliceous beds of Tampa and the Pliocene beds of the Caloosahatchie River, including in many cases a complete revision of the generic groups treated of and their American Tertiary species. Part V. Teleodesmacea: *Solen* to *Diplodonta*. *Transactions of the Wagner Free Institute of Science of Philadelphia*, 3(5): 949–1218, pls. 36–47
- 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, . . . XXXVIII. 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, . . . XIV. Harvard College [University], *Bulletin of the Museum of Comparative Zoology*, 43(6): 205–487, pls. 1–22
- DALL, W. H., 1912, New species of fossil shells from Panama and Costa Rica collected by D. F. MacDonald. *Smithsonian Miscellaneous Collections*, 59(2)[2077]: 1–10
- DALL, W. H., 1916a, *Checklist of the Recent Bivalve Mollusks (Pelecypoda) of the Northwest Coast of America from the Polar Sea to San Diego, California*. Los Angeles (Southwest Museum), 44 pp., 1 portrait
- DALL, W. H., 1916b, Diagnoses of new species of marine bivalve mollusks from the northwest coast of America in the collection of the United States National Museum. *Proceedings of the United States National Museum*, 52(2183): 393–417
- DALL, W. H., 1921, Summary of the marine shell-bearing mollusks of the northwest coast of America, from San Diego, California, to the Polar Sea, mostly contained in the collection of the United States National Museum, with illustrations of hitherto unfigured species. *Bulletin of the United States National Museum*, 112: iii + 217 pp., 22 pls.
- DALL, W. H., 1925, Illustrations of unfigured types of shells in the collection of the United States National Museum. *Proceedings of the United States National Museum*, 66(2554): 1–41, pls. 1–36
- DAUTZENBERG, P., 1912, Mission Gravel sur la côte occidentale d’Afrique (1909–1910). *Annales de l’Institut Océanographique* (Monaco), 5(3): 1–111, 2 pls.
- DE CAUWER, G., 1985, Gastropod predation on corbulid valves—palaeoecology or taphonomy. *Annales de la Société Royale Zoologique de Belgique*, 115(2): 183–196
- DeLONG, J. H., 1941, The paleontology and stratigraphy of the Pleistocene at Signal Hill, Long Beach, California. *Transactions of the San Diego Society of Natural History*, 9(25): 229–252
- DESHAYES, G. P., 1824 [1824–1837], *Description de coquilles fossiles des environs de Paris*. Paris (l’Auteur, Bechet Jeune, Baudouin Frères, Treuttel & Wurtz, Levrault) [1(5): 57–80 + 5–6, pls. 9–12, September 1824]
- DESHAYES, G. P., 1845–1848, *Histoire naturelle des mollusques*, vol. 1: Mollusques acéphalés. In: *Exploration scientifique de l’Algérie pendant les années 1840, 1841, 1842*, . . . Zoologie. Paris (Impr. Nationale) Text: xx + 609 pp; Atlas: 160 pp., 155 pls. [issued in as-yet undated parts]
- DESHAYES, G. P., 1857 [1856–1865], *Description des animaux sans vertèbres découverts dans le Bassin de Paris pour servir de supplément à la*

- descriptions des coquilles fossiles des environs de Paris comprenant un revue général de toutes les espèces actuellement connues. . . .* Paris (Baillièrre et fils). Vol. 1: 912 pp.; Atlas: 87 + 2 pls.; Vol. 2: 968 pp.; Vol. 3: 668 pp.; Atlas: 107 pls. [Vol. 1: pls. 11–20, 28 Feb. 1857; pp. 161–240, 19 May 1857]
- DICKERSON, R. E., 1922, Tertiary and Quaternary history of the Petaluma, Point Reyes and Santa Rosa quadrangles. *Proceedings of the California Academy of Sciences*, (4)11(19): 527–601, pls. 17–41
- DUDA, T. F., 1994, Genetic population structure of the recently introduced Asian clam, *Potamocorbula amurensis*, in San Francisco Bay. *Marine Biology*, 119(2): 235–242
- DUJARDIN, F., 1837, Mémorie sur les couches du sol un Touraine, et description des coquilles de la craie et des faluns. *Mémoires de la Société Géologique de France*, 2(2): 211–311, pls. 1–6
- DURHAM, J. W., 1950, 1940 E. W. Scripps Cruise to the Gulf of California, part II: megascopic paleontology and marine stratigraphy. *Memoir of the Geological Society of America*, 43: viii + 216 pp., 48 pls.
- DuSHANE, H., 1962, A checklist of mollusks for Puertecitos, Baja California, Mexico. *The Veliger* 5(1): 39–50
- EMERSON, W. K., 1980, Invertebrate faunules of Late Pleistocene age, with zoogeographic implications, from Turtle Bay, Baja California Sur, Mexico. *The Nautilus*, 94(2): 67–89
- EMERSON, W. K. & E. P. CHACE, 1959, Pleistocene mollusks from Tecolote Creek, San Diego, California. *Transactions of the San Diego Society of Natural History*, 12(21): 335–346
- EMERSON, W. K. & L. G. HERTLEIN, 1964, Invertebrate megafossils of the Belvedere Expedition to the Gulf of California. *Transactions of the San Diego Society of Natural History*, 13(17): 333–368
- EMERSON, W. K., G. L. KENNEDY, J. F. WEHMILLER & E. KEENAN, 1981, Age relations and zoogeographic implications of late Pleistocene marine invertebrate faunas from Turtle Bay, Baja California Sur, Mexico. *The Nautilus*, 95(3): 105–116
- FLEMING, J., 1828, A history of British animals, exhibiting the descriptive characters and systematical arrangement of the genera and species of quadrupeds, birds, reptiles, fishes, Mollusca, and Radiata of the United Kingdom; . . . . Edinburg (Bell & Bradfute) & London (Duncan), xxiii + 565 + [1] pp.
- GABB, W. M., 1873a, Description of some new genera of Mollusca. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 24: 270–274, pls. 9–11
- GABB, W. M., 1873b, On the topography and geology of Santo Domingo. *Transactions of the American Philosophical Society*, (2)15(4): 49–259, 2 maps.
- GARDNER, J. A., 1926, The nomenclature of the superspecific groups of *Corbula* in the lower Miocene of Florida. *The Nautilus*, 40(2): 41–47
- GARDNER, J. A., 1928, The molluscan fauna of the Alum Bluff group of Florida. Part V. Tellinacea, Solenacea, Maत्रacea, Myacea, Molluscoidea. *United States Geological Survey Professional Paper*, 142E: 185–249 + iv + iii pp., pls. 29–36
- GARDNER, J. A., 1944, Mollusca from the Miocene and lower Pliocene of Virginia and North Carolina. Part I. Pelecypoda. *Professional Paper of the United States Geological Survey*, 199A: iv + 1788, pls. 1–23 [as “1943”]
- GEMMELL, J., B. W. MYERS & C. M. HERTZ, 1987, A faunal study of the bivalves of San Felipe and environs, Gulf of California, from the Gemmell collection (1965 to 1976). *The Festivus*, 18 (Supplement): 72 pp.
- GLIBERT, M. & L. VAN DE POEL, 1966, Les Bivalvia fossiles du Cénozoïque étranger des collections de l'Institut Royal des Sciences Naturelles de Belgique. III. Heteroconchia (1—Laternulidae à Chamidae). *Mémoires d'Institut Royal des Sciences Naturelles de Belgique*, (2)81: 82 pp.
- GOMOIU, M.-T., 1965, The dynamics of *Aloidis* populations. *Revue Roumaine de Biologie (Zoologie)*, 10(5): 353–360, 2 fold-out figs.
- GOULD, A. A. & P. P. CARPENTER, 1857, Descriptions of shells from the Gulf of California, and the Pacific coasts of Mexico and California. Part II. *Proceedings of the Zoological Society of London*, for 1856[24](313): 198–208
- GRANT, U. S., IV & H. R. GALE, 1931, Catalogue of the marine Pliocene and Pleistocene Mollusca of California and adjacent regions. . . . *Memoirs of the San Diego Society of Natural History*, 1: 1036 pp., 32 pls. [reprinted, 1958]
- GUPPY, R. J. L., 1866a, On the Tertiary Mollusca of Jamaica. *Quarterly Journal of the Geological Society of London*, 22(3)[87]: 281–295, pls. 16–18
- GUPPY, R. J. L., 1866b, On the relations of the Tertiary formations of the West Indies. *Quarterly Journal of the Geological Society of London*, 22(4): 570–590, pl. 26
- HAAS, F., 1953, Mollusks from Ilha Grande, Rio de Janeiro, Brazil. *Fieldiana (Zoology)*, 34(20): 203–209
- HABE, T., 1949, Erodonidae in Japan. In T. KURODA, ed., *Illustrated Catalogue of Japanese Shells*, 1: 1–6, pl. 1
- HABE, T., 1955, Notes on *Potamocorbula* (gen. nov.) *amurensis* (Schrenck). *Zoological Magazine (Tokyo) [Dobutsugaku Zasshi]* 64(9): 271–272
- HABE, T., 1977, *Systematics of Mollusca in Japan. Bivalvia and Scaphopoda*. Tokyo (Zukanno-Hokuryukan), xiii + 372 pp. + [4] pp. errata, 72 pls.
- HANLEY, S. C. T., 1843, 1856 [1842–1856], *An illustrated and descriptive catalogue of Recent bivalve shells*. London (Williams & Norgate), xviii + 392 + 24 pp., pls. 9–24 [p. 47, pl. 10, p. 4 of pl. expl., 1843; p. 344, 1856]
- HANNA, G. D., 1924, Rectifications of nomenclature



- ture. *Proceedings of the California Academy of Sciences*, 13(10): 151–186
- HARPER, E. L., 1994, Are conchiolin sheets in corbulid bivalves primarily defensive? *Palaeontology*, 37(3): 551–578
- HEDLEY, C., 1918, A check-list of the marine fauna of New South Wales. *Journal of the Royal Society of New South Wales*, 51, Supplement: M1–M20
- HERRMANNSEN, A. N., 1847 [1846–1849], *Indicis generum malacozoorum primordia*. Cassells (Fischer). Vol. 1: i–xxvii + 1–637; Vol. 2: xxix–xlii + 1–717 [vol. 1: 233–360, containing the Corbulidae, 1 March 1847]
- HERTLEIN, L. G., 1934, Pleistocene mollusks from the Tres Marias Islands, Cedros Island, and San Ignacio Lagoon, Mexico. *Bulletin of the Southern California Academy of Sciences*, 33(2): 59–73, pl. 21
- HERTLEIN, L. G., 1957, Pliocene and Pleistocene fossils from the southern portion of the Gulf of California. *Bulletin of the Southern California Academy of Sciences*, 56(2): 57–75, pl. 13
- HERTLEIN, L. G. & W. K. EMERSON, 1956, Marine Pleistocene invertebrates from near Puerto Peñasco, Sonora, Mexico. *Transactions of the San Diego Society of Natural History*, 12(8): 154–176, pl. 12
- HERTLEIN, L. G. & U. S. GRANT, IV, 1972, The geology and paleontology of the marine Pliocene of San Diego, California. Part 2B: Paleontology: Pelecypoda. *Memoirs of the San Diego Society of Natural History*, 2: 135–409, frontis., pls. 27–57
- HERTLEIN, L. G. & A. M. STRONG, 1950, Eastern Pacific expeditions of the New York Zoological Society. XLII. Mollusks from the west coast of Mexico and Central America. Part IX. *New York Zoological Society, Zoologica*, 35(4): 217–252, 2 pls.
- HERTLEIN, L. G. & A. M. STRONG, 1955, Marine mollusks collected during the "Askoy" Expedition to Panama, Colombia, and Ecuador in 1941. *Bulletin of the American Museum of Natural History*, 107(2): 159–317, pls. 1–3
- HINDS, R. B., 1843, [descriptions of new species of shells collected during the voyage of Sir Edward Belcher, C. B., and H. Cuming, Esq., in his late visit to the Philippine Islands . . . ]. *Proceedings of the Zoological Society of London*, for 1843[11](124): 55–59 (Nov.) [reprinted in *Annals and Magazine of Natural History*, (2)13(83): 228–232, 1844]
- HINDS, R. B., 1844–1845, *The zoology of the voyage of H. M. S. Sulphur, under the command of Capt. Sir Edward Belcher, . . . during the years 1836–42*, Vol. 2 [Mollusca]. London (Smith, Elder & Co.), 72 pp., 21 pls. [pp. 1–24, pls. 1–7, July 1844; 25–48, pls. 8–14, October 1844; 49–72, pls. 15–21, January 1845]
- HODSON, F. & H. K. HODSON, 1931, Some Venezuelan mollusks. *Bulletins of American Paleontology*, 16(59): 1–94, 24 pls.
- HOFFSTETTER, R., 1948, Notas sobre el Cuaternario de la Península de Santa Elena (Ecuador). II. Pelecypoda del Tercer Tablazo. *Boletín de Informaciones Científicas Nacionales*, 2(13/14): 67–83
- HOFFSTETTER, R., 1952, Moluscos subfósiles de los estanques de sal de Salinas (Pen. de Santa Elena, Ecuador). Comparación con la fauna actual del Ecuador. *Boletín del Instituto de Ciencias Naturales*, 1(1): 3–79
- HOOTS, H. W., 1931, Geology of the eastern part of the Santa Monica Mountains, Los Angeles, California. *United States Geological Survey Professional Paper*, 165C: 83–134, pls. 16–34
- HRS-BRENKO, M., 1981, Population studies of *Corbula gibba* (Olivi), Bivalvia, Corbulidae, in the northern Adriatic Sea. *Journal of Molluscan Studies*, 47(1): 17–24
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1999, *International Code of Zoological Nomenclature*, 4<sup>th</sup> ed. London, England (International Trust for Zoological Nomenclature), xxix + 306 pp.
- IREDALE, T., 1936, More notes on the marine Mollusca of New South Wales. *Records of the Australian Museum*, 17(9): 384–407, pls. 62–65
- JOHNSON, J. E., 1987, The late Pleistocene Miller-ton Formation. *Bulletin of the Southern California Paleontological Society*, 19(11/12): 11–12.
- JOHNSON, R. G., 1962, Mode of formation of marine fossil assemblages of the Pleistocene Miller-ton Formation of California. *Bulletin of the Geological Society of America*, 73(1): 113–130.
- JOHNSON, R. I., 1964, The Recent Mollusca of Augustus Addison Gould. *Bulletin of the United States National Museum*, 239: 182 pp., 45 pls.
- JORDAN, E. K., 1926, Expedition to Guadalupe Island, Mexico, in 1922. No. 4: Molluscan fauna of the Pleistocene of San Quintin Bay, Lower California. *Proceedings of the California Academy of Sciences*, (4)15(7): 241–255, pl. 25.
- JORDAN, E. K., with an introduction by L. G. HERTLEIN, 1936, The Pleistocene fauna of Magdalena Bay, Lower California. *Stanford University, Contributions from the Department of Geology*, 1(4): 103–173, pls. 17–19.
- JUNG, P., 1965, Miocene Mollusca from the Paraguana Peninsula, Venezuela. *Bulletins of American Paleontology*, 49(223): 385–652, pls. 50–79.
- JUNG, P., 1969, Miocene and Pliocene mollusks from Trinidad. *Bulletins of American Paleontology*, 55(247): 289–657, pls. 13–60.
- KAISER, K. L., 1997, The Recent molluscan fauna of the Islas Galápagos. *The Festivus*, 29 (Supplement): 67 pp.
- KARDON, G., 1998, Evidence from the fossil record of an antipredatory exaptation: conchiolin layers in corbulid bivalves. *Evolution*, 52(1): 68–79.
- KANAKOFF, G. P. & W. K. EMERSON, 1959, Late Pleistocene invertebrates of the Newport Bay area, California. *Contributions in Science, Los Angeles County Museum*, 31: 47 pp.
- KEEN, A. M., 1958, *Sea shells of tropical west America; marine mollusks from Lower California*

- to Colombia, 1st ed. Stanford, California (Stanford University Press), xii + 624 pp., 10 pls. [reprinted: 1960].
- KEEN, A. M., 1966, West American mollusk types at the British Museum (Natural History). II. Species described by R. B. Hinds. *The Veliger*, 8(4): 265–275, pls. 46, 47 [corrections by editor, *The Veliger*, 9(1): 87].
- KEEN, A. M., 1968, West American types at the British Museum (Natural History), IV. Carpenter's Mazatlan collection. *The Veliger*, 10(4): 389–439, pls. 55–59.
- KEEN, A. M., 1969a. Superfamily Tellinacea. Pp. 613–639, in: L. R. COX ET AL., Part N [Bivalvia], *Mollusca* 6, vols. 1 and 2: xxxvii + 952 pp. In: R. C. MOORE, ed., *Treatise on invertebrate paleontology*. Lawrence, Kansas (Geological Society of America & University of Kansas).
- KEEN, A. M., 1969b. Superfamily Myacea. Pp. 690–699, in: L. R. COX ET AL., Part N [Bivalvia], *Mollusca* 6, vols. 1 and 2: xxxvii + 952 pp. In: R. C. MOORE, ed., *Treatise on invertebrate paleontology*. Lawrence, Kansas (Geological Society of America & University of Kansas).
- KEEN, A. M., 1971. *Sea shells of tropical west America; marine mollusks from Baja California to Peru*, 2nd ed. Stanford, California (Stanford University), xiv + 1064 pp., 22 pls. [reprinted, 1984 with only 12 pls.]
- KERN, J. P., T. E. STUMP & R. J. DOWLEN, 1971, An upper Pleistocene marine fauna from Mission Bay, San Diego, California. *Transactions of the San Diego Society of Natural History*, 16(15): 329–338.
- LAMARCK, J. B. P. A. de M. de, 1799, Prodrôme d'une nouvelle classification des coquilles. *Mémoires de la Société d'Histoire Naturelle de Paris*, 1: 63–90.
- LAMARCK, J. B. P. A. de M. de, 1801, *Système des animaux sans vertèbres, ou tableau général des classes, des ordres et des genres de ces animaux*; . . . Paris (chez l'auteur & Deterville), viii + 432 pp.
- LAMARCK, J. B. P. A. de M. de, 1818, *Histoire naturelle des animaux sans vertèbres*, . . . Vol. 5. Paris (Verdière, Deterville & chez l'auteur), 612 pp.
- LAMY, É., 1926, Notes sur les espèces rangées par Lamarck dans le genre *Corbula* Bruguière. *Bulletin du Muséum National d'Histoire Naturelle*, 32(1): 81–85.
- LAMY, É., 1941, Révision des Corbulidae vivants du Muséum National d'Histoire Naturelle de Paris. *Journal de Conchyliologie*, 84[(4)38](1): 5–33, (2): 121–144; (3): 211–254.
- LEA, I., 1833, *Contributions to geology*. Philadelphia (Carey, Lea & Blanchard), vi + 227 pp., 6 pls.
- LEWY, Z. & C. SAMTLEBEN, 1979, Functional morphology and palaeontological significance of the conchiolin layers in corbulid pelecypods. *Lethaia*, 12(4): 341–351.
- LI, C. C., 1930. The Miocene and Recent Mollusca of Panama Bay. *Bulletin of the Geological Society of China*, 9(3): 249–296, pls. 1–8.
- LINNAEUS, C., 1758, *Systema naturae per regna tria naturae . . . editio decima, reformata*, vol. 1 (*Regnum animale*). Stockholm (Salvii), 824 + iii pp.
- MANGER, G. E., 1934, The geology of San Quintin Bay. *Johns Hopkins University, Studies in Geology*, 11: 273–303, pl. 21.
- MANSFIELD, W. C., 1932, Miocene pelecypods of the Choctawhatchee Formation of Florida. *Bulletin of the Florida State Geological Survey*, 8: 240 pp., 34 pls.
- MARINCOVICH, L. N., 1976, Late Pleistocene molluscan faunas from upper terraces of the Palos Verdes Hills, California. *Natural History Museum of Los Angeles County, Contributions in Science*, 281: 28 pp.
- MARSHALL, W. B., 1928, New fresh-water and marine bivalve shells from Brazil and Uruguay. *Proceedings of the United States National Museum*, 74(2762): 1–7, pls. 1–4.
- MAURY, C. J., 1912, A contribution to the paleontology of Trinidad. *Journal of the Academy of Natural Sciences of Philadelphia*, (2)15: 25–112, pls. 5–13.
- MAURY, C. J., 1917, Santo Domingo type sections and fossils. *Bulletins of American Paleontology*, 5(29–30): 165–459 [= 1–252, 1–43], pls. 27–65 [= 1–39].
- MAURY, C. J., 1920, Tertiary Mollusca from Porto Rico. *New York Academy of Sciences, Scientific Survey of Porto Rico and the Virgin Islands*, 3(1): 1–77, pls. 1–9.
- MAURY, C. J. 1925. A further contribution to the paleontology of Trinidad (Miocene horizons). *Bulletins of American Paleontology*, 10(42): 153–404 [= 1–252], pls. 12–54 [= 1–43].
- MCLEAN, R. A., 1942, The sculpture of inaequivalve mollusks. *The Nautilus*, 55(4): 142–143.
- MEGERLE von MÜHLFELD, J. K., 1811, Entwurf eines neuen system's der Schalthiergehäse. *Magazin für die Neuesten Entdeckungen in der Gasamnten Naturkunde, Gesellschaft Naturforschender Freunde zu Berlin*, 5: 38–72.
- MENKE, K. T., 1847, Verzeichniss einer Sendung von Conchylien von Mazatlan, mit einigen kritischen Bemerkungen. *Zeitschrift für Malakozoologie*, 4(12): 177–191.
- MODEER, A., 1793, Inledning til kunslapen om Mäskkräken i allmänhet. *Konglige Svenska Vetenskaps-Akademiens Nya Handlingar*, 14(3): 163–183.
- MOODY, C. L., 1916, Fauna of the Fernando of Los Angeles. *University of California Publications, Bulletin of the Department of Geology*, 10(4): 36–62, pls. 1, 2.
- MORRISON, J. P. E., 1946, The nonmarine mollusks of San Jose Island, with notes on those of Pedro Gonzales Island, Pearl Islands, Panama. *Smithsonian Miscellaneous Collections*, 106(6) [3850]: 1–49, 3 pls.
- MORTON, B., 1986, The biology and functional morphology of *Corbula crassa* (Bivalvia: Corbulidae) with special reference to shell structure and function. Pp. 1055–1073, in: B. MORTON, ed., *Pro-*

- ceedings of the Second International Marine Biological Workshop: the marine flora and fauna of Hong Kong and southern China*, Vol. 3: *Behaviour, morphology, physiology and pollution*. Hong Kong (Hong Kong University), x + 943–1268 pp.
- NELSON, E. T., 1870, On the molluscan fauna of the later Tertiary of Peru. *Transactions of the Connecticut Academy of Arts and Sciences*, 2(1): 186–206, pls. 6, 7.
- NICHOLS, F. H., J. K. THOMPSON & L. E. SCHEMEL, 1990, Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam *Potamocorbula amurensis*. II. Displacement of a former community. *Marine Ecology—Progress Series*, 66: 95–101.
- NYST, P. H., 1845, Description des coquilles et des polypiers fossiles des terrains Tertiaires de la Belgique. *Mémoire Couronné de l'Académie Royale des Sciences et Belles-Lettres de Bruxelles*, 17: 1–687, pls. 1–15 [dated 1843 and sometimes listed as 1844, but not published until 1845; also separately reprinted, 1845–1846, with 33 additional pls.]
- OLDROYD, I. S., 1925, The marine shells of the west coast of North America, Vol. 1 [Bivalvia]. *Stanford University Publications, University Series, Geological Sciences*, 1(1): 247 pp., 57 pls. [not "1924," as stated on title page; reprinted: Stanford University, 1978]
- OLIVI, G., 1792, *Zoologia Adriatica: ossia catalogo ragionato degli animali del Golfo e della Lagune de Venezia*; . . . Bassano, Italy (Remondini), xxxiii + 334 pp., 9 pls.
- OLSSON, A. A., 1932, Contributions to the Tertiary paleontology of northern Peru: Part 5, the Peruvian Miocene. *Bulletins of American Paleontology*, 19(68): 272 pp., 24 pls.
- OLSSON, A. A., 1942, Tertiary and Quaternary fossils from the Burica Peninsula of Panama and Costa Rica. *Bulletins of American Paleontology*, 27(106): 157–258 [= 5–106], pls. 14–25 [= 1–12].
- OLSSON, A. A., 1961, *Mollusks of the tropical eastern Pacific particularly from the southern half of the Panamic-Pacific faunal province (Panama to Peru)*. *Panamic-Pacific Pelecypoda*. Ithaca, New York (Paleontological Research Institution), 574 pp., 86 pls.
- OLSSON, A. A., 1964, Neogene mollusks from northwestern Ecuador. Ithaca, New York (Paleontological Research Institution), 256 pp., 38 pls.
- OLSSON, A. A. & A. HARBISON, 1953, Pliocene Mollusca of southern Florida with special reference to those from north Saint Petersburg . . . with special chapters on Turridae by William G. Fargo and Vitrinellidae and fresh-water mollusks by Henry A. Pilsbry. *Monograph of the Academy of Natural Sciences of Philadelphia*, 8: v + 457 pp., 65 pls. [reprinted: New York (Krieger), 1979; Sanibel, Florida (Shell Museum and Educational Foundation), 1990].
- ORBIGNY, A. D. d', 1842–1843, Paleontology, in: *Voyage dans l'Amérique Méridionale* . . . 3(4): 7–188, 22 pls. Paris (Bertrand) & Strasbourg (Levrault). [dates not yet fully known].
- ORBIGNY, A. D. d', 1845, 1847 [1834–1847], Mollusques, in: *Voyage dans l'Amérique Méridionale* . . . 5(3): xliii + 758, 85 pls. [in Atlas]. Paris (Bertrand) & Strasbourg (Levrault) [pp. 529–600, 1845; pls. 78, 79, 81, 82, 1847].
- ORBIGNY, A. A. d', 1853 [1841–1853], Mollusques. In: R. DE LA SAGRA, *Histoire physique, politique, et naturelle de l'île de Cuba*, part 2, *Histoire naturelle*, French ed. 2 vols., 380 pp., 28 pls. [dates of many parts as yet uncertain; bivalves in both text and plates of both French and Spanish editions now thought not to have appeared until 1853, in spite of various dates being quoted in the literature for the species contained therein].
- ORCUTT, C. R., 1921, Pleistocene beds of San Quintin Bay, Lower California. *The West American Scientist*, 19(3): 23–24.
- ORR, P. C., 1960, Late Pleistocene marine terraces on Santa Rosa Island, California. *Bulletin of the Geological Society of America*, 71(7): 1113–1120, 1 pl.
- OYAMA, K., 1980, Revision of Matajira Yokoyama's type Mollusca from the Tertiary and Quaternary of the Kanto area. *Palaeontological Society of Japan, Special Papers*, 17: 148 pp., 57 pls.
- PALMER, K. E. H. v. W., 1951, Catalog of the first duplicate series of the Reigen collection of Mazatlan shells in the State Museum at Albany, New York. *Bulletin of the New York State Museum*, 342: 79 pp., 1 pl.
- PALMER, K. E. H. v. W., 1958, Type specimens of marine Mollusca described by P. P. Carpenter from the West Coast (San Diego to British Columbia). *Memoir of the Geological Society of America*, 76: viii + 376 pp., 35 pls.
- PALMER, K. E. H. v. W., 1963, Type specimens of marine Mollusca described by P. P. Carpenter from the west coast of Mexico and Panama. *Bulletins of American Paleontology*, 46(211): 285–408, pls. 58–70.
- PALMER, K. E. H. v. W. & D. C. BRANN, 1965, Catalogue of the Paleocene and Eocene Mollusca of the southern and eastern United States. Part I. Pelecypoda, Amphineura, Pteropoda, Scaphopoda, and Cephalopoda. *Bulletins of American Paleontology*, 48(218): 1–466, 3 pls.
- PARKER, R. H., 1964, Zoogeography and ecology of some macro-invertebrates, particularly mollusks, in the Gulf of California and the continental slope off Mexico. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening*, 126: 178 pp., 15 pls.
- PHILIPPI, R. A., 1836, Beschreibung einiger neuen Conchylien-Arten und Bermerkung über die Gattung *Lacuna* von Turton. *Archiv für Naturgeschichte*, for 1836(2): 224–235, pls. 7, 8.
- PHILIPPI, R. A., 1846, Diagnosen einiger neuen Conchylien-Arten. *Zeitschrift für Malacologie*, 3(2): 19–24.
- PHILIPPI, R. A., 1848, Beschreibung zweier neuer



- Conchylien aus der Sammlung des Herrn Consul Gruner in Bremen. *Zeitschrift für Malacologie*, 5(1): 12–13.
- PIAZZA, M. & E. ROBBA, 1998, Autochthonous biofacies in the Pliocene Loreto Basin, Baja California Sur, Mexico. *Rivista Italiana di Paleontologia e Stratigrafia*, 104(2): 227–262.
- PILSBRY, H. A., 1897, New Australian mollusks. *Proceedings of the Academy of Natural Sciences of Philadelphia*, for 1897: 360–364, pl. 9.
- PILSBRY, H. A., 1922, Revision of W. M. Gabb's Tertiary Mollusca of Santo Domingo. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 73[for 1921](2): 305–436, pls. 16–47.
- PILSBRY, H. A., 1931, The Miocene and Recent Mollusca of Panama Bay. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 83[for 1931]: 427–440, pl. 41.
- PILSBRY, H. A., 1932, Note on a Panamic corbulid clam—*Panamicorbula*, a new subgenus of *Corbula*. *The Nautilus*, 45(3): 105.
- PILSBRY, H. A. & A. A. OLSSON, 1941, A Pliocene fauna from western Ecuador. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 93[for 1941]: 1–79, pls. 1–19.
- POWELL, C. L., II, 1988, The Miocene and Pliocene Imperial Formation of southern California and its molluscan fauna: an overview. *Annual Report of the Western Society of Malacologists*, 20: 11–18.
- PRESTON, H. M., 1931, Report on the Fruitvale Oil Field. *California Department of Natural Resources, Division of Oil & Gas, Summary of Operations—California Oil Fields*, 16(4): 5–24, 5 pls.
- REEVE, L. A., 1843–1844, Monograph of the genus *Corbula*. In: L. A. REEVE, ed., *Conchologia iconica; or illustrations of the shells of molluscous animals*, 2: 5 pls. + title page + index. London (Reeve) [pl. 1, August 1843; 2, September 1843; 3, January 1844; 4, April 1844; 5, May 1844]
- RICHARDS, H. G., 1947, Invertebrate fossils from deep wells along the Atlantic coastal plain. *Journal of Paleontology*, 21(1): 23–37, pls. 11–15
- RODDA, P. U., 1957, Paleontology and stratigraphy of some marine Pleistocene deposits in north-west Los Angeles Basin, California. *Bulletin of the American Association of Petroleum Geologists*, 41(11): 2475–2492
- RÖDING, P. F., 1798, *Museum Boltenianum . . . : pars secunda contiens conchyliis sive testacea univalvia, bivalvia & multivalva*. Hamburg (Trappii), vii + 109 pp.
- ROWLAND, R. W., 1972, Paleontology and paleoecology of the San Diego Formation in north-western Baja California. *Transactions of the San Diego Society of Natural History*, 17(3): 25–32
- RUTSCH, R. F., 1942, Die Mollusken der Springvale-Schichten (Obermiocaen) von Trinidad (Britisch-West-Indien). *Verhandlungen der Naturforschenden Gesellschaft in Basel*, 54: 96–182, pls. 3–9
- RUTTEN, L. M. R., 1931, Our palaeontological knowledge of the Netherlands West-Indies in 1930. *Leidsche Geologische Mededeelingen*, 5(1): 651–672
- SAY, T., 1822, An account of some of the marine shells of the United States. *Journal of the Academy of Natural Sciences of Philadelphia*, 2(2): 221–248, 257–276, 302–325
- SAY, T., 1824, An account of some of the fossil shells of Maryland. *Journal of the Academy of Natural Sciences of Philadelphia*, 4: 124–155, 410, pls. 7–13
- SCARLATO, O. A., 1981, Dvustvorchatye molliuski umerennykh shiroi zapadnoi chasti Tikhogo Okeana. [Bivalve mollusks of the temperate latitudes of the western part of the Pacific Ocean]. *Akademiia Nauk SSSR, Zoologicheskii Institut, Opredeliteli po Faune SSSR*, 126: 480 pp., 64 pls.
- SCHMIDT, F. C., 1818, *Versuch über die beste Einrichtung zur Aufstellung, Behandlung und Aufbewahrung der verschiedenen Naturkörper und Gegenstände der Kunst, vorzüglich der Conchlien-Sammlungen, . . .* Gotha (Perthes), [vi] + 252 pp.
- SCHRENCK, L. I., 1861, Vorläufige Diagnosen einiger neuer Molluskenarten aus der Meerenge der Tatarei und dem Nordjapanischen Meere. *Bulletin, Académie Impériale des Sciences de Saint Pétersbourg*, (3)4(7): cols. 408–413
- SCHRENCK, L. I., 1867, Mollusken des Amur-Landes und des Nordjapanischen Meeres. *Reisen und Forschungen im Amur-Lande in den Jahren 1854–1856 im Auftrage der Kaiserl. Akad. Wissensch. zu St. Petersburg ausgeführt und in Verbindung mit mehreren Gelehrten herausgegeben . . .* 2[Zool.](3): 259–974, pls. 12–30
- SMITH, A. G., 1968, Table 1. Invertebrate fossils from the marine facies of the Santa Rosa Island Formation. P. 22, in P. C. ORR, *Prehistory of Santa Rosa Island*. Santa Barbara (Santa Barbara Museum of Natural History), xxi + 253 pp., frontis.
- SMITH, E. A., 1872, A list of species of shells from West Africa, with descriptions of those hitherto undescribed. *Proceedings of the Zoological Society of London*, for 1871(3): 727–739, pl. 75
- SMITH, E. A., 1885, Report on the Lamellibranchiata collected by H. M. S. Challenger, during the years 1873–76. *Report on the Scientific Results of the Voyage of H. M. S. Challenger during the years 1873–76, . . . Zoology*, 13(35): 341 pp., 25 pls.
- SOOT-RYEN, T., 1957, On a small collection of pelecypods from Peru to Panama. *Lunds Universitets Årsskrift*, (n.f.)(2)53(10): 1–12
- SOPER, E. K. & U. S. GRANT IV, 1932, Geology and paleontology of a portion of Los Angeles, California. *Bulletin of the Geological Society of America*, 43(4): 1041–1067
- SOWERBY, G. B., I, 1833, [characters of new species of Mollusca and Conchifera, collected by Hugh Cuming] [one part of several]. *Proceedings*

- of the *Zoological Society of London*, for 1833[1] (1-3): 34-38
- SOWERBY, J., 1814, *The mineral conchology of Great Britain*; . . . , 1(14): 169-178, pls. 74-78
- SOWERBY, J., 1822, *The mineral conchology of Great Britain*; . . . , 4(63): 83-90, pls. 360-365
- SOWERBY, J. de C., 1835, *The mineral conchology of Great Britain*; . . . , *Systematical Index*, 4(105): 239-250
- SOWERBY, J. de C., 1840, [The shells on this and the following plates are figured and described by Mr. James de Carle Sowerby]. *Transactions of the Geological Society of London*, (2)5(2): [17 unnumbered pls., expl. for pls. 21-26]
- SPIEKER, E. M., 1922, The paleontology of the Zorritos Formation of the north Peruvian oil fields. *Johns Hopkins University, Studies in Geology*, 3: 197 pp., 10 pls.
- STANTON, R. J., 1966, Megafauna of the upper Miocene Castaic Formation, Los Angeles County, California. *Journal of Paleontology*, 40(1): 21-40, pl. 7
- STEINER, G. & S. HAMMER, 2000, Molecular phylogeny of the Bivalvia inferred from 18S rDNA sequences with particular reference to the Pteriomorpha. Pp. 11-29, in E. M. HARPER, J. D. TAYLOR & J. A. CRAME, eds., The evolutionary biology of the Bivalvia. *Geological Society of London Special Publication*, 177: vii + 494 pp.
- STUMP, T. E., Pleistocene molluscan paleoecology and community structure of the Puerto Libertad region, Sonora, Mexico. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 17(1975): 177-226
- TOULA, F., 1909, Eine jungtertiäre Fauna von Gatun am Panama-Kanal. *Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt*, 58(4): 673-760, pls. 25-28 [also paginated 1-88, pls. 1-4]
- TOWNSEND, C. H., 1901, Dredging and other records of the United States Fish Commission steamer *Albatross*. . . . *Report of the U.S. Commission on Fish and Fisheries*, year ending June 30, 1900[6], Appendix, Doc. 472: 387-562
- TRYON, G. W., Jr., 1869, Catalogue of the families Saxicavidae, Myidae and Corbulidae. *American Journal of Conchology*, 4(5)[Appendix]: 57-68
- TURNER, R. D., 1956, The eastern Pacific marine mollusks described by C. B. Adams. *Harvard University, Museum of Comparative Zoology, Occasional Papers on Mollusks*, 2(20): 21-135, pls. 5-21
- VALENTINE, J. W., 1956, Upper Pleistocene Mollusca from Potrero Canyon, Pacific Palisades, California. *Transactions of the San Diego Natural History Society*, 12(10): 181-205, pl. 13
- VALENTINE, J. W. 1957, Late Pleistocene faunas from the northwestern coast of Baja California, Mexico. *Transactions of the San Diego Society of Natural History*, 12(16): 289-308
- VALENTINE, J. W., 1959, Pleistocene molluscan notes. II: Faunule from Huntington Beach Mesa, California. *The Nautilus*, 73(2): 51-57
- VALENTINE, J. W., 1961, Paleocologic molluscan geography of the Californian Pleistocene. *University of California Publications in Geological Sciences*, 34(7): 309-442
- VALENTINE, J. W. & R. F. MEADE, 1961, Californian Pleistocene paleotemperatures. *University of California Publications in Geological Sciences*, 40(1): 1-46
- VALENTINE, J. W. & R. W. ROWLAND, 1969, Pleistocene invertebrates from northwestern Baja California del Norte, Mexico. *Proceedings of the California Academy of Sciences*, (4)36(17): 511-530
- VEDDER, J. G., 1960, Previously unreported Pliocene Mollusca from the southeastern Los Angeles Basin. *United States Geological Survey Professional Paper*, 400B: 326-328
- VOKES, H. E., 1945, Supraspecific groups of the pelecypod genus *Corbulidae*. *Bulletin of the American Museum of Natural History*, 86(1): 32 pp., 4 pls.
- WATTS, W. L., 1897, Oil and gas yielding formations of Los Angeles, Ventura, and Santa Barbara counties. *Bulletin of the California State Mining Bureau*, 11: x + 94 pp.
- WHITE, K. M., 1942, The pericardial cavity and the pericardial gland of Lamellibranchiata. *Proceedings of the Malacological Society of London*, 25(2): 37-88
- WILLETT, G., 1937, An upper Pleistocene fauna from the Baldwin Hills, Los Angeles County, California. *Transactions of the San Diego Society of Natural History*, 8(30): 379-406, pl. 25, 26
- WILLIAMSON, M. B., 1905, Some west American shells—including a new variety of *Corbula luteola* Cpr. and two new varieties of gastropods. *Bulletin of the Southern California Academy of Sciences*, 4(8): 118-129
- WILLAN, R. C., 1993, Taxonomic revision of the family Psammobiidae (Bivalvia: Tellinoidea) in the Australian and New Zealand region. *Records of the Australian Museum, Supplement*, 18: 132 pp.
- WINCKWORTH, R., 1930, Notes on nomenclature. *Proceedings of the Malacological Society of London*, 19(1): 14-16
- WINTERER, E. L. & D. L. DURHAM, 1962, Geology of southeastern Ventura Basin, Los Angeles County, California. *United States Geological Survey Professional Paper*, 334H: iv + 275-366, pls. 44-49
- WOODRING, W. P., 1938, Lower Pliocene mollusks and echinoids from the Los Angeles Basin, California. *United States Geological Survey Professional Paper*, 190: 67 pp., pls. 5-9
- WOODRING, W. P., 1982, Geology and paleontology of Canal Zone and adjoining parts of Panama. Description of Tertiary mollusks (pelecypods: Propeamussiidae to Cuspidariidae; additions to families covered in P 306-E; additions to gastropods; cephalopods). *United States Geological Survey Professional Paper*, 306F: iv + 541-759, pls. 83-124

- WOODRING, W. P., R. B. STEWART AND R. W. RICHARDS, 1941, Geology of the Kettleman Hills oil field, California: stratigraphy, paleontology, and structure. *United States Geological Survey, Professional Paper*, 195: 170 pp., 57 pls. [as "1940"]
- YOKOYAMA, M., 1922, Fossils from the Upper Musashino of Kazusa and Shimosa. *Journal of the College of Science, Tokyo [Imperial] University*, 44(1): 200 + viii, 17 pls.
- YONGE, C. M., 1946, On the habits and adaptations of *Aloidis (Corbula) gibba*. *Journal of the Marine Biological Association of the United Kingdom*, 26(3): 258-276
- ZHUANG, Q. & Y. CAI, 1983, Studies on the Corbulidae (Bivalvia) off Chinese coasts. *Transactions of the Chinese Society of Malacology*, 1: 57-68

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