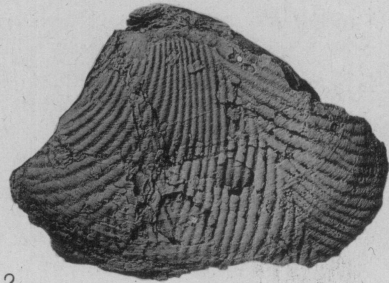
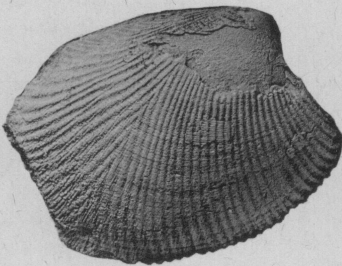


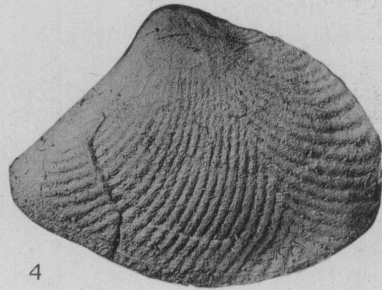
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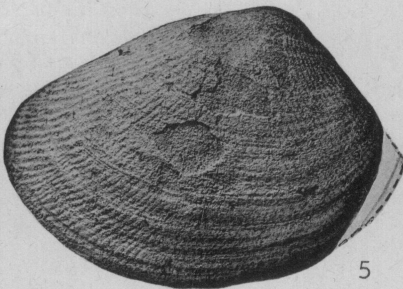
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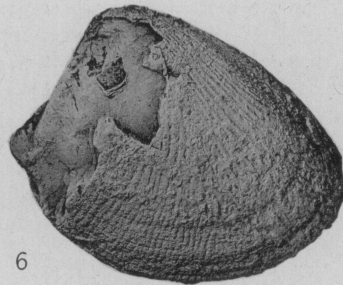
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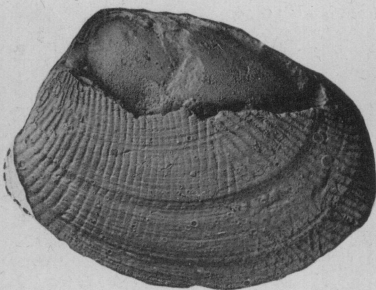
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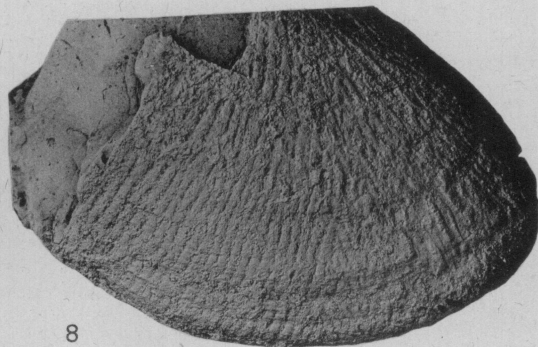
5



6



7



8

Schenck, Upper Cretaceous Acilas

high. As it was tilted when photographed in order to accentuate the details of the ribbing, the characteristic profile of the species cannot be judged from this figure. The Pleasants sandstone specimen shown in figure 7 measures 15.2 mm. in length, 12.3 mm. in height; this figure was designed to illustrate the nature of the ribbing on the posterior part of the shell; the exact profile of this valve is indeterminate owing to the matrix. Another Pleasants sandstone specimen, figure 3, is 13.5 mm. long, 10.6 mm. high.

The sculpturing of the two species is similar in proportions, but the ribs are wider in *A. princeps*. On the new species there are about 1.6 to 1.8 radial ribs per millimeter, in contrast to 2.2 to 2.4 ribs per millimeter on *A. demessa*. No distinct area of obsolete radial ribbing has been noted on topotypes of *A. demessa*, whereas this feature is present on the holotype of *A. princeps*.

In general, the umbonal angle of *A. demessa* appears to be greater than in *A. princeps*, the median of the former being 110°. The median of the ratio of height to length in *A. demessa* is 80 percent, whereas in *A. princeps* (N = 26) the median falls in the 79 percent class interval.

Comparison with Acila (Truncacila) sp. D.—On plate 9, fig. 5, is figured a specimen (type no. 7368, Stanford Univ. Paleont. Type Coll.) from the "Chico" formation

exposed along the Santa Fe railroad near Martinez, Contra Costa County, California, at locality 2180 (75 mm. west, 20 mm. south of intersection of Lat. 38°00' and Long. 122°05', on the map of the Concord quadrangle). A description of the section through this locality is contained in a report by Watson (1941). According to current views on correlation based on foraminiferal faunules, the sandstone with this specimen is not only older than the Moreno formation but is also older than the lowest known occurrence of *Acila demessa*.

Acila (Truncacila) sp. D is about 21 mm. long, 14.6 mm. in height, thus falling into the general size category of *A. princeps*, but the largest radial rib is about 350 microns wide, in contrast to the coarser ornamentation of *A. princeps*. In sculpturing but not in proportions, therefore, *Acila* sp. D resembles *A. demessa*.

Comparison with Acila (Truncacila) sp. E.—On plate 9, figure 4, is illustrated a specimen (type no. 7369, Stanford Univ. Paleont. Type Coll.) from the Moreno formation in the NE corner of the SE $\frac{1}{4}$ sec. 23, T. 16 S., R. 12 E., M.D.M., Fresno County, California, collector Donald C. Birch. This single specimen is a mold in a white-weathering limestone concretion in brown shale. This is the same species as that which the writer (1936-b, p. 50) has called "*Acila (Truncacila) cf. demessa*," as based on hypotype no.

EXPLANATION OF PLATE 9

Specimens illustrated in Figs. 1, 3, 7 at California Institute of Technology; others in Stanford University Paleontological Type Collection.

- FIGS. 1, 3, 7—*Acila (Truncacila) demessa* Finlay. Upper Cretaceous, Corona Quad., Santa Ana Mts., Orange Co., California. 1, Left valve, $\times 3.5$, from Upper Holz shale, C. I. T. loc. 1059, $\frac{1}{4}$ mi. above mouth of Harding Canyon. 3, Left valve, $\times 3$, from Pleasants sandstone, C. I. T. loc. 975, 300 feet NW of middle of S line of sec. 29, T. 5 S., R. 7 W., S.B.M. 7, Right valve, $\times 3$, Pleasants sandstone, C. I. T. loc. 974, middle of S line of sec. 29, T. 5 S., R. 7 W., S.B.M. Hypotypes, C. I. T. nos. 4650-4652. (p. 64)
- 2, 4—*Acila (Truncacila) sp. E.* Marca shale member, Moreno formation (Upper Cretaceous) 2, Right valve, from L.S.J.U. loc. 2574, 1000 feet. NE of center of sec. 17, T. 19 S., R. 15 E., M. D. B. & M., Fresno County, California; a crushed specimen, $\times 2.2$, details of profile uncertain; hypotype 5906, 4, Right valve, $\times 2.8$, rubber cast from mold in limestone concretion, L.S.J.U. loc. 2575, NE cor. SE $\frac{1}{4}$ sec. 23, T. 16 S., R. 12 E., M. D. B. & M., Fresno County, California; hypotype 7369. (p. 65)
- 5—*Acila (Truncacila) sp. D.* Upper Cretaceous near Martinez, Contra Costa County, California; L.S.J.U. loc. 2180, in railroad cut 500 feet west of Santa Fe Railroad tunnel above Franklin Canyon Inn. Rubber cast from mold of left valve, $\times 2.5$; details of profile uncertain; hypotype 7368. (p. 65)
- 6, 8—*Acila (Truncacila) sp. F.* Upper Cretaceous. Calif. Acad. Sci. loc. 950, San Antonio del Mar, Baja California, Mexico. 6, Right valve, $\times 1.7$, of specimen 26 mm. long; 8, enlarged view of anterior portion, $\times 2.8$, to show ribbing; hypotype 6023, Calif. Acad. Sci. (p. 66)

5906, Stanford Univ. Paleont. Type Coll., a crushed specimen about 19 mm. long, 16 mm. high, illustrated on plate 9, figure 2.

The specimen collected by Birch came from 500 feet stratigraphically below the top of the Moreno formation. This would be the Marca shale member of the Moreno formation of this area, which according to Payne (written communication) is overlain by the Dos Pálos shale member and is underlain by the Tierra Loma shale member, below which, in turn, is the Mercy sand lentil. Payne believes that this *Acila* from the Marca member is geologically younger than *Acila princeps*.

Acila (Truncacila) sp. E (pl. 9, fig. 4) is 17 mm. long, 12 mm. high, thus falling into the general size category of *Acila demessa*. Viewed posteriorly, however, the Marca specimen has radial ribs ($450 \pm$ microns wide) continuing to the margin of the valve, whereas in *demessa* the ribless area in the "escutcheonal" region is a striking morphologic feature. Finally, the sculpturing of *Acila* sp. E is coarser than that of *demessa*. Compared with *A. princeps*, the smaller size and comparatively coarser ornamentation will separate the species.

Other specimens referred to *Acila* sp. E were generously donated by Arthur S. Huey from the Superior Oil Company well "Ciervo Unit Plan" No. 1, 330 feet north, 2156 feet west of the SE corner sec. 20, T. 16 S., R. 13 E., M.D.B.&M., depth (approximate) 5220 feet, associated with numerous specimens of *Siphogenerinoides*. The stratigraphic position is estimated to be 810 feet below the top of the Moreno formation.

Comparison with Acila (Truncacila) sp. F.—The specimen figured on plate 9, figures 6, 8, from Baja California, Mexico,¹ is the one which Schenck (1936-b, pp. 49-50) had identified as *A. demessa*. According to F. M. Anderson (as transmitted by L. G. Hertlein) the strata at the locality are upper Campanian in age. Measurements are as follows: length, 26 mm.; height, 20 mm.;

¹ California Academy of Sciences Locality 950: Hard lens about 1 foot thick outcropping behind old distillery on Johnson Ranch at San Antonio del Mar, Lower California, Mexico. Upper Cretaceous mollusks collected by E. K. Jordan and L. G. Hertlein, January, 1926.

radial ribs near middle of the ventral margin, 430 microns in width. Compared with *A. princeps* this specimen differs in profile and ornamentation. Its large size, shape and ornamentation are the reasons for now excluding it from *A. demessa*.

Comparison with Acila hokkaidoensis (Nagao).—The new species approaches the Japanese species in size. The holotype of *hokkaidoensis* is 30 mm. long and 22 mm. in height; the largest paratype measures 30 mm. in length, 20 mm. in height, and 10 mm. in thickness (two valves). Thus, *princeps* differs in height-length relations and is more inflated than *hokkaidoensis*. The two species differ somewhat in profile and ornamentation.

AGE AND ORIGIN OF THE SANDSTONE AT LOCALITY 2372

The precise dating of the sand lentil with *Acila princeps* at locality 2372 in terms of the European standard of the Cretaceous is not possible with the limited data now in hand, although certain inferences may be offered for testing. The "*Acila*-scale" would date the sandstone as Aptian or younger, as the oldest known *Acila* is Aptian. The fossiliferous beds of the upper Panoche formation, stratigraphically below the sandstone carrying the new species, are believed to be Campanian in age. *Siphogenerinoides whitei* Church from the shale $260 \pm$ feet stratigraphically above the locality of the new species is closely related to *Siphogenerinoides cretacea* Cushman from the lower Colon shale (possibly Campanian) of Venezuela. The foraminiferal faunule from this superjacent shale contains enough species to warrant a correlation with at least a part of the type Tierra Loma shale member of the Moreno formation, where late Cretaceous reptiles have been collected and reported upon by Stock (1941). The mollusks associated with *Acila princeps* are thought to be restricted to the Upper Cretaceous. Although available evidence proves that the sand lentil with this new nuculid pelecypod is late Cretaceous in age, only indirect reasoning permits the surmise that it is Maestrichtian.

Refined correlations of finely-spun lithogenetic units such as the sand lentil with *Acila princeps* with others of the Cretaceous

in California are inconclusive at this time. Perhaps, however, a few of the occurrences of *Acila demessa* will be suggestive of synchronizations.

The uppermost sandstone member of the Panoche formation at its type area, as defined by Anderson and Pack (1915), carries abundant specimens of *Acila demessa* in association with *Baculites*, *Glycymeris veatchii*, *Hamites ellipticus*, *Parallelodon* cf. *van-couverensis*, and *Turritella chicoensis* var., at L.S.J.U. locality 2251 (600 feet south, 700 feet west of the NE cor. sec. 12, T. 15 S., R. 11 E., M.D.M., Fresno Co.). This is the assemblage that occurs in the upper member of the Panoche formation, as mapped by Payne, in the Charleston School quadrangle.

G. D. Hanna and J. H. Show collected *A. demessa* from California Academy of Sciences locality 1552, sec. 28, T. 26 S., R. 18 E., M.D.M., 500 feet west of center of section 28, in the Panoche formation. This is in the area of "Knoxville-Chico" rocks mapped by Arnold and Johnson (1910) at the north end of Shale Hills.

Acila demessa occurs in the type Chico formation about 1250 feet above its base, as measured by Taff, Hanna, and Cross (1940). The specimens are from C. A. S. locality 27838 (sec. 23, T. 23 N., R. 2 E.) on Big Chico Creek. From the same locality those authors figure specimens of "*Ammonites*" *chicoensis*, *Baculites chicoensis*, *Oligoptycha obliqua*, *Anchura falciformis*, *Tenea inflata*, and *Trigonocallista varians*. The "*Ammonites*" is *Submortonicerias*, according to Siemon Wm. Muller (personal communication), and is Campanian in age.

In Shasta County, Redding region, Popenoe has collected numerous specimens of *Acila*, some of which are certainly *demessa*. He has stated (written communication) that the total stratigraphic range of *Acila demessa* in that area is about 1100 feet.

In the Santa Ana mountains, Corona quadrangle, Orange County, Popenoe has collected *Acila demessa* (pl. 9, figs. 3, 7) from C. I. T. locality 974 (middle south line sec. 29, T. 5 S., R. 7 W.), locality 975 (300 feet northwest of loc. 974), and locality 976 (NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 19, T. 5 S., R. 7 W.), about 50-75 feet above the Pleasants member of the Williams formation. The range of the

species, its occurrences at other localities, and associated fossils are given by Popenoe (1942). Among the many species found with *A. demessa* in the Pleasants member are *Baculites*, *Clisocolus cordatus*, *Cymbophora ashburnerii*, "*Fulgur*" *hilgardi*, *Glycymeris veatchii*, *Gyrodus expansus*, *Legumen ooides*, *Metaplacenticeras pacificum*, *Oligoptycha obliqua*, *Perissitys brevirostris*, and *Turritella chicoensis* (flat-whorled variety).

The subjacent upper Holz shale carries *Acila demessa* (p. 9, fig. 1) at C. I. T. locality 1059, between Santiago and Williams canyons, about 4650 feet N. 62° W. of the dam one-fourth mile upstream from the mouth of Harding canyon, Corona quadrangle. The molluscan fauna of the upper Holz shale, according to Popenoe, includes *Clisocolus cordatus*, *Cymbophora ashburnerii*, *Flaventia lens*, *Glycymeris veatchii*, *Tenea inflata*, *Turritella chicoensis perrini*, and many other species. No specimens of *Acila* were recorded from the middle and lower Holz shale nor from the subjacent Baker Canyon sandstone member of the Ladd formation. The recorded stratigraphic range of *Acila demessa* in the Santa Ana mountains is thus provisionally estimated to be approximately 300 feet.

The careful work by Popenoe seems to have established the Teilzone of *Acila demessa* in the Santa Ana mountains and in Shasta County. The writer is struck by the fact that the fauna of the Pleasants sandstone is closely comparable with that recorded by Schenck (1936-b, p. 49) from the type locality of *A. demessa* in Butte County. He is also impressed by the similarity of these two faunas with the assemblages from the upper sandstone member of the Panoche formation at its type area and from the upper Panoche, as mapped by Payne, in the Charleston School quadrangle, well below the sandstone with *A. princeps*. Hence, the conclusion is reached that *Acila princeps* is geologically younger than *Acila demessa*.

If such correlations as have been drawn in this paper are correct, then it would seem possible to propose a sequence of species of *Acila* in California. The oldest known *Acila* is the one from Contra Costa County here described as *Acila (Truncacila)* sp. D. Next in chronological order is *Acila (Truncacila) demessa* Finlay. Still younger is *Acila (Trun-*

cacila) *princeps* Schenck. The youngest Cretaceous species so far collected is the one described as *Acila* (*Truncacila*) sp. E from the Marca shale member of the Moreno formation.

Finally, a possible origin of the sandstone at locality 2372 may be inferred from the distribution of Recent specimens of *Acila* and from the petrographic study of Krauskopf. The hypothesis is that the sand was deposited rapidly without much weathering in the late Cretaceous sea between 8 and 800 fathoms, in water temperatures probably lower than 72° Fahrenheit and higher than 34° F. The sand may have been laid down in the lower neritic or upper bathyal zone in temperate waters.

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