

Diagnosis: Shell small to medium, trigonal to trigonal-oblong, with subequilateral, equally inflated, and nearly equal-sized valves. Left valve smooth or with very weak commarginal ribs, rarely with weakly ribbed nepionic cap. Right valve initially smooth or with very weak ribs becoming stronger toward venter. Posterior slope on right valve very narrow (groovelike) to moderately wide, and set off by two, narrowly spaced keels close to valve margin; one keel emanating from approximately midline of valve and other keel formed by ridge along posterior dorsal margin. Left-valve hinge with inclined, slightly projecting spoon-shaped chondrophore bearing median groove. Right-valve hinge with large, single cardinal tooth; adjoining pit deep.

Discussion: The new genus resembles *Ursirivus* Vokes, 1945, a Cenomanian corbulid, but the new genus has a more trigonal shape, discrepant sculpture, and an absence of a deep lunule.

The new genus also resembles *Vokesula* Stenzel & Twining in Stenzel et al., 1957, which ranges from the early Eocene to early Oligocene (Stenzel et al., 1957; Keen, 1969), but the new genus has less discrepant-sized valves, and two keels rather than only one on the right valve. In addition, *Excorbula* has a less inflated and proportionally shorter right valve with narrower umbones than *Vokesula*.

The new genus resembles *Varicorbula* Grant & Gale, 1931, which ranges from the early Eocene to Recent (Keen, 1969), but *Excorbula* has less discrepant-sized valves, no faint radial ribs on the surface of the left valve, and two keels rather than a single obscure one on the right valve.

The new genus resembles *Notocorbula* Iredale, 1930, which ranges from the Eocene to Recent (Stenzel et al., 1957), but *Excorbula* has a more or less quadrate shape; is much more equivalved in terms of size, height, and inflation; has a keel on right valve much nearer posterior dorsal margin; and the dorsal margin is keellike, lacks

radial ribs on the left valve, and has a much narrower posterior slope. In addition, *Excorbula* has a proportionally lower and less inflated right valve than *Notocorbula*.

The new genus resembles *Jurassicorbula* Fürsich, 1981, a Late Jurassic corbulid, but *Excorbula* has a less elongate shape, more equal inflation of the valves, two keels (on the right valve), and no posterior lateral teeth on the right-valve hinge.

Excorbula somewhat resembles *Caryocorbula*, but *Excorbula* differs by having a more trigonal shape, valves with discrepant sculpture, two keels, and a groove on the chondrophore rather than a median ridge.

Etymology: The generic name is a combination of the Latin *ex*, meaning from, and *Corbula*, meaning a little basket.

Excorbula coqua Squires & Saul, sp. nov.

(Figures 23–28)

Diagnosis: Small *Excorbula* with shell oblong. Commarginal ribs of left valve very weak, but strong on right valve. Posterior slope narrow on right valve.

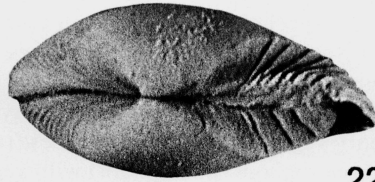
Description: Shell small (maximum length 9.9 mm). Valves trigonal oblong, tapered posteriorly, moderately inflated, nearly equivalved, and subequilateral. Left valve very slightly smaller than right valve. Anterior end rounded. Posterior end projected into short rostrum. Posterior slope on left valve wide and nearly smooth, set off by low keel. Posterior slope on right valve very narrow, concave, grooved, and set off by two, narrowly spaced keels close to valve margin; one keel emanating from approximately midline of valve and second, stronger "keel" formed by ridge along posterior dorsal margin. Posterior dorsal margin ridge usually widened posteriorly. Umbones moderately high, at midline of valves; beaks prosogyrate, just anterior to midline. Sculpture consisting of commarginal ribs becoming stronger with increased valve

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Figures 21–39. Specimens coated with ammonium chloride. Figures 21, 22. *Caryocorbula lomana* Squires & Saul, sp. nov. Figure 21. Paratype LACMIP 13109, LACMIP loc. 2853, right valve, $\times 7.8$. Figure 22. Paratype SDSNH 81142, SDSNH loc. 3387, dorsal view, $\times 11.7$. Figures 23–28. *Excorbula coqua* Squires & Saul, gen. & sp. nov. Figure 23. Paratype LACMIP 13111, LACMIP loc. 8180, left valve, $\times 9.3$. Figures 24, 25. Holotype LACMIP 13110, LACMIP loc. 10884, right valve, $\times 4.6$. Figure 24. Right valve. Figure 25. Oblique view of dorsal margin. Figure 26. Paratype LACMIP 13112, LACMIP loc. 10882, right valve, $\times 6.2$. Figure 27. Paratype LACMIP 13113, LACMIP loc. 10769, immature right valve, $\times 4.8$. Figure 28. Paratype LACMIP 13114, LACMIP loc. 10889, dorsal view, $\times 6$. Figures 29–35. *Excorbula parkyi* Squires & Saul, gen. & sp. nov. Figures 29–34. LACMIP loc. 10816. Figure 29. Paratype LACMIP 13115, left valve, $\times 3$. Figures 30, 31. Paratype LACMIP 13116. Figure 30. Left-valve hinge, $\times 3.3$. Figure 31. Left-valve hinge, dorsal view, $\times 3.8$. Figure 32. Holotype LACMIP 13117, right valve, $\times 2.9$. Figure 33. Paratype LACMIP 13118, right valve, oblique view, $\times 2.9$. Figure 34. Paratype LACMIP 13119, right-valve interior, $\times 2.9$. Figure 35. Paratype LACMIP 13120, LACMIP loc. 10787, dorsal view, $\times 4$. Figures 36–39. *Excorbula shastana* Squires & Saul, gen. & sp. nov. Figure 36. LACMIP paratype 13121, LACMIP loc. 24648, left valve, $\times 10.5$. Figure 37. LACMIP holotype 13122, LACMIP 24666, right valve, $\times 5.6$. Figure 38. LACMIP paratype 13123, LACMIP loc. 24217, partial right valve, $\times 6.7$. Figure 39. LACMIP paratype 13121, LACMIP loc. 24648, dorsal view, $\times 10$.



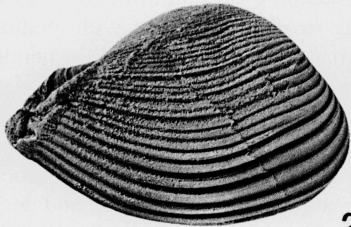
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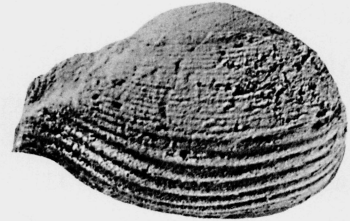
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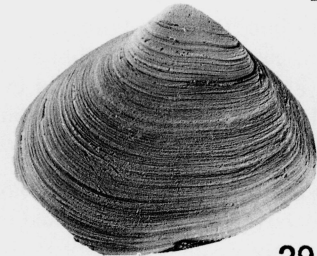
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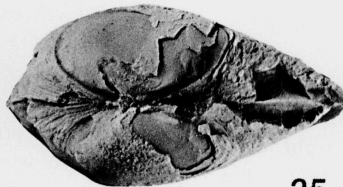
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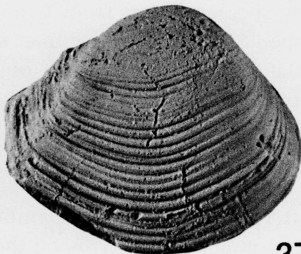
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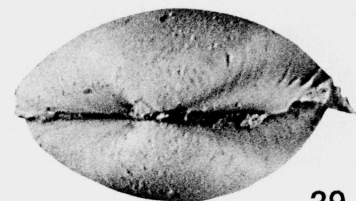
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size. Left-valve sculpture with very weak ribs becoming weak and more widely spaced toward venter, especially antero-ventrally. Right-valve sculpture with very weak closely spaced (7 ribs/mm) commarginal ribs on nepionic cap and becoming medium strength to strong, wavy, and much more widely spaced (2 to 3 ribs/mm) ventrally. Left-valve hinge with slightly projecting chondrophore; adjoining pit deep.

Dimensions of holotype:

Holotype: LACMIP 13110.

Type locality: LACMIP 10884, 33°42'01"N, 117°36'27"W.

Paratypes: LACMIP 13111 to 13114.

Geologic age: Turonian.

Distribution: Redding Formation, Bellavista Sandstone Member, east of Redding, Shasta County, northern California (Figure 1, locale 5); Ladd Formation, Baker Canyon Member, Santa Ana Mountains, Orange County, southern California (type locality) (Figure 1, locale 19).

Discussion: This new species is based on 62 specimens: 48 right valves, 12 left valves, and two pairs of conjoined valves. Only a single specimen (right valve) was found with a predatory drill hole. At LACMIP loc. 10079 in the Baker Canyon Member, the new species co-occurs with a few specimens of *Caryocorbula vacca*.

The new species is most similar to *Excorbula shastana*, gen. & sp. nov., but *E. coqua* differs by having a more elongate left valve, very weak ribs on the left valve, a narrower distance between the keel and the posterior dorsal margin on the adult right valve, and stronger ribs on the right valve.

Etymology: The specific name *coqua* is Latin, meaning to bake, and refers to the Baker Canyon Member.

Excorbula parkyi Squires & Saul, sp. nov.

(Figures 29–35)

Diagnosis: Medium *Excorbula* with shell trigonal. Left valve smooth. Commarginal ribs strong on right valve. Posterior slope very narrow (groovelike) on right valve.

Description: Shell medium (maximum length 15 mm), longer than high. Valves trigonal, equally moderately inflated, nearly equivalved, and nearly equilateral. Left valve slightly smaller than right valve. Anterior and posterior dorsal margins moderately steep and nearly equal. Posterior slope on left valve set off by low keel; posterior slope on some left valves also with weaker radial rib emanating from umbo and continuing to mid portion of posterior margin. Posterior slope on right valve coincident with narrow groove, set off by two, closely spaced keels, of nearly equal strength, and close to margin of valve.

One keel emanating from approximate midline of valve; outer keel coincident with ridge on posterior dorsal margin. Umbones moderately high, at midline of valves; beaks prosogyrate, just anterior to midline. Sculpture discrepant on valves. Left valve usually with only prominent growth lines; rarely immature part (nepionic to 2 mm in height) with very weak, closely spaced ribs becoming obsolete ventrally. Right valve with very weak commarginal ribs on immature part (nepionic to 5 mm in height). Ribs on right valve becoming stronger ventrally, with medium strength ribs on early mature part (6 to 8 mm in height) and strong ribs on more mature part; coarse ribs overlapping shinglelike toward umbo and wavy on some specimens and with deep interspaces on ventral part of valve. Left-valve hinge with projecting, broad, chondrophore bearing median groove; adjoining pit triangular and deep. Right-valve hinge with strong central cardinal tooth, curved upward; adjoining pit broad and deep.

Dimensions of holotype: Right valve, 11.4 mm in height, 15 mm in length.

Holotype: LACMIP 13115.

Type locality: LACMIP loc. 10816, 40°38'10"N, 122°6'W.

Paratypes: LACMIP 13116 to 13120.

Geologic age: Coniacian to early Santonian.

Distribution: CONIACIAN: Redding Formation, Bear Creek Sandstone Member and Member IV, east of Redding, Shasta County, northern California (type locality) (Figure 1, locale 5); Chico Formation, Ponderosa Way Member, Chico Creek, Butte County, northern California (Figure 1, locale 7). LOWER SANTONIAN: Redding Formation, Member V, east of Redding, Shasta County, northern California (Figure 1, locale 5).

Discussion: This new species is based on 398 specimens: 282 right valves, 113 left valves, and three pairs of conjoined valves. Many of the single-valved specimens are fragments. Eleven specimens (five left valves and six right valves) show predatory drill holes. The new species is most abundant at the type locality in Oak Run east of Redding, northern California.

The new species resembles *Jurassicorbula edwardi* (Sharpe, 1850:191–192, pl. 21, figs. 2a, b; Fürsich, 1981: 738–739, figs. 1a, b) from Upper Jurassic strata of Portugal and France. The new species differs from *J. edwardi* by having a trigonal-shaped left valve rather than an elliptical one, equally inflated valves, two keels on right valve and somewhat stronger ribs on the right valve, as well as no lateral teeth on the right-valve hinge.

Excorbula parkyi also resembles *Panzacorbula pozo*, but *E. parkyi* differs by having a trigonal shape, no deep lunule, no ribs on the left valve, no ribs on the immature part of the right valve, and much weaker ribs on the mature part of the right valve.

Etymology: The species is named for Willis Parkison ("Parky") Popenoe, in recognition of his insightful and careful work on Cretaceous mollusks from the study area.

Excorbula shastana Squires & Saul, sp. nov.

(Figures 36–39)

Diagnosis: Small *Excorbula* with shell trigonal to sub-trigonal. Left valve smooth. Commarginal ribs on right valve up to medium strength. Posterior slope moderately wide on right valve.

Description: Shell small (maximum 8 mm in length), longer than high. Left valve trigonal ovate; right valve trigonal to subtrigonal, rarely rostrate. Valves nearly equi-valved, moderately inflated, right valve more inflated than left valve. Left valve slightly smaller than right valve. Anterior end rounded. Posterior end truncate, or rarely rostrate. Posterior slope of left valve set off by rounded keel. Posterior slope of right valve moderately wide and set off by two low keels, both becoming more distinct ventrally. Ventral-most keel strongest, dorsal-most keel near but not coincident with posterior dorsal margin. Umbones wide and low, at midline of valves; beaks prosogyrate, just anterior to midline. Left valve nearly smooth. Right valve with nearly smooth umbo (occasional minute radial threads), sculpture beginning about just ventral of umbo and consisting of moderately closely spaced (5 ribs/mm), very weak strength commarginal ribs, becoming slightly stronger (weak) and somewhat wavy ventrally.

Dimensions of holotype: Right valve, 5.5 mm in height, 6.8 mm in length.

Holotype: LACMIP 13121.

Type locality: LACMIP 24666, 40°4'23"W, 121°44'38"W.

Paratypes: LACMIP 13122 & 13123.

Geologic age: Late Coniacian to early Campanian.

Distribution: UPPER CONIACIAN: Chico Formation, Ponderosa Way Member, Chico Creek, Butte County, northern California (Figure 1, locale 7). SANTONIAN: Redding Formation, upper part of Member VI, east of Redding, Shasta County, northern California (type locality) (Figure 1, locale 5); Chico Formation, Musty Buck Member, Chico Creek, Butte County, northern California (Figure 1, locale 7). LOWER CAMPANIAN: Chico Formation, Ten Mile Member, Chico Creek, Butte County, northern California (Figure 1, locale 7); Chico Formation, Pentz Road member (informal), near Pentz, Butte County, northern California (Figure 1, locale 8).

Discussion: This new species is based on 121 specimens: 106 right valves, 13 left valves, and two pairs of conjoined valves. Specimens are the most abundant at LAC-

MIP loc. 24648. Three specimens (all right valves) show predatory drill holes.

The new species co-occurs with *Caryocorbula traskii* in the Musty Buck Member, Ten Mile Member, and Pentz Road member.

The new species is most similar to *E. coqua*, but *E. shastana* differs by having a less elongate left valve, no ribs on the left valve, a wider distance between the keel and the posterior dorsal margin on the adult right valve, and weaker ribs on the right valve.

Etymology: The species is named for Shasta County, northern California.

Panzacorbula Squires & Saul, gen. nov.

Type species: *Panzacorbula pozo* (Dailey & Popenoe, 1966); Late Cretaceous (early late Campanian to early Maastrichtian), southern and south-central California.

Diagnosis: Shell medium, subpryiform to elongate trigonal. Right valve slightly more inflated than left valve. Lunule deep. Commarginal ribs on left valve very weak to weak, and right valve covered with strong ribs. Keel well developed on juveniles, obsolete on mature specimens. Chondrophore inclined and spoon-shaped with long, narrow pit posteriorly adjoining it.

Discussion: The new genus is the only known Cretaceous brackish-marine corbulid from the study area.

The new genus resembles *Indocorbula* Fürsich et al., 2000, from Middle Jurassic strata in western India, but *Panzacorbula* differs by having discrepant sculpture; obsolete keel; an inclined, spoon-shaped chondrophore; a long, narrow pit posteriorly adjoining the chondrophore; and no indication of radial ornament.

The new genus somewhat resembles *Ursirivus* Vokes, 1945, from Cenomanian strata of Texas (Stephenson, 1952) and Upper Cretaceous strata of Wyoming and Idaho (Vokes, 1945), but *Panzacorbula* differs by being smaller and having a less elongate shape, discrepant inflatedness of the valves, discrepant sculpture, stronger sculpture on the right valve, and the presence of a long, narrow pit posteriorly adjoining the chondrophore.

Etymology: The genus is named for its occurrence in the La Panza Mountain Range, California.

Panzacorbula pozo (Dailey & Popenoe, 1966)

(Figures 40–45)

Corbula pozo Dailey & Popenoe, 1966:19–20, pl. 5, figs. 6–10.

Corbula? sp. aff. *C. pozo* Dailey & Popenoe. Elder et al., 1998:152, pl. 1, fig. 15.

Corbula n. sp. aff. *C. pozo* Dailey & Popenoe. Throckmorton, 1988:pl. 1, fig. 2, table 1.

Corbula sp. Throckmorton, 1988:table 1.