Nonmarine Ostracodes of Early Cretaceous Age From Pine Valley Quadrangle Nevada

GEOLOGICAL SURVEY PROFESSIONAL PAPER 643-B

Nonmarine Ostracodes of Early Cretaceous Age From Pine Valley Quadrangle Nevada

By I. G. SOHN

CONTRIBUTIONS TO PALEONTOLOGY

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Descriptions of two new nonmarine ostracode species of Aptian age

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NONMARINE OSTRACODES OF EARLY CRETACEOUS AGE FROM PINE VALLEY QUADRANGLE, NEVADA

By I. G. Sohn

ABSTRACT

Nonmarine *Cypridea* (*Cypridea*) *pecki* n. sp. and *C.* (*Bisulcocypridea*) *vicostata* n. subgen., n. sp. are described from Nevada. *C.* (*C.*) *pecki*, associated in Nevada with "*Paracypridea*" sp. and *Petrobrasia*? sp., was recorded from the Draney Limestone (upper Aptian) of Idaho-Wyoming as *C. diminuta* Vanderpool, 1928. Its presence indicates that the age of the rocks in Nevada is late Aptian. *C.* (*C.*) *lubimovae* new name is proposed for *C. spinigera* Lubimova, 1956, not *C. spinigera* (Sowerby), 1836.

INTRODUCTION

A nonmarine ostracode faunule of Early Cretaceous age was discovered during geologic mapping in Elko County, Nev. In 1956, J. F. Smith and K. B. Ketner collected a sample of dark mudstone, which contains carbonaceous inclusions and many poorly preserved ostracodes, from an unnamed formation in the Pine Valley quadrangle (fig. 1, loc. 2). I was guided to this locality in July 1959 by J. F. Smith, K. B. Ketner, Jack Wolfe, and Pedro Gelabert, all of the U.S. Geological Survey, and made two collections: one (USGS Mesozoic loc. 27753), from about halfway up the shale slope in the center of W½NW¼ sec. 21, T. 29 N., R. 53 E.; the second (USGS Mesozoic loc. 27754), from the original locality at the top of the slope.

ACKNOWLEDGMENTS

I am grateful to J. F. Smith and K. B. Ketner for guiding me to the localities. Photographs are by D. H. Massie and R. H. McKinney, and the plates were assembled by Elinor Stromberg and Sharie L. May, all of the Geological Survey. Prof. Nicolas Grekoff, of the Institut Français du Pétrole, Paris, furnished duplicates of his species and permitted me to illustrate one of the specimens.

CRETACEOUS SEDIMENTARY ROCKS IN NEVADA

Only four Cretaceous formations that have type-localities in Nevada have been known previously. This report documents an additional Nevada occurrence of Lower Cretaceous fossiliferous rocks. Smith and Ketner (oral commun., Nov. 1967) tentatively correlated the ostracode-bearing sedimentary rocks in Elko County with the Newark Canyon Formation in the Eureka district.

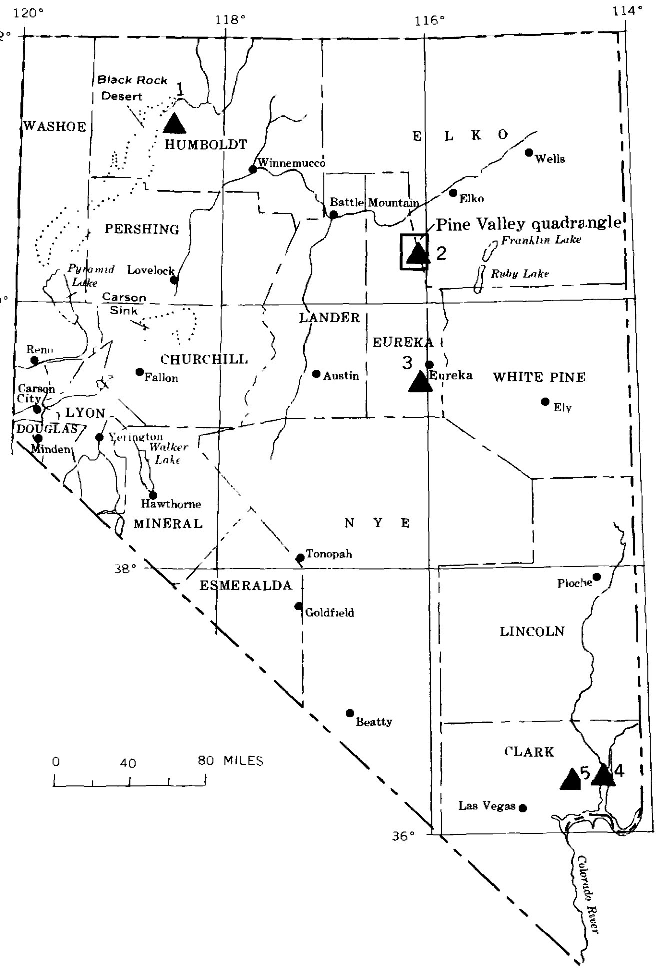

FIGURE 1.—Index map of Nevada showing the approximate location of areas from which Cretaceous nonmarine sedimentary rocks have been reported. Locality numbers are referred to in the text.

Longwell (1949, p. 931–933) described the Upper Cretaceous Baseline Sandstone and the Willow Tank Formation from the Muddy Mountain area near Las Vegas, in southern Nevada (fig. 1, loc. 4), and the Upper Cretaceous(?) Thumb Formation (Longwell, 1952, p. 35) from Frenchman Mountain, also in southern Nevada (fig. 1, loc. 5). Ostracodes found in the Willow Tank Formation were examined by Peck, who referred to them (in Longwell, 1949, p. 932) as "* * * numerous specimens of a species of *Metacypris* that are also found in the Gannett group and Bear River."

Nolan and others (1956, p. 69) described the Lower Cretaceous Newark Canyon Formation from the Eureka district (fig. 1, loc. 3). The age was based on previously described mollusks (MacNeil, 1939) and a species of fish (David, 1941). A slab from this formation that bears a specimen of the fish *Leptolepis nevadensis* David, 1941, contains molds and casts of ostracodes that are smooth and that differ on the family level from those described in this paper. Willden (1958, p. 2382–2391) described the King Lear Formation from the Jackson Mountains, Humboldt County (fig. 1, loc. 1). An Early Cretaceous age for this formation is based on the identification by J. B. Reeside, Jr., of a collection of mollusks which he considered to be similar to those described by MacNeil (1939).

INTERPRETATION OF THE OSTRACODES

One collection (USGS Mesozoic loc. 27753) contains abundant ostracodes, among which are a notched type belonging to *Cypridea* (*Cypridea*) *pecki* n. sp. Representatives of this species were previously identified by Peck (1941, p. 298) from the Draney Limestone (upper Aptian) of Idaho-Wyoming as being the lower Albian *C. diminuta* Vanderpool, 1928. *C.* (*C.*) *pecki* suggests a late early Cretaceous age for the sedimentary rocks in Nevada.

The other collection (USGS Mesozoic loc. 27754) does not contain *C.* (*C.*) *pecki;* it contains abundant poorly preserved specimens of a notched bisulcate ostracode *C.* (*Bisulcocypridea*) *bicostata* n. sp., to the virtual exclusion of other forms. A few smooth very poorly preserved ostracodes are present, but they are unidentifiable. Because *C.* (*B.*) *bicostata* is new and not closely related to known species, it does not aid in determining the geologic age of the rocks.

The fresh-water Early Cretaceous Cyprideinae have a worldwide distribution. Unlike other fresh-water ostracodes, this group developed considerable variability in the shell morphology; consequently, individual species are easily recognized, and misidentification is less likely than in the smooth, nondescript forms.

C. (*C.*) *pecki* n. sp. and *C.* (*C.*) *diminuta* Vanderpool, 1928, in North America differ only slightly in size, shape, and surface ornament from the older (Wealden) *C.* (*C.*) *ultima* Grekoff, 1957, and *C.* (*C.*) *primaria* Grekoff and Krömmelbein, 1967, in Africa and from the Barremian *C.* (*Ulwellia*) *karataigysensis* Lubimova, 1956, in the Ciscaspian of Eurasia. *C. hystricoides* Krömmelbein, 1962 (Late Jurassic? to Early Cretaceous), from Brazil is represented by a close relative, *C.* n. sp. aff. *C. hystricoides* Krömmelbein, in probably somewhat younger beds in Israel (Sohn, 1968, pl. 1, figs. 22, 23). It is particularly significant that the same species have been identified in beds of approximate similar ages on both sides of the South Atlantic. Grekoff and Krömmelbein (1967) identified and illustrated seven species of *Cypridea* and three additional related species from the Cocobeach Series of Gabon, Africa, that were originally described from the Bahia Series of Brazil. The total number of Brazilian forms found in Africa is 30 species and six related species, all distributed in 10 genera.

The circumglobal distribution of *Cypridea* suggests that the group possibly deposited eggs that could withstand dessication. This hypothesis is supported by the morphology of the carapace. Dimorphism in *Cypridea* is unknown, although Krömmelbein (1961) described sexual dimorphism in *Paracypridea* as consisting of a somewhat wider posterior in dorsal outline of heteromorphs. This difference in width is not as pronounced as it is in the *Metacypris-Gomphocythere-Theriosynoecum* group, in which the females have an inflated posterior. I have found first and second instars associated with eggs within the inflated posterior of an as yet unidentified species of a living "*Metacypris*," and Elofson (1941, p. 368) noted that certain genera having inflated posteriors are viviparous. The absence of an inflated posterior in *Cypridea* and related genera suggests that the group was not viviparous and that the females deposited their eggs. There is no evidence for or against parthenogenesis in the Cyprideinae, except that *Paracypridea* may have been dioecious. Many modern fresh-water ostracodes deposit eggs that can withstand dessication, and this property is considered to facilitate their wide distribution.

The large distances between localities from which Cyprideinae have been described in North America, South America, Eurasia, Asia Minor, and North Africa requires an explanation. The hypothesis of continental drift (Krömmelbein, 1966a, 1966b) does not explain this wide distribution, because even if the continents were closer to each other during Early Cretaceous time, the distances between localities would still have been considerable. These nonmarine organisms require a transporting agent for their dispersal. Although small aquatic organisms may be transported and dispersed by many animals, their main means of dispersal is considered to be winds, insects, and birds. The fact that one Cyprideinae locality is south of the present equator and the rest are north of the equator, and that Cyprideinae distribution is circumglobal from north to south, would rule out winds and insects that are dependent on winds for their distribution as effective agents of Cyprideinae dispersal.

Proctor (1964) proved that ostracodes can be distributed by birds. He cultured fresh-water ostracodes from eggs obtained from fecal pellets and from the lower digestive tracts of domestic and wild ducks.

All these considerations suggest that the Early Cretaceous freshwater ostracodes may have been dispersed by migratory birds, but the obvious difficulty with this hypothesis is that migratory birds of Early Cretaceous age are not known. The oldest recorded birds in North America are *Ichthyornis* and *Hesperornis* from the Niobrara Formation (Late Cretaceous) of Kansas (Romer, 1950, p. 263; 1966, p. 167). *Ichthyornis* was similar to a modern tern in structure; it may have been able to travel considerable distances (Thomson, 1964, p. 323). In addition, Fisher (1967, p. 735) recorded the stratigraphic range of the Phoenicopteriformes as Barremian, and probably Berriasian, to Holocene and indicated that the Enaliornithidae of Albian age were possibly ancestral to the Gaviiformes of Maestrichtian to Holocene ages. Both the Phoenicopteriformes and the Gaviiformes are strong fliers. The possibility that additional, as yet undiscovered, birds existed during Early Cretaceous time should not be discounted.

SYSTEMATIC DESCRIPTIONS

Subfamily CYPRIDEINAE Martin, 1940

Diagnosis.—Straight-hinged smooth or ornamented inequivalved ostracodes having a well-developed to a weakly developed anteroventral beak and closed notch (furrow) extending upward from ventral margin; ridge and groove hingement; terminal dentition weak or lacking.

Discussion.—When I previously discussed this group (Sohn, 1958, p. 122), I recorded the stratigraphic range as Middle Jurassic through Eocene and listed the following genera in the Cyprideinae:

Cyamocypris Anderson, 1939
Cypridea Bosquet, 1852
Langtonia Anderson, 1939=*Pseudocypridina* Roth, 1933
Morinia Anderson, 1939 [misspelling of *Morinina*]
Paracypridea Swain, 1946
Pseudocypridina Roth, 1933
Ulwellia Anderson, 1939=*Cypridea* Bosquet, 1852

All these genera were treated as synonyms of *Cypridea* in the Russian treatise (Lubimova, Mandelstam, and Schneider in Tchernysheva, 1960, p. 353), and their stratigraphic range was recorded as "Upper Permian-Oligocene." I am grateful to Dr. G. F. Schneider, Vsesoyuznyi Neftyanyi Nauchno-Issledovatelskii Geologo-Razvedochnyi Institut (VNIGRI), Leningrad (written commun., 1967), for the information that Mandelstam (1956, p. 103) had discovered a species of *Cypridea* in the lower horizons of the Il'inskoi Formation (Permian) in the Kuznetzk Basin. Until that species is described and illustrated, a Late Permian range for *Cypridea* remains in doubt. The Oligocene occurrence is based on the description and illustrations of the Early Cretaceous species *C. spinigera* (Sowerby), 1836, from the Hamstead Beds (Middle Oligocene) on the Isle of Wight by Jones and Sherborn (1889, p. 14, pl. 1, figs. 8–11; pl. 3, figs. la, b). I discussed this anomalous occurrence with Dr. F. W. Anderson at the Institute of Geological Sciences, London, in July 1967. Dr. Anderson stated that he had investigated this problem and concluded that the alleged Oligocene specimens are similar in preservation and color of the matrix to Weald Clay and not to the Hamstead sedimentary rocks. Furthermore, notched ostracodes have not been found again in rocks of Oligocene age; consequently, it is reasonable to assume that there had been a mixup in labels and that the *C. spinigera* specimens are of Early Cretaceous age. Sylvester-Bradley (1949, p. 127) and Anderson (1967, p. 249) hinted at the same conclusion.

The American treaties (Swain, in Moore, 1961, p. Q241) considered the genera in my original list as being subgenera of *Cypridea* and added to the subfamily the subgenus *C.* (*Humenia*) Hou, 1958, and the Triassic genus *Cultella* Lubimova, 1959.

Krömmelbein (1962, p. 460, 471) described two subgenera from the Bahia Series in Brazil (Upper Jurassic to Lower Cretaceous): *C.* (*Sebastianites*) and *C.* (*Morininoides*). *C.* (*Morininoides*) has an anteroventral beak and notch, but *C.* (*Sebastianites*) was defined as being with or without an anteroventral beak. The type-species *C.* (*S.*) *fida* Krömmelbein, 1962, and one additional species, *C.* (*S.*) *devexa* Krömmelbein, 1962, do not have anteroventral beaks; therefore, because this structure is diagnostic of the Cyprideinae, the subgenus *Sebastianites* is not considered to belong to *Cypridea*. Instead, *C.* (*S.*) *fida* seems to be related to the Early Cretaceous genus *Dsunbaina* Galeeva, 1955, originally assigned to the Limnocypridae. Krömmelbein (1962, p. 463–466) described and illustrated three additional species, one having two subspecies, as *Sebastianites*?.

These taxa do have the diagnostic anteroventral structures and should be reassigned in the Cyprideinae.

Mandelstam (in Mandelstam and Schneider, 1963, p. 111, 113) referred to the Cyprideinae the new genera *Latonia* Mandelstam, 1963, and *Zejaina* Mandelstam, 1963, both from Lower Cretaceous sedimentary rocks. These two genera, *Cultella* Lubimova, 1959, and *Cyprideamorphella* Mandelstam, 1956, do not have anteroventral beaks and notches; consequently they do not belong in the Cyprideinae as defined above and also as defined by van Morkhoven (1963, p. 6), who stated "* * * typically with a more or less prominent anteroventral beak * * *."

Cypridea and related genera are unknown from normal marine environments. More than 275 species have been described in the genus *Cypridea*, and more than half of these are from Lower Cretaceous deposits.

Triebel (1960) showed similarities in shell morphology between *Cypridea* and the living genus *Chlamydotheca* Saussure, 1858 (subfamily Cypridinae Baird, 1845). Except for the alleged Late Permian record of notched forms, ancestral forms of Paleozoic or early Mesozoic age are unknown.

The beak of the continental Pliocene genus *Karshicypridea* Gramm and Bukharina, 1967, is more similar to that of *Acratia* Delo, 1930, and related genera of Devonian to Triassic age than to the Cyprideinae. In addition, the adductor muscle-scar pattern of *Karshicypridea* resembles more that of *Candona* Baird, 1845, than that of *Cypridea*. The probable function of the beak (rostrum) is unknown, although Gramm and Bukharina (1967, p. 97) "guessed" that a second pair of antennae may have been involved. The absence of any muscle-scars that would indicate such organs invalidates that hypothesis.

Genus **CYPRIDEA** Bosquet, 1852

1852. *Cypridea* Bosquet, (1850–51), Acad. Royale Sci. Belgique Mém., v. 24, p. 47.
1949. *Cypridea* Sylvester-Bradley, Geologists' Assoc., London Proc., v. 60, pt. 2, p. 130.
1959. *Cypridea* Wolburg, Senckenbergiana Lethaea, v. 40, p. 242 (see for synonymy).
1967. *Cypridea* Anderson, *in* Anderson, Bazley, and Shephard-Thorn, Great Britain Geol. Survey Bull. 27, p. 201.

Type-species (subsequent designation by Sylvester-Bradley, 1947)—*Cypris granulosa* Sowerby in Fitton (1836, p. 345, pl. 21, fig. 4). Middle Purbeck (Jurassic), England.

Diagnosis.—Cyprideinae less than 2 mm (millimeters) in greatest length, smooth, punctate, reticulate, tuberculate or spinose, having incised dorsum.

Discussion.—As indicated in the discussion of the subfamily, there have been differences of opinion as to the classification of these notched ostracodes. Some consider segments as genera, others consider them as subgenera, and a few would lump most into the one genus *Cypridea.*

Wolburg (1959) divided the notched forms in the Wealden of northwest Germany into two superspecific groups—one with normal overlap (*Cypridea* A), the other with reversed overlap (*Cypridea* B=*Ulwellia* Anderson, 1939). Reversal of overlap and hingement is not a good criterion for discriminating genera and species because some taxa consistently exhibit this feature; for example, the dextral-sinistral ratio may vary from 1:1, as in *Sansabella amplectens* Roundy, 1926, to 1:250 or more, as in *Aurikirkbya wordensis* (Hamilton), 1942. However, when reversal of overlap and hingement is consistent within a group of species, I consider it convenient to use that as a criterion for subgeneric differentiation, and therefore I retain *Ulwellia* Anderson, 1939, as a subgenus in *Cypridea.*

Other species-groups that were designated by Wolburg (1959, p. 240) constitute distinct forms that should be designated as subgenera. For example, the *C. alta* group (Wolburg, 1959, p. 262) should be assigned to *C.* (*Pseudocypridina*) Roth, 1933. Swain (in Moore, 1961, p. Q242) did not correctly interpret this taxon because his specimens from Brazil, which he identified as *C.* (*Pseudocypridina*) *piedmonti* Roth, 1933 (Swain, 1946, p. 550, pl. 83, figs. 10–12), are neither conspecific nor congeneric with Roth's types from the Black Hills of South Dakota. Swain's specimens have since been described and illustrated by Krömmelbein (1962, p. 457, pl. 59, figs. 39a, b) as *C. salvadorensis salvadorensis* Krömmelbein, 1962.

The published record of *Cypridea* and related genera contains a group having only one sulcus; *C.* (*Morinina*) Anderson, 1939, was defined as having a subcentral sulcus. *C.* (*Morininoides*) Krömmelbein, 1962, differs from *C.* (*Morinina*) in having three nodes. Bisulcate species in *Cypridea* are here referred to the new subgenus *C.* (*Bisulcocypridea*).

Key to the subgenera

1.	Nonsulcate	2
1a.	Sulcate	4
2 (1).	Left valve larger	3
2a.	Right valve larger	*Ulwellia*
3 (2).	Ventrolateral ridge on left valve	*Pseudocypridina*
3a.	No ventrolateral ridge on left valve	*Cypridea*
4 (1a).	One sulcus	*Morinina, Morininoides*
4a.	Two sulci	*Bisulcocypridea*

Stratigraphic range.—Middle Jurassic to Eocene.

Subgenus CYPRIDEA Bosquet, 1852

Type-species.—Same as for the genus.

Diagnosis.—Nonsulcate; left valve larger; smooth, punctate, reticulate, tuberculate or spinose; without ventrolateral ridge on left valve.

Discussion.—The record contains 190 species and subspecies which conform with the above description. Three homonyms were noted: one has an available synonym discussed below, a substitute name is proposed for the second and the state of homonymy of the third is recorded.

Stratigraphic range.—Middle Jurassic to Upper Cretaceous. The majority of the described species are from the Lower Cretaceous.

Cypridea (Cypridea) kleinbergi Galeeva, 1955

Cypridea kleinbergi Galeeva, 1955, Moscow, VNIGNI, p. 31, pl. 8, figs. 2a–e [d]. Lower Cretaceous, Mongolia.

Cypridea bispinosa Galeeva, 1955, Moscow, VNIGNI, p. 36, pl. 9, figs. 1a–d [g]. Same locality as above.

Lubimova, 1956, VNIGRI, Trudy, n. ser., no. 93, p. 25, pl. 5, figs. 2–4. Same locality as above.

[not] *Cypridea bispinosa* Jones, 1878, Geol. Mag. new ser., Dec. 2, v. 5, p. 109, pl. 3, figs. 9, 10. Lower Cretaceous, England.

[not] *Cypridea ventrosa* var. *bispinosus* Vanderpool, 1928, Jour. Paleontology, v. 2, p. 104, pl. 14, figs. 1, 2=*Cypridea dequeenensis* Swain and Brown, 1964.

According to Lubimova (1956, p. 25), *C. kleinbergi* was based on young individuals of *C. bispinosa.* Because *C. bispinosa* is a junior synonym, *C. kleinbergi* is available for that species.

Cypridea (Cypridea) lubimovae Sohn, new name

Cypridea spinigera Lubimova, 1956, VNIGRI, Trudy, n. ser., No. 93, p. 55, pl. 12, figs. 1a–c [v]. Lower Cretaceous, Mongolia.

[not] *Cypris spinigera* Sowerby *in* Fitton, 1836, Geol. Soc. London Trans., ser. 2, v. 4, p. 345, pl. 21, fig. 3. Wealden, England.

Howe and Laurencich (1958, p. 135) and Coryell (1963, p. 564) noted the state of homonymy without proposing a substitute name. Because of the time interval between the above two publications and the present, during which a substitute name has not been published by Lubimova, *C.* (*Cypridea*) *lubimovae* is here proposed.

Homonym not renamed

The following junior homonym is not renamed because its author was not informed of the homonymy. *Cypridea rostrata* Galeeva, 1955 (p. 42, pl. 9, figs. 3a–c), from Upper Cretaceous deposits of Mongolia, is preoccupied by *Cypris rostrata* Dunker, 1843 (p. 173), which was later illustrated by Dunker (1846, p. 61, pl. 13, fig. 27). Dunker's illustration is definitely of a *Cypridea*, and Martin (1940, p. 284) transferred that species to this genus.

Cypridea (Cypridea) pecki Sohn, n. sp.

Plate 1, figures 1–4, 7–9, 12–16

Cypridea diminuta Vanderpool. Peck [part], 1941, Jour. Paleontology, v. 15, p. 298, pl. 44, figs. 29–31 [not fig. 32=*C.* (*Cypridea*) *diminuta* Vanderpool, 1928]. Draney Limestone, Wyoming-Idaho.

Peck, 1951, Jour. Paleontology, v. 25, p. 312, pl. 49, fig. 6. Same formation and locality as above.

Howe and Laurencich, 1958, Louisiana State Univ. Press, p. 121, figure on p. 122. Same formation and locality as above.

Name.—In honor of Dr. R. E. Peck, University of Missouri.

Holotype.—USNM 162797.

Paratypes.—USNM 162798–162802.

Material.—Several hundred valves, a few carapaces.

Type-locality.—USGS Mesozoic locality 27753.

Type-level.—Upper Aptian (Lower Cretaceous).

Diagnosis.—Small, less than 0.9 mm in greatest length, subquadrate, reticulated; without pustules, spines, or nodes; rostrum blunt, weakly developed, without furrow.

Description.—The valves are subovoid in lateral view; the ventral margin is straight; the dorsal margin straight to very gently curved; the anterior margin is slightly more convex than the posterior margin and meets the dorsal margin at about one-fourth the greatest length; the posterior margin joins the ventral margin approximately at 90° in the right valve and slightly more than 90° in the left valve. The overlap is slight along free margins; the hinge of the left valve is a groove into which the dorsal edge of the right valve fits. The surface is covered by distinct, minute, polygonal reticulations which do not extend to the periphery of the valve. The sides are straight and subparallel in dorsal outline.

Measurements (in mm).—

Specimen	Fig. No. (pl. 1)	Maximum length	Maximum height	Maximum width
Holotype	1–4	0.78	0.45	0.33
Paratype	7	.64	.37	
Do	8, 9	.66	.34	
Do	12	.65	.38	
Do	13, 15	.60	.33	
Do	14	.60	.34	
Do	16	.63	.42	

Discussion.—This species is similar to *C. diminuta* Vanderpool, 1928, from which it differs in having a more subdued dorsoanterior angulation and in lacking scattered small pustules. Peck's specimens from the Draney Limestone (Lower Cretaceous), Idaho-Wyoming, identified as *C. diminuta* Vanderpool, 1928, are conspecific with the specimens from Nevada.

In size, shape, and surface ornament the new species resembles *C.* (*C.*) *diminuta* Vanderpool, 1928 (pl. 1, figs. 5, 6), *C.* (*C.*) *ultima* Grekoff, 1957 (pl. 1, fig. 10, 11), from the Wealden of the Congo Basin, and *C.* (*Ulwellia*) *karataigysensis* Lubimova, 1956, from the Barremian of the Ciscaspian Depression. The geographic distribution of these species is discussed earlier in this report. I do not know the affinities of the Wealden specimen from the Congo Basin, Africa, that was illustrated by Grekoff (1957, p. 55, pl. 2, fig. 36) as (?) *Cypridea diminuta* Vanderpool, 1928.

Subgenus BISULCOCYPRIDEA Sohn, n. subgen.

Type-species.—*Cypridea* (*Bisulcocypridea*) *bicostata* Sohn, n. sp.

Diagnosis.—Bisulcate, smooth or punctate; may bear pustules, nodes, or spines.

Discussion.—Swain (1949, p. 180) suggested that the bisulcate forms might belong to a distinct subgenus, but because at that time its separation would serve no stratigraphic purpose, he did not describe the new taxon. In addition to *C.* (*B.*) *bicostata*, the following species should be referred to this subgenus:

Ilyocypris arvadensis Swain, 1949, Jour. Paleontology, v. 23, p. 178, pl. 32, figs. 20–22; pl. 33, figs. 1–9. Paleocene and Eocene, Western United States.

[not] *Ilyocypris arvadensis tuberculata* Swain, 1949, Jour. Paleontology, v. 23, p. 179, pl. 33, figs. 10–12=*Ilyocypromorpha linonodosa* (Swain), 1951.

Cypridea bisulcata Swain, 1949, Jour. Paleontology, v. 23, p. 180, pl. 33, figs. 13–19, Wasatch Formation (Eocene), Utah.

Pseudocypridina laevicula Peck, 1951, Jour. Paleontology, v. 25, p. 319, pl. 48, figs. 1–4. Bear River Formation (Albian, Lower Cretaceous), Wyoming.

?*Cypridea mera* Stepanaitis, 1967, Paleont. Zhur., 1967, no. 2, p. 76, text figs. c. Barremian, western Turkmenia.

Cypridea nyensis Swain, 1964, Jour. Paleontology, v. 38, p. 278, pl. 44, figs. 9a–c. Early Tertiary?, Nevada.

Cypridea orientalis orientalis Bischoff, 1963, Senckenbergiana Lethaea, v. 44, p. 304, pl. 42, figs. 1–4. Lower Aptian, Lebanon.

Cypridea orientalis tenuituberosa Bischoff, 1963, Senckenbergiana Lethaea, v. 44, p. 305, pl. 42, figs. 5, 6. Lower Aptian, Lebanon.

Cypridea skeeteri Peck, 1951, Jour. Paleontology, v. 25, p. 316, pl. 49, figs. 15–26. Bear River Formation (Albian, Lower Cretaceous), Wyoming.

?*Cypridea* (*Cypridea*) Y 187 Grekoff, 1960, Mus. Royal Congo Belge Annales, Sci. Géol., v. 35, p. 41, pl. 6, figs. 39, 40. Wealden B, Congo Basin, Africa.

Stratigraphic range.—Lower Cretaceous to Eocene.

Cypridea (Bisulcocypridea) bicostata Sohn, n. sp.

Plate 2, figures 1–10, 13–15

Name.—Two horizontal ridges on each valve.

Holotype.—USNM 162808.

Paratypes.—USNM 162804–07, 162809, 162810, 162815, 162816.

Material.—More than 100 poorly preserved crushed valves; a few carapaces.

Type-locality.—USGS Mesozoic locality 27754.

Type-level.—Upper Aptian (Lower Cretaceous).

Diagnosis.—Has lateral ridges near dorsal and ventral margins; dorsal ridge interrupted by sulci; surface smooth or finely pitted, scattered spinelets sparse on lateral surface, more abundant near end margins; beak blunt, furrow extends to approximately lower third of greatest height; dorsal and ventral margins straight, converge gently toward posterior.

Description.—The lateral outline is subquadrate and has gently rounded end margins; the dorsal and ventral margins converge slightly toward the posterior so that the posterior margin is not so high as the anterior margin. The anterior cardinal angle is distinct, approximately in line with postrostral furrow. The ventral ridge is thin, subparallel to the ventral margin, and extends from the furrow to the posterior margin. This ridge overhangs the contact margin in some individuals, and in others it is slightly above the ventral margin. The dorsal ridge is thick and high; it is well developed along the posterior of the valve near the dorsal margin, where it extends above the hingeline; it is terminated by the sulci, where it appears to bifurcate toward the anterior. The lower branch of the dorsal ridge extends over the top of the central lobe and continues as the lower part of a pinched anterior lobe; the upper branch extends above the central lobe and continues as the upper part of the anterior lobe. Both sulci are deep, start below the dorsal margin, and extend downward to above midheight. The beak is blunt and extends slightly below the ventral margin; it is bordered by a distinct, anteriorly convex furrow that extends upward and terminates below midheight. Minute pustules are scattered on the surface of the valves; they appear to be more abundant over the anterior part of the valve in front of the furrow and also on the posterior quarter of the valve. The dorsal margin extends to the anterior cardinal angle as a thin crest. The venter is flat; the overlap along the ventral margin is slight.

Measurements (*in mm*).—

Specimen	Figure number (pl. 2)	Maximum length (parallel to dorsal margin)	Maximum height (normal to dorsal margin)	Maximum width
Holotype	13	1.25	0.82	------------
Juvenile	1	.78	.51	------------
Paratype	2, 3	.99	.69	------------
Do	4	1.15	.69	------------
Do	5–8	.99	.68	0.40
Do	10	1.06	.70	------------
Do	9	1.06	.66	------------
Do	14	1.22	.64	------------
Do	15	.98	.60	------------

Discussion.—In addition to rare juveniles (pl. 2, fig. 1), the species is represented by forms that differ in lateral outline. The largest specimen (pl. 2, fig. 13) is much higher in the posterior than slightly shorter specimens (pl. 2, fig. 14), but both types have proportionally the same width in dorsal outline. Whether this difference in height of the posterior represents dimorphism cannot be demonstrated with the material on hand. All measurements of the height are from the straight dorsal margin, below the overreaching ridge crest, to the base of the notch. The one measurement of width was from the venter and does not include the overreaching ridges along the dorsal margin.

Genus PARACYPRIDEA Swain, 1946

"Paracypridea" sp.

Plate 2, figures 17–20

More than 50 valves—filled with matrix including fragments and partly exfoliated valves—of large, rather thin-shelled, elongated, notched ostracodes are associated with *Cypridea* (*Cypridea*) *pecki* at USGS Mesozoic locality 27753. A partly exfoliated right valve that has a preserved muscle-scar pattern was lost during scanning electron micrography. The muscle-scar pattern seen on the illustrated specimen (pl. 2, figs. 19, 20) was observed as colored spots on several additional specimens when they were wetted. This pattern differs from that of *Paracypridea* Swain, 1946, in having fewer and proportionally larger individual scars. The general configuration is similar to that of the candonid type. Because the general size and outline is similar to *Paracypridea*, I am referring the specimens from Nevada in open nomenclature to *Paracypridea*.

Measurements (*in mm*).—

	Maximum length	Maximum height
Figured specimen (pl. 2, fig. 18)	2.12	1.21

Age.—Late Aptian (Early Cretaceous).
Locality.—USGS Mesozoic locality 27753.

Family unknown

Genus PETROBRASIA Krömmelbein, 1965

Petrobrasia Krömmelbein, 1965, Senckenbergiana Lethaea, v. 46a, p. 193. Grekoff and Krömmelbein, 1967, Inst. Français Pétrole Rev., v. 22, no. 9, p. 1327.

Type-species (original designation).—*Dolerocypris? marfinensis* Krömmelbein, 1962 (p. 489, pl. 58, figs. 38a, b). São Sebastião Beds (Lower Cretaceous), well in Reconcavo, Bahia, Brazil.

Discussion.—Krömmelbein established *Petrobrasia* for some Mesozoic cyprid ostracodes that had been referred to Holocene genera, in part because the internal shell structure of the Mesozoic forms is unknown. The genus was diagnosed as having strong to weak surface ribbing or being smooth shelled. *Cetacella* Martin, 1958, differs in having a more rugose surface sculpture and a distinctive muscle-scar pattern, a feature as yet not described in *Petrobrasia*. Fragments from Nevada (pl. 2, figs. 11, 12) have a muscle-scar pattern which differs from that of *Cetacella*; consequently the valves and associated fragments are tentatively referred to *Petrobrasia*.

Petrobrasia? sp.

Plate 2, figures 11, 12, 16

More than 50 fragments and valves filled with matrix are associated with *Cypridea* (*Cypridea*) *pecki* at USGS Mesozoic locality 27753. The surface of these specimens is smooth, and the lateral outline is similar to two smooth forms previously placed in *Petrobrasia*: *P. gibbosa* Krömmelbein, 1965, from the Upper Ulhas Formation of Brazil; and *P. glabra* Grekoff and Krömmelbein, 1967, from Gabon, Africa. Because well-preserved specimens are not available, this species has not been formally named. Plate 2, figures 11 and 12, show the muscle-scar patterns of fragments of a right and a left valve. One left and two right broken valves were converted to fluorite, and all have the same two small scars shown on the lower right of the muscle-scar pattern, which indicates that the scars are not artifacts. Two small antennal scars are present to the left and above the central muscle-scar group.

Measurements (*in mm*).—

	Maximum length	Maximum height
Figured specimen (pl. 2, fig. 16)	1.31+	0.87+

Age.—Late Aptian (Early Cretaceous).
Locality.—USGS Mesozoic locality 27753.

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PLATES 1, 2

PLATE 1

[Magnification as indicated. Photographs by R. H. McKinney. Scanning electron micrographs by D. H. Massie]

FIGURES 1–4, 7–9, 12–16. *Cypridea* (*Cypridea*) *pecki* Sohn n. sp. (p. B5).

1–4. Right, ventral, left, and dorsal views of carapace; approximately × 30. Holotype, USNM 162797.

7. Outside view of left valve; approximately × 60. Paratype, USNM 162798.

8, 9. Outside and ventral views of right valve; approximately × 60. Paratype, USNM 162798A.

12. Inside view of left valve; scanning electron micrograph; × 135. Paratype, USNM 162799.

13, 14. Inside views of two right valves; scanning electron micrographs; approximately × 150. Paratypes, USNM 162800, 162801.

15. Muscle-scar pattern of specimen illustrated as figure 13; × 720.

16. Left view of carapace, scanning electron micrograph; × 125. Paratype, USNM 162802.

5, 6. *Cypridea* (*C.*) *diminuta* Vanderpool, 1928 (p. B6).

Dorsal and right views of holotype; × 30. USNM 132523. DeQueen Limestone (lower Albian), Ark.

10, 11. *Cypridea* (*C.*) *ultima* Grekoff, 1957 (p. B6).

Left and ventral views of carapace; × 30. Topotype USNM 162803. Wealden, Congo Basin, Democratic Republic of the Congo, Africa.


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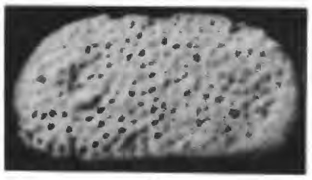
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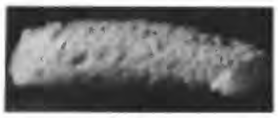
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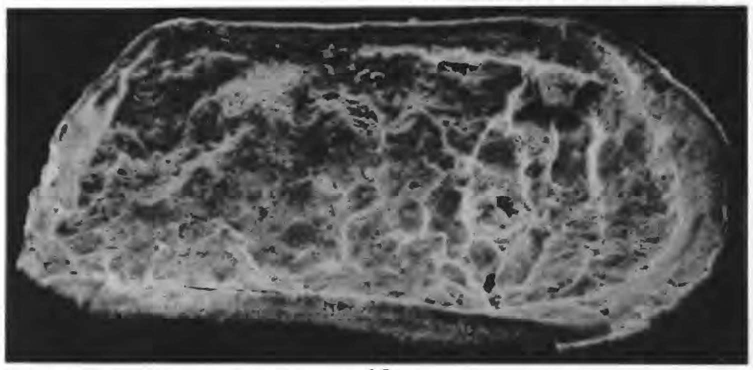
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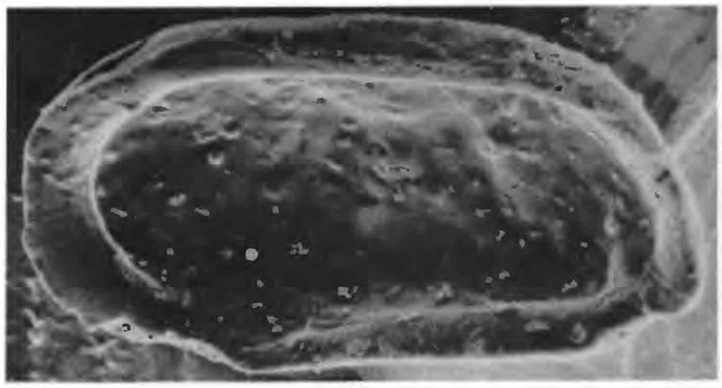
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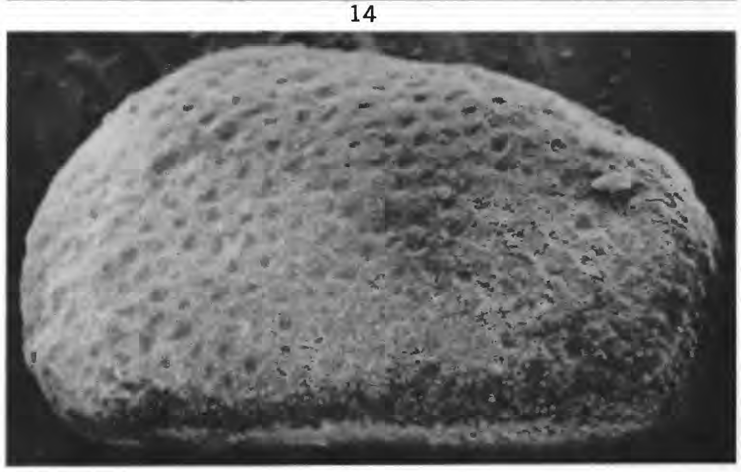
16

CYPRIDEA (CYPRIDEA)

PLATE 2

[Except where otherwise indicated, magnification approximately × 30 and except where otherwise indicated, photographs by R. H. McKinney]

FIGURES 1–10, 13–15. *Cypridea (Bisulcocypridea) bicostata* Sohn, n. sp. (p. B6).

1. Outside view of left valve, juvenile. Paratype, USNM 162804.
2, 3. Outside and inside views of left valve, preadult stage. Paratype, USNM 162805.
4. Outside view of right valve. Paratype, USNM 162815.
5–8. Right, dorsal, left, and ventral views of carapace. Paratype, USNM 162806.
9. Outside view of left valve. Paratype, USNM 162807.
10. Inside of right valve converted to fluorite. Paratype, USNM 162816.
13. Outside view of adult left valve. Holotype, USNM 162808.
14. Outside view of adult right valve; shell near the dorsal margin is missing. Paratype, USNM 162809.
15. Outside view of right valve. Paratype, USNM 162810.

11, 12, 16. *Petrobrasia*? sp. (p. B7).

11, 12. Muscle-scar patterns of a right valve interior and left valve exterior; approximately × 120. Figured specimens, USNM 162811. Photographs by D. H. Massie.
16. Lateral view of broken left valve. Figured specimen, USNM 162812.

17–20. "*Paracypridea*" sp. (p. B7).

17. Interior view of broken left valve. Figured specimen, USNM 162814.
18. Outside view of right valve. Figured specimen, USNM 162813.
19, 20. Scanning electron micrograph of outside of a partly exfoliated right valve to show muscle-scar pattern on steinkern, approximately × 36, and enlargement of muscle-scar area, approximately × 90. Figured specimen lost. Micrographs by D. H. Massie.

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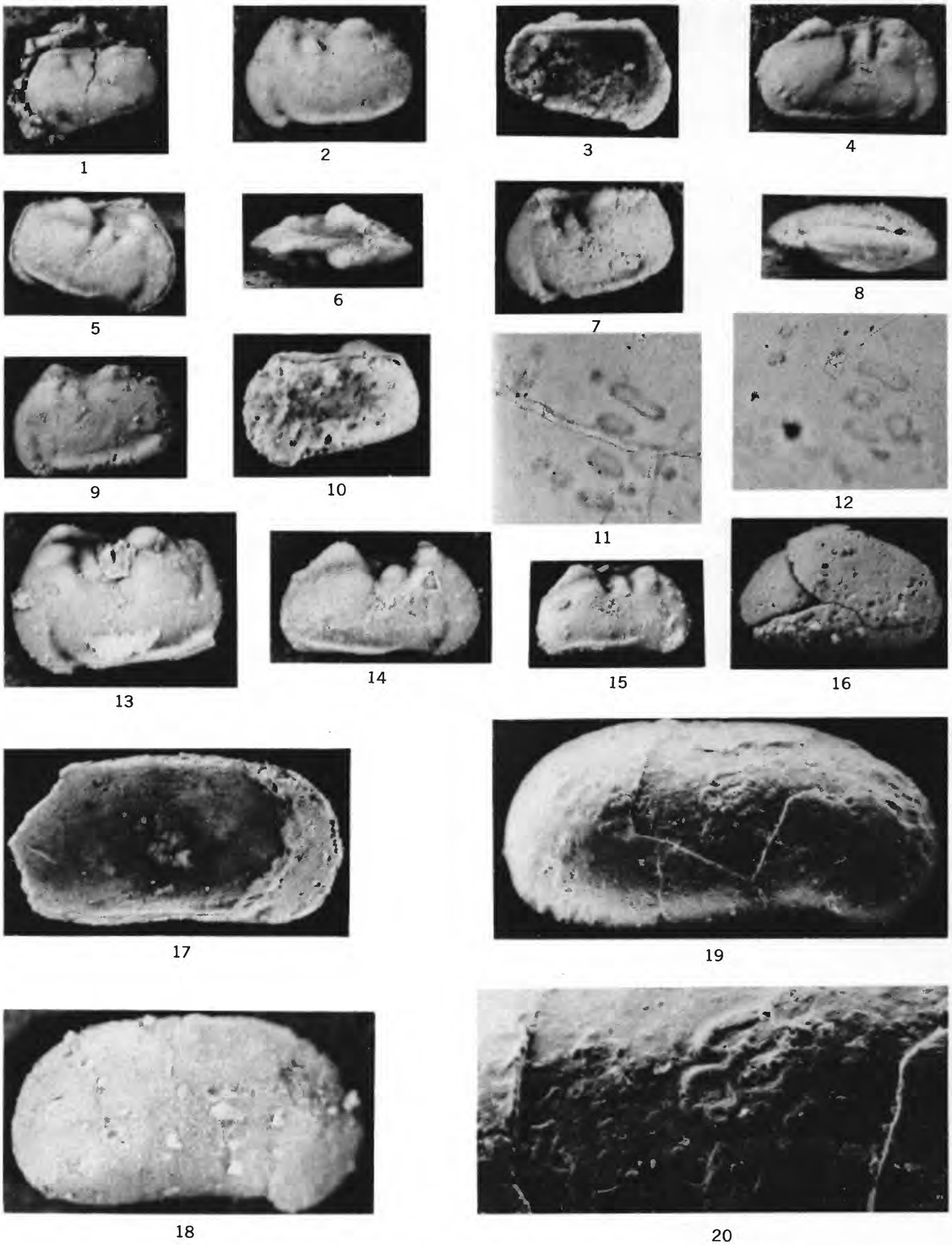

CYPRIDEA (BISULCOCYPRIDEA), PETROBRASIA?, AND *"PARACYPRIDEA"*