

Nonmarine Ostracodes in the Lakota Formation (Lower Cretaceous) From South Dakota and Wyoming

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By I. G. SOHN

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*Revision of nonmarine Lower Cretaceous
ostracode genera from the Black Hills,
and description of two new genera
and four new species. On the
basis of this revision, the Lakota
Formation is considered
to be pre-Aptian in age*



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NONMARINE OSTRACODES IN THE LAKOTA FORMATION (LOWER CRETACEOUS) FROM SOUTH DAKOTA AND WYOMING

By I. G. SOHN

ABSTRACT

The stratigraphic age of the Early Cretaceous Lakota Formation in the Black Hills of South Dakota and Wyoming is Barremian or older rather than late Aptian as previously considered. This age is based on the study of certain ostracodes in 46 collections and the revision of several previously described taxa in North America.

The new genera *Trapezoidella* and *Longispinella*, and the new species *T. rothi* and *L. asymmetrica*, as well as *Cypridea* (*Pseudocypridina*) *laeli* and *C. (P.) henrybelli*, are described and illustrated. "*Cypridea*" sp. 1 is illustrated as an example of an as-yet-undescribed genus to which many of the species previously referred to *Cypridea* s.l. should be referred. Subgenera of *Cypridea* Bosquet, 1852, are elevated to generic status except *Cypridea* (*Cypridea*) and *C. (Pseudocypridina)* Roth, 1933. Species previously referred to the Paleozoic marine subgenus *Bythocypris* (*Bairdiocypris*) Kegel, 1932, are illustrated and referred to the new family Trapezoidellidae in the genera *Trapezoidella* and *Limnocypridea* Lübimova, 1956. Dimorphism similar to that in the living genus *Candona* Baird, 1845, is proposed for *Limnocypridea morrisonensis* (Roth, 1933), which, unlike most nonmarine ostracodes, is demonstrated to be variable in lateral outline. A lectotype is designated for *Bairdiocypris albertensis* Loranger, 1951, from the Blairmore Formation (Aptian-Albian) in Alberta, Canada, and one for *Limnocypridea equalis* (Harper and Sutton, 1935), from the Lakota Formation, South Dakota. The Canadian species is reillustrated and questionably referred to *Limnocypridea*.

INTRODUCTION

Because of the presence of uranium, the Mesozoic sedimentary deposits in the southern Black Hills, S. Dak. and Wyo. (Gott, Wolcott, and Bowles, 1974, and references therein), have been mapped by the U.S. Geological Survey in cooperation with the U.S. Atomic Energy Commission. Nonmarine ostracodes are the most common fossils in the Upper Jurassic (Morrison Formation) and in the Lower Cretaceous sedimentary rocks (Robinson, Mapel, and Bergendahl, 1964, and references therein). I received ostracode collections during the early stages of field work, and I joined the field parties in 1957 to obtain additional collections.

The nonmarine ostracodes from the Black Hills

were described and illustrated as faunules from the Morrison Formation of Late Jurassic age by Roth (1933) and later by Harper and Sutton (1935). Roth (1933) described, among other species, *Bythocypris* (*Bairdiocypris*) *morrisonensis*, *B. (B.) trapezoidalis*, and *Pseudocypridina piedmonti* as part of the nonmarine fauna. Harper and Sutton (1935, p. 627) added to the faunule from a second locality, *B. (B.) celtiformis*, *B. (B.) morrisonensis* var. *equalis*, and *Darwinula dakotensis*. Loranger (1951, p. 2360; 1954, p. 286) described *Bythocypris* (*Bairdiocypris*) *albertensis* from the Lower Cretaceous Blairmore Formation in central and southern Alberta, Canada. Howe and Laurencich (1958, p. 79) stated that Loranger's description does not fit *Bairdiocypris*.

I demonstrated that the sedimentary rocks in South Dakota from which Roth, and also Harper and Sutton, described the ostracodes are actually from the Lower Cretaceous Lakota Formation (Sohn, 1957, 1958). In that study I was able to differentiate between the Jurassic and Lower Cretaceous sedimentary rocks in the Black Hills, because the Jurassic Morrison Formation contains *Theriosynoecum* Branson, 1936, and does not contain notched forms that belong in the Cyprideidae Martin, 1940. In contrast, the Lower Cretaceous sedimentary rocks do not contain *Theriosynoecum* and do contain notched forms. I was not able, however, at that time to correlate the Lower Cretaceous rocks in the Western United States with the cosmopolitan stratigraphic scheme which is based primarily on marine faunas.

During the past two decades, publications on Lower Cretaceous stratigraphy of the Black Hills and on nonmarine Early Cretaceous ostracodes abroad (see references cited) have made it possible to suggest a tentative correlation. On the basis of selected taxa discussed in this paper, the Lakota Formation is inferred to be pre-Aptian in age.

When Post and Bell (1961) defined the Chilson Member of the Lakota Formation in the southern

Black Hills, they recognized the Minnewaste Limestone Member above the Chilson Member and below the Fuson Member of the Lakota Formation. The Minnewaste Limestone Member is present only in the southern and southeastern Black Hills in Custer and Fall River Counties, S. Dak. (Waagé, 1959, fig. 7), and where it is absent, the Chilson Member is disconformably overlain by the Fuson Member (Post and Bell, 1961, figs. 349.1, 349.2). Rocks equivalent to the Chilson Member of the Lakota Formation thin westward and pinch out beneath rocks equivalent to the Fuson Member west of a line that approximately bisects R. 63 W. in Crook and Weston Counties, Wyo. (Post and Bell, 1961, p. D178, fig. 349.2; Robinson, Mapel, and Bergendahl, 1964, p. 25). For this reason, Mapel and Pillmore (1963, p. M17, pl. 1) mapped the rocks in Wyoming as Lakota Formation.

Map localities 5-7 of this report are in Wyoming in rocks considered to be equivalent to the Fuson Member of the Lakota Formation in the southern Black Hills in South Dakota (Post and Bell, 1961, p. D178), rather than to the Chilson Member. However, the ostracodes in eight collections from the Fuson Member in Fall River and Custer Counties, S. Dak., although low in diversity (three genera), differ on the generic level from the high-diversity (eight genera) ostracodes in the Chilson Member of South Dakota (Sohn, 1958, unpublished reports on referred collections, MD-57-60, MD-57-61), and also from those in Wyoming. The ostracodes from map localities 5-7 in Wyoming (pls. 1, 3, 7, and 8), as well as some not included in this report, are identical on the species level with those from the Chilson Member. Because of the short period of absolute time involved, the ostracodes of the Chilson member may have extended into the Fuson Member during similar environmental conditions northwest of Inyan Kara Creek in Wyoming, and the difference on the generic level between the ostracodes of the two members in South Dakota may have been due to different environments. It cannot be stated with certainty that the similarity of ostracodes on the species level between the Lakota Formation undifferentiated in Wyoming and the Chilson Member of the Lakota Formation in South Dakota indicates a time equivalence. All the previously described ostracode species (Roth, 1933; Harper and Sutton, 1935) and the newly described species, with the possible exception of those from Wyoming, are from the Chilson Member of the Lakota Formation.

The Mesozoic nonmarine species previously referred to *Bythocypris* (*Bairdiocypris*) are rede-

scribed, reillustrated, and referred to Mesozoic genera, and the Middle Devonian marine genus *Bairdiocypris* Kegel, 1932 (see Sohn, 1960, p. 83), is restricted to Paleozoic rocks: Silurian (Lundin, 1965, p. 37; Pranskevichius, 1972, p. 139), Carboniferous (Green, 1963, p. 99; Buschmina, 1965, p. 83; 1968, p. 94; 1970, p. 28), and questionably Permian (Willey, 1970, p. 130).

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AGE OF THE ROCKS

The nomenclatural history of the Lower Cretaceous formations was discussed by Waagé (1959, p. 18) and later by Wolcott (1967, p. 433). The Lakota Formation consists, in ascending order, of the Chilson Member, the Minnewaste Limestone Member, and the Fuson Member. Post and Bell (1961, p. D173) divided the Chilson Member into two units. The lower (Unit 1) consists mostly of fine-grained yellowish-gray sandstone interbedded or interfingered with highly carbonaceous siltstone and mudstone layers and ranges in thickness from zero to about 400 feet (122 m). Unit 2 unconformably overlies the older unit. It consists of lenticular bodies of grayish-yellow or reddish-orange to reddish-brown fine-grained well-sorted sandstones that are interbedded with and finger laterally into varicolored siltstone or claystone. Unit 2 ranges in thickness from zero to 437 feet (133 m). The mudstone and sandstone are calcareous in many places; consequently, it is inferred that Roth's as well as Harper and Sutton's collections came from this unit.

The exact stratigraphic position of the Lower Cretaceous continental deposits in the Western Interior of the United States in terms of the European stages is as yet uncertain. I (Sohn, 1958, p. 122) suggested that the basal part of the Lakota Forma-

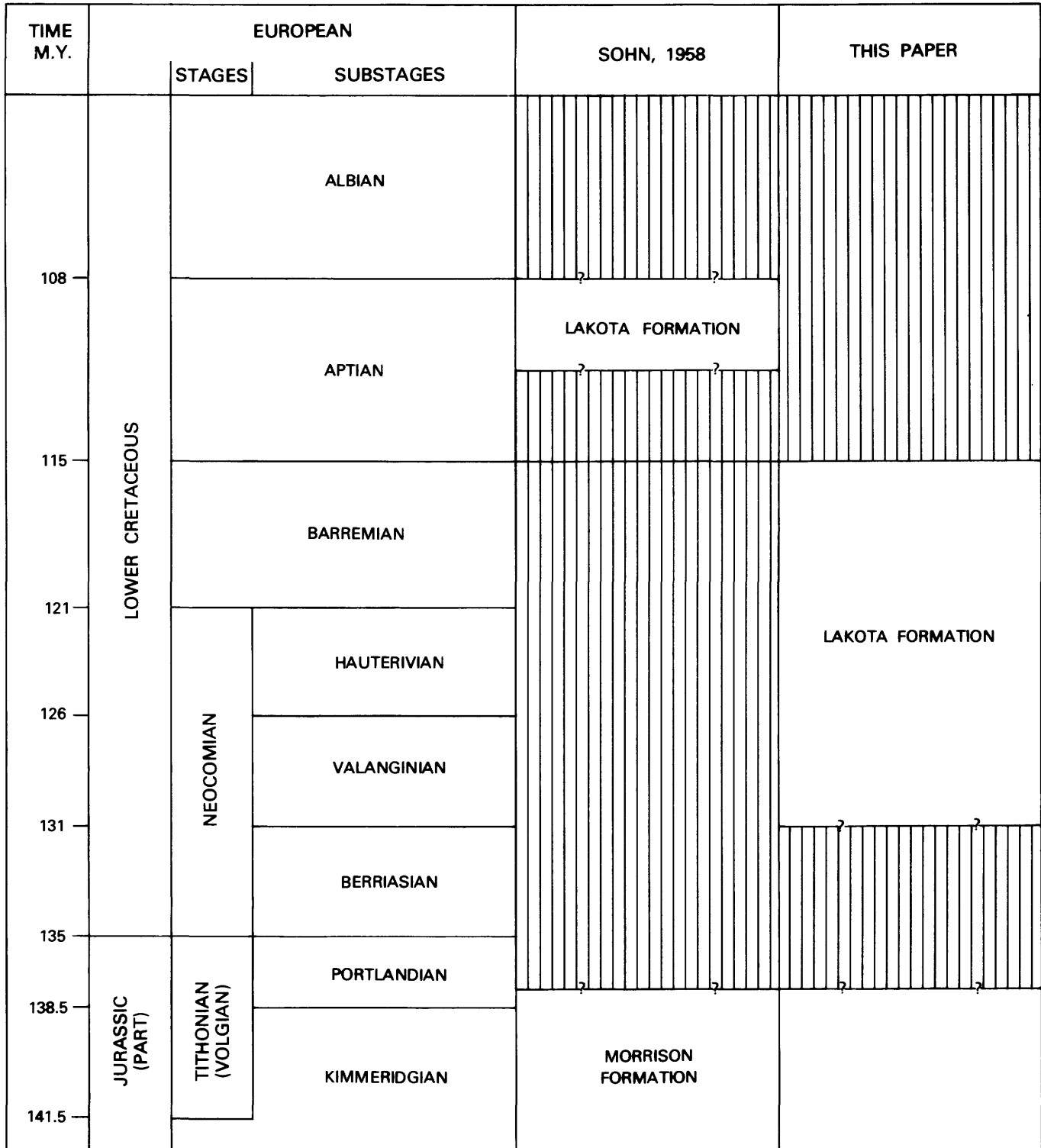


FIGURE 1.—Probable stratigraphic position of the Lakota Formation. Absolute scale from van Hinte (1976b).

tion may prove to be older than Aptian (1958, fig. 2, p. 124). Lane (1963, p. 232) summarized the previous work on the Lower Cretaceous of the

Western Interior and concluded that the boundaries within the formations were still highly conjectural. Anderson (1973, fig. 1) extended the Lower Cre-

taceous of South Dakota to the approximate base of the Middle Valanginian but noted that the North American ages are subject to considerable revision. Cook and Bally (1975, p. 206) showed the Lakota Formation of South Dakota as starting in the Middle Aptian(?), extending through the Barremian, and questionably terminating at the top of the Hauterivian.

Because the Early Cretaceous ostracodes in the Black Hills of South Dakota and Wyoming are endemic, all the known species and those described here as new offer no clues to intercontinental correlation. However, some idea as to the probable stratigraphic position of the rocks might be obtained by recording the ranges of related species in Europe, Asia, and South America. Figure 1 shows the probable stratigraphic position of the Lakota Formation on the basis of such a comparison.

The Lakota Formation contains, among other species, *Cypridea* (*Pseudocypridina*) *piedmonti* Roth, 1933, *C. (P.) henrybelli* n. sp., and *C. (P.) laeli* n. sp. The resemblance of *C. (P.) piedmonti* to *C. (P.) unicostata* Galeeva, 1955, from the Barremian of Mongolia, as shown in the discussion of the species, suggests that the Lakota Formation is probably not younger than the Barremian. *C. (P.) henrybelli* is shown in the discussion of the species to belong, on the basis of lateral outline and rostrum, to the *Cypridea parallela*-line of Wolburg that has a stratigraphic range of Wealden 4 to Wealden 6 Beds in Germany. The Wealden Beds 4 to 6 were considered to be Valanginian in age by Anderson (1973, fig. 1) but van Hinte (1976b) regarded these beds as Berriasian in age. The lateral nodes relate this species to *C. (P.) binodosa* (Martin, 1940) from the middle Purbeckian of Germany, and to *C. (P.) salvadorensis nodifer* (Krömmelbein, 1962) as well as to *C. (P.) subtilis* (Krömmelbein, 1965), both from Brazil. The Brazilian species are considered to be at least partly younger than the Wealden Beds of Germany, and are probably of approximate Valanginian Age. *C. (P.) laeli* is shown in the discussion of the species to resemble the Purbeckian *Cypridea fasciculata*-group of Wolburg and also the late Purbeckian-Berriasian *C. alta*-group of Wolburg. Certain structures on the surface of the carapace could have developed from similar structures on species described from Purbeckian through Berriasian Ages. On the basis of the resemblances and postulated evolutionary stages of development in relation to the known species outside of North America, *C. (P.) henrybelli* and *C. (P.) laeli* suggest that the plausible age

for the Lakota Formation is younger than Berriasian and possibly also younger than early Valanginian.

According to van Hinte's proposed absolute time scales for the Jurassic (1976a) and for the Cretaceous (1976b), the time involved between the underlying Morrison Formation (Kimmeridgian) and the base of the Aptian is approximately 26 m.y., of which 6 m.y. are in the Jurassic and the remaining 20 m.y. in the Early Cretaceous. On the basis of the estimates of the timespan in the standard section, the Lakota Formation should fall somewhere within the 16-m.y. span between the Berriasian and the base of the Aptian. As the ostracodes dealt with in this paper are from the Chilson Member, the lowest of three members of continental deposits, I estimate the timespan of the rocks represented by the ostracodes to be less than 10 m.y., somewhere between 118 m.y. and 128 m.y. before the present.

PALEOECOLOGY

The Lower Cretaceous sedimentary rocks in the Black Hills represent limnic and fluviatile deposits, and the ostracodes in those rocks belong to genera described from nonmarine environments in other parts of the world. The one possible exception is presented in a study by Allen and others (1973) on the basis of isotopic ratios of the carbonate in fossils from the Lower Cretaceous Wealden clay in Europe (England and Germany). They concluded that two species of *Cypridea*: *C. bispinosa suthringensis* [sic] = *C. bispinosa suthringensis* Anderson, 1967, and *C. recta tillsdenensis* Anderson, 1967, "might be marine" (Allen and others, 1973, p. 619), and that other species of *Cypridea* used in their study may be freshwater. It is known that nonmarine ostracodes have been transported into brackish and also marine environments. I have recovered from the same samples (Sohn, 1967, p. 123) *Cypridea* specimens and charophytes associated with typically marine ostracodes as well as the foraminifer *Chofatella decipiens* Schlumberger, 1905.

However, the paleogeographic framework of the European Lower Cretaceous differs from that in the Black Hills. In Europe, the Lower Cretaceous sediments were deposited during a marine-freshwater transgressive and regressive sequence (Anderson and others, 1967, p. 174-175), whereas no evidence exists in North America of a marine incursion in Wyoming and South Dakota during Early Cretaceous time (Lane, 1963, fig. 2).

The population dynamics of the limnic ostracodes

in the Black Hills area must have been such as to induce an unusual variety in the shell morphology. The development of lateral ridges on the valves, asymmetrical on the carapace as on *Trapezoidella* (pl. 1, figs. 5, 8, 16; pl. 2, figs. 14, 16, 18, 20-24, 28, 30, 36), and on *Cypridea* (*Pseudocypridina*) (pl. 3, figs. 1, 4, 9, 10, 13; pl. 6, figs. 1, 5, 8, 10, 13, 16, 21, 23, 32, 41, 42; pl. 8, figs. 29, 30) on which they are developed only on the left valves, and the asymmetrical structure on the left valve only in *Longispinella* (pl. 4, figs. 9, 13, 16, 17, 18; pl. 5, figs. 7, 13, 20, 21; pl. 7, figs. 5, 7) probably reflects some functional response to their ecology.

Sohn (1962) and Sohn and Anderson (1964) demonstrated that the presence and position of every spine and node in the Mesozoic freshwater cypridacean ostracode *Theriosynoecum* Branson, 1936, are genetically controlled, and later workers (Benson, 1972; Liebau, 1975) showed that the same is true for marine cytheraceans. Some of the species in the Black Hills show a variation contrary to this principle, as illustrated in this paper in *Cypridea* (*Pseudocypridina*) *henrybelli* (pl. 3, figs. 14-17; pl. 8, figs. 1-25). Although similar structures have been recorded on other limnic cypridaceans, nobody has proposed an explanation for their presence. At the present state of knowledge, such structures cannot be ascribed to a definite ecological factor.

USGS MESOZOIC COLLECTION LOCALITIES

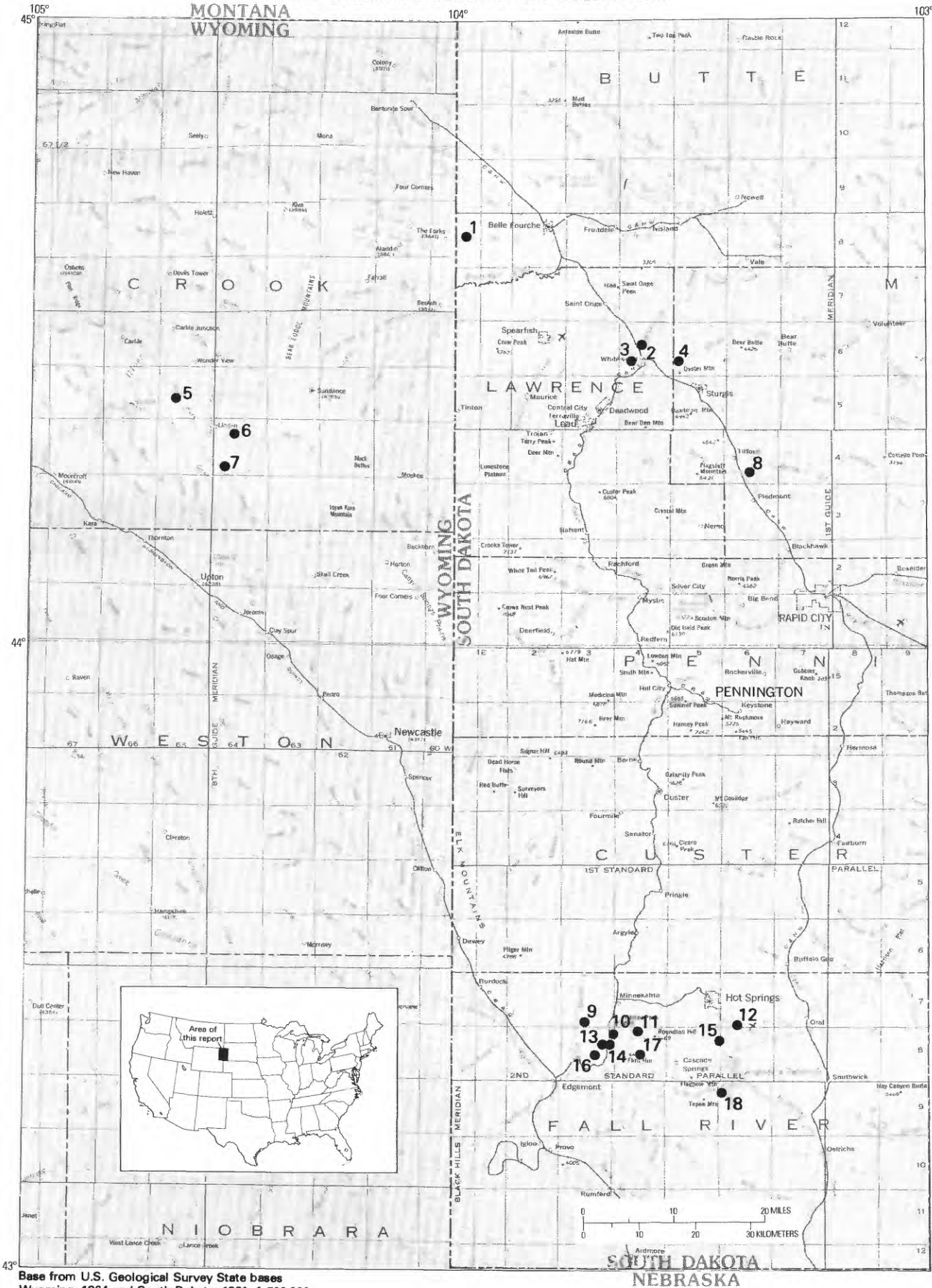
[Map locality numbers refer to figure 2]

- USGS 25460. Chilson Member of Lakota Formation. Unit 2, Buck Canyon, SE $\frac{1}{4}$ sec. 15, T. 8 S., R. 4 E., Flint Hill quadrangle, Fall River County, S. Dak. Colln. H. Bell, 1954, (MD-55-11, field No. HBP-70-54). Map loc. 17.
- USGS 25643. Lakota Formation, NE $\frac{1}{4}$ sec. 9, T. 50 N., R. 64 W., Crook County, Wyo. Colln. W. J. Mapel, 1956 (F-56-32, field No. MP-41-23). Map loc. 6.
- USGS 25644. Lakota Formation, NW $\frac{1}{4}$ sec. 21, T. 51 N., R. 65 W., Crook County, Wyo. Colln. W. J. Mapel, 1956 (F-56-32, field No. MP-48-19). Published in error as USGS 24644 by Robinson, Mapel, and Bergendahl (1964, p. 37, unit 13), see USGS 31001. Map loc. 5.
- USGS 25645. Same locality as USGS 25644. Colln. W. J. Mapel, 1956 (F-56-32, field No. MP-48-20). Published in error as USGS 24645 by Robinson, Mapel, and Bergendahl (1964, p. 37, unit 14), see USGS 31001. Map loc. 5.
- USGS 25646. Lakota Formation, approximately 80 feet (24.4 m) above base. Sec. 16, T. 6 N., R. 4 E., Lawrence County, S. Dak., vicinity of Sturgis. Colln. W. J. Mapel, 1956 (F-56-32, field No. MP-119-9). Map loc. 2.
- USGS 25647. Lakota Formation, N $\frac{1}{2}$ sec. 30, T. 6 N., R. 5 E., Meade County, S. Dak., Colln. W. J. Mapel, 1956 (F-56-32, field No. MP-119-10). Map loc. 4.
- USGS 26098. Chilson Member of Lakota Formation, Unit 2, Buck Canyon measured section, 56 to 63 feet (17 to 22 m) above base. SE $\frac{1}{4}$ sec. 15, T. 8 S., R. 4 E., Flint Hill quadrangle, Fall River County, S. Dak. Colln. H. Bell, 1954 (MD-56-6, field No. HBP-51-54). Map loc. 17.
- USGS 26100. AEC Diamond Drill Hole RE-17 (Bell and Post, 1971, p. 557, pl. 32), same as USGS 30988, core at 267.0 feet (81 m). Colln. H. Bell, 1955 (MD-56-6, field No. RE-17B). Map loc. 16.
- USGS 26468. Lakota Formation, measured section in SE $\frac{1}{4}$ sec. 1, T. 8 S., R. 3 E., elevation 4,170 feet (1,271 m), Fall River County, S. Dak. Colln. V. R. Wilmarth, 1956 (MD-57-11, field No. MK-S-56). Map loc. 10.
- USGS 26469. Same locality and section as USGS 26468 at elevation 4,200 feet (1,280 m). Colln. V. R. Wilmarth, 1956 (MD-57-11, field No. MK-T-56). Map loc. 10.
- USGS 26939. Lakota Formation, 20 feet (6 m) above base, SW $\frac{1}{4}$ sec. 9, T. 50 N., R. 64 W., Crook County, Wyo. Colln. W. J. Mapel and C. L. Pillmore, 1957 (F-57-31, field No. 213-6). Map loc. 6.
- USGS 26940. Lakota Formation, basal part, sec. 29, T. 50 N., R. 64 W., Crook County, Wyo. Colln. W. J. Mapel and C. L. Pillmore, 1957 (F-57-31, field No. 216-1). Map loc. 7.
- USGS 26941. Lakota Formation, limestone bed, 1 foot (0.30 m) above USGS 26940. Colln. W. J. Mapel and C. L. Pillmore, 1957 (F-57-31, field No. 216-2). Map loc. 7.
- USGS 30985. Chilson Member of Lakota Formation, upper part, mudstone, dark greenish gray, somewhat sandy, Unit 2, SE $\frac{1}{4}$ sec. 11, T. 8 S., R. 3 E., Flint Hill quadrangle, Fall River County, S. Dak. Colln. H. Bell, 1954 (field No. HB-1-54=Station B-136). Map loc. 13.
- USGS 30986. Chilson Member of Lakota Formation, upper part, thin sandstone in Unit 2 (Bell and Post, 1971, p. 520), SW $\frac{1}{4}$ sec. 12, T. 8 S., R. 3 E., Flint Hill quadrangle, Fall River County, S. Dak. Colln. H. Bell, 1954 (MD-55-11, field No. HB-2-54). Map loc. 13.
- USGS 30987. Chilson Member of Lakota Formation, white clay, Unit 2, 1.8 miles (2.9 km) southeast of 30986. Flint Hill quadrangle, Fall River County, S. Dak. Colln. H. Bell, 1953 (MD-53-55, field No. HB-14-53). Map loc. 16.
- USGS 30988. Chilson Member of Lakota Formation, Unit 2, AEC Diamond Drill Hole RE-17 (Bell and Post, 1971, p. 557, pl. 32), corner common to secs. 14, 15, 22, 23, T. 8 S., R. 3 E., Flint Hill quadrangle, Fall River County, S. Dak. Core at 289.5 feet (88 m) interbedded mudstone and sandstone. Colln. H. Bell, 1955 (MD-56-6, field No. RE-17I). Map loc. 16.
- USGS 30989. Chilson Member of Lakota Formation, Unit 2. AEC Diamond Drill Hole RE-14 (Bell and Post, 1971, p. 555, pl. 32), SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 11, T. 8 S., R. 3 E., Flint Hill quadrangle, Fall River County, S. Dak. Core at 346.0 feet (105 m), siltstone, dark-gray, carbonaceous; some dark-greenish-gray claystone. Colln. H. Bell, 1955 (MD-56-6, field No. RE-14J). Map loc. 13.
- USGS 30990. Chilson Member of Lakota Formation, Unit 1, mudstone about 10 feet (3 m) above base of section, Upper Chilson Canyon, Marty's Ranch, T. 8 S., R. 3 E., Flint Hill quadrangle, Fall River County, S. Dak. Colln. I. G. Sohn and H. Bell, 1957, field No. 8/15/10/57. Map loc. 14.
- USGS 30991. Chilson Member of Lakota Formation, Unit 1, same locality as above, limestone below and between paper shale sequence. Colln. I. G. Sohn and H. Bell, 1957, field No. 8/15/18/57. Map loc. 14.

- USGS 30993. Lakota Formation, core in NE $\frac{1}{4}$ sec. 33, T. 7 S., R. 3 E., Edgement quadrangle, Fall River County, S. Dak. Colln. W. B. Braddock, 1953 (MD-53-33, field No. BB-45-33). Map loc. 9.
- USGS 30994. Chilson Member of Lakota Formation, mudstone below typical Lakota sandstones and above the Unkpapa Sandstone. Sec. 4, T. 8 S., R. 4 E., Minnekahta quadrangle, Fall River County, S. Dak. Colln. H. Bell, 1953 (MD-53-33, field No. HB-9-53a). Map loc. 11.
- USGS 30995. Lakota Formation, 95 feet (29 m) below top, center NW $\frac{1}{4}$ sec. 17, T. 8 N., R. 1 E., Butte County, S. Dak. Colln. W. J. Mapel, 1957 (F-57-35, field No. 253-13a). Map loc. 1.
- USGS 30996. Lakota Formation, gray silty claystone, carbonaceous, approximately 150 feet (45.7 m) below top of formation, 4,300 feet (1,311 m) N. 35° E. from common corner secs. 11, 12, 13, 14, T. 8 S., R. 5 E., Cascade Springs quadrangle, Fall River County, S. Dak. Colln. J. J. Conner, 1957 (MD-57-60, field No. AS-58). Map loc. 15.
- USGS 30997. Chilson Member of Lakota Formation, probably Unit 2, coquina at Roth's (1933) type-locality, sec. 28, T. 4 N., R. 6 E., Meade County, S. Dak., 3 miles (4.8 km) north of Piedmont. Colln. I. G. Sohn, 1957 (field No. 8/10/2/57). Map loc. 8.
- USGS 30998. Lakota Formation, laminated ostracodal clay, Harper and Sutton's (1935) type-locality, NW $\frac{1}{4}$ sec. 29, T. 6 N., R. 4 E., Lawrence County, S. Dak. Colln. I. G. Sohn and H. Bell, 1957 (field No. 8/11/2/57) Map loc. 3.
- USGS 30999. Lakota Formation, shale with ostracodes, about 3 feet (0.9 m) below the sandstone, same locality as above. Colln. I. G. Sohn and H. Bell, 1957 (field No. 8/11/4/57). Map loc. 3.
- USGS 31001. Lakota Formation, near top, shale above limestone, near Corral Creek, NE $\frac{1}{2}$ sec. 20 and NW $\frac{1}{4}$ sec. 21, T. 51 N., R. 65 W. Crook County, Wyo. Colln. I. G. Sohn and W. J. Mapel, 1957 (field No. 8/20/21/57), same as USGS 24645-25655 (see Robinson, Mapel, and Bergendahl, 1964, p. 37, unit 14). Map loc. 5.
- USGS 31002. Chilson Member of Lakota Formation, Unit 2, mudstone, gray to green calcareous, core at 314.5 feet (96 m) in same drill hole as USGS 30989. Colln. H. Bell, 1955 (MD-56-6, field No. RE-14A). Map loc. 13.
- USGS 31003. Same unit, formation and drill hole as above, core at 321.8 feet (98.1 m). Colln. H. Bell, 1955 (MD-56-6, field No. RE-14D). Map loc. 13.
- USGS 31004. Same unit, formation and drill hole as above, core at 334.0 feet (102 m). Colln. H. Bell, 1955 (MD-56-6, field No. RE-14G). Map loc. 13.
- USGS 31005. Same unit, formation and drill hole as above, siltstone, dark-gray, carbonaceous, core at 345.0 feet (105 m). Colln. H. Bell, 1955 (MD-56-6, field No. RE-14I). Map loc. 13.
- USGS 31006. Chilson Member of Lakota Formation, Unit 2. Same drill hole as USGS 30988. Mudstone, dark-olive-gray, carbonaceous, core at 283.5 feet (86 m). Colln. H. Bell, 1955 (MD-56-6, field No. RE-17H). Map loc. 16.
- USGS 31007. Chilson Member of Lakota Formation, Unit 2, Buck Canyon, SE $\frac{1}{4}$ sec. 15, T. 8 S., R. 4 E., Flint Hill quadrangle, Fall River County, S. Dak. Mudstone, brownish gray, silty; bedding irregular, unit 10 of Bell and Post (1971, p. 531), 52 feet (15.8 m) above base. Colln. H. Bell, 1955 (MD-56-6, field No. HB-23-54). Map loc. 17.
- USGS 31008. Same unit as above, slightly higher. Colln. H. Bell, 1955 (MD-56-6, field No. HB-24-54). Map loc. 17.
- USGS 31009. Lakota Formation, variegated clay just below USGS 30998. Colln. I. G. Sohn and H. Bell, 1957 (field No. 8/11/3/57). Map loc. 3.
- USGS 31129. Chilson Member of Lakota Formation, Unit 1, same location as USGS 30990, about 5 feet (1.5 m) below USGS 30990, Fall River County, S. Dak. Colln. I. G. Sohn and H. Bell, 1957 (field No. 8/15/11/57). Map loc. 14.
- USGS 31130. Chilson Member of Lakota, Unit 1, sandy layer, just above USGS 31129. Fall River County, S. Dak. Colln. I. G. Sohn and H. Bell 1957, (field No. 8/15/12/57). Map loc. 14.
- USGS 31153. Lower part of the Lakota Formation, shale, sec. 32, T. 7 S., R. 6 E. Channel sample of upper one-half of 15-foot (4.6-m) lens in cut on north side of Fall River Road, 3.2 miles (5.1 km) southeast of city limits (1940) of Hot Springs, Fall River County, S. Dak. Same locality as Peck (1957, p. 11) loc. D286. Colln. I. G. Sohn, D. E. Wolcott, and C. E. Price, 1957 (field No. 8/16/1/57). Map loc. 12.
- USGS 31154. Same locality as above, channel sample of lower one-half of the same lens to contact with underlying Unkpapa Sandstone (Upper Jurassic). Colln. I. G. Sohn, D. E. Wolcott, and C. E. Price, 1957 (field No. 8/16/2/57). Map loc. 12.
- USGS 31171. Chilson Member of Lakota Formation, probably Unit 2, shale, about 3 feet (0.9 m) above USGS 30997, and approximately 33 feet (10 m) above base. Sec. 28, T. 4 N., R. 6 E., Meade County, S. Dak. Colln. I. G. Sohn, 1957 (field No. 8/10/1/57). Map loc. 8.
- USGS 31172. Chilson Member of Lakota Formation, probably Unit 2 shale, about 25 feet (7.6 m) below USGS 30997, and approximately 5 feet (1.5 m) above base. Sec. 28, T. 4 N., R. 6 E., Meade County, S. Dak. Colln. I. G. Sohn, 1957 (field No. 8/10/3/57). Map loc. 8.
- USGS 31237. Chilson Member of Lakota Formation, same locality as USGS 30990, shale, Unit 1, about 3 feet (0.9 m) lower in the section than USGS 31129. Colln. I. G. Sohn, and H. Bell, 1957 (field No. 8/15/13/57). Map loc. 14.
- USGS 31238. Same locality as above, 2 feet (0.6 m) below USGS 31237. Colln. I. G. Sohn and H. Bell, 1957 (field No. 8/15/14/57). Map loc. 14.
- USGS 31239. Lakota Formation, gray, silty claystone approximately 150 feet (45.7 m) below top, 5,400 feet (1,646 m) N. 45 E. from common corner of secs. 11, 12, 13, 14, T. 9 S., R. 5 E., Cascade Springs quadrangle, Fall River County, S. Dak. Colln. J. J. Conner, 1957 (MD-57-60, field No. AS-33). Map loc. 18.

The geographic location of the samples in Wyoming and South Dakota is shown in figure 2. Collection localities that are too close to each other to be shown on the map are lumped under one number. Table 1 shows the USGS Mesozoic localities under each of the location numbers on the map.

USGS MESOZOIC COLLECTION LOCALITIES



Base from U.S. Geological Survey State bases
 Wyoming, 1964 and South Dakota, 1961, 1:500,000

FIGURE 2.—Map showing the location of the collection localities in South Dakota and Wyoming.

TABLE 1.—USGS Mesozoic collections represented by each number on the locality map (fig. 2)

Map location No.	USGS Mesozoic collection No.
1	30995
2	25646
3	30998, 30999, 31009
4	25647
5	25644, 25645, 31001
6	25643, 26939
7	26940, 26941
8	30997, 31171, 31172
9	30993
10	26468, 26469
11	30994
12	31153, 31154
13	30985, 30986, 30989, 31002, 31003, 31004, 31005, 31129
14	30990, 30991, 31129, 31130, 31237, 31238
15	30996
16	26100, 30987, 30988, 31006
17	25460, 26098, 31007, 31008
18	31239

SYSTEMATIC DESCRIPTIONS

Class OSTRACODA Latreille, 1802 emend. 1804

Order PODOCOPIDA Sars, 1865

Superfamily CYPRIDACEA Baird, 1845

Family TRAPEZOIDELLIDAE Sohn, n. fam.

Diagnosis.—Medium to large (between 0.75 mm and 2½ mm or larger), thick walled, with straight to curved dorsal margin. Surface smooth or tuberculate, with or without ventrolateral ridge or node on larger valve. Overlap strong along dorsal and ventral margins, variable on end margins. Duplicature wide on end margins, hingement ridge and groove, with or without anterior toothlike widening on ridge. Dimorphism unknown.

Discussion.—Galeeva (1955, p. 26) described *Limnocypridae* Mandelstam, 1948, for the genera *Dsunbaina* Galeeva, 1955, *Cypridea* Bosquet, 1850, *Mongolianella* "Mandelstam in litt. 1948," and "*Cyprideamorphella*," but did not describe, illustrate, or cite a reference to *Limnocypridea*, the type-genus. Because *Limnocypridea* Lübmova, 1956, had not been validated in 1955, the family *Limnocypridae* is a nomen nudum, and does not compete with the Trapezoidellidae. Howe (1962, p. 134) discussed the *Limnocypridae*, and stated that "As used this family is more or less equivalent to the Cyprideinae Martin, 1940 * * * ."

Lübmova (1956b, p. 9) transferred *Limnocypridea* Lübmova, 1956, and *Mongolianella* Mandelstam, 1955, to the Cyprideinae, and Mandelstam and Schneider (1963, p. 106) added to the subfamily the genera *Latonia* Mandelstam, 1963, *Zefaina* Mandelstam, 1963, and *Ilyocypromorpha* Mandelstam,

1955. The Cyprideinae were elevated to family status, the Cyprideidae Martin, 1940, by Hartmann and Puri (1974, p. 57) who stated that all the genera in this family possess a "rostrum-like" incisure at the border of the anterior and ventral margins. Because none of the genera except *Cypridea* discussed above has an anteroventral incisure, I am referring them to the new family Trapezoidellidae.

Key to the genera in the Trapezoidellidae

1	Left valve larger than right	2
1a	Right valve larger than left	5
2(1)	Ventrolateral ridge and dorsolateral groove on left valve	<i>Trapezoidella</i>
2a	Without ventrolateral ridge and dorsolateral groove on left valve	3
3(2a)	Dorsal margin overreaches right valve	<i>Limnocypridea</i>
3a	Dorsal margin does not overreach right valve ..	4
4(3a)	Dorsoposterior margin pointed	<i>Zefaina</i>
4a	Dorsoposterior margin rounded	<i>Mongolianella</i>
5(1a)	Dorsal margin round	<i>Latonia</i>
5a	Dorsal margin straight	6
6(5a)	Lateral surface tuberculate	<i>Ilyocypromorpha</i>
6a	Lateral surface not tuberculate	<i>Cyprideamorphella</i>

Genus TRAPEZOIDELLA Sohn, n. gen.

Type-species.—*Bythocypris* (*Bairdiocypris*) *trapezoidalis* Roth, 1933.

Diagnosis.—Large, to 1.6 mm in greatest length, trapezoidal, with straight or convex dorsal margin. Surface smooth, with ventrolateral ridge near ventral margin, and dorsolateral thin groove subparallel to dorsal margin of left valve. Overlap and overreach of left valve over right. End outline subtriangular, ridge and overlap forming almost straight base, dorsal outline subelliptical, greatest width at approximate midlength, posterior wider than anterior.

Discussion.—This genus is established for the type-species, *T. trapezoidalis* (Roth, 1933), and *T. rothi* n. sp., both from the Lower Cretaceous Lakota Formation in the Black Hills. Harper and Sutton (1935, p. 627) stated in their discussion of *Bythocypris* (*Bairdiocypris*) *morrisonensis* Roth, 1933 (= *Limnocypridea*), "A semi-false keel paralleling the dorsal margin of the left valve is the only surface ornament," and Loranger (1951, p. 2360) stated in her description of *Bairdiocypris albertensis* Loranger, 1951 (= *Limnocypridea*?), "Surface ornamentation commonly consists of straight ridge or false keel on left valve parallel with the ventral margin." Both of the above species do not have the diagnostic ventrolateral ridge and are discussed under *Limnocypridea* Lübmova, 1956. Krömmelbein (1963, p. 387) described and illustrated *Salva-*

doriella redunca subsp. *comitans* from the upper part of the Ilhas Formation of Bahia, Brazil, that is trapezoidal in lateral outline and has a ventrolateral ridge on both valves, which, combined with the lateral outline, differentiates it from the nominate subspecies, the type-species of *Salvadoriella*. Because Krömmelbein did not mention a dorsolateral groove, I do not know whether the Brazilian taxon belongs in the new genus. *Salvadoriella* Krömmelbein, 1963 (type-species *Candona? redunca* Krömmelbein, 1962) differs from *Trapezoidella* in having a concave ventroanterior, is smaller in size, has a relatively narrow overlap, and lacks the ventrolateral ridge and dorsolateral groove on the larger left valve.

Stratigraphic range.—Lower Cretaceous.

***Trapezoidella trapezoidalis* (Roth, 1933)**

Plate 1, figures 6–9, 12–17; plate 2, figures 30–32

Bythocypris (*Bairdiocypris*) *trapezoidalis* Roth, 1933, Jour. Paleontology, v. 7, no. 4, p. 402, pl. 48, figs. 6a–d. Lakota Formation, Meade County, S. Dak.; Harper and Sutton, 1935, Jour. Paleontology, v. 9, no. 8, p. 628, pl. 76, figs. 16, 17 (orientation reversed 180°). Lakota Formation, Lawrence County, S. Dak.

Diagnosis.—Straight backed, with straight ventrolateral ridge near middle of larger valve.

Discussion.—The holotype (USNM 74470) is a young individual about one-half the size of available specimens (compare pl. 1, figs. 6–9 with figs. 16, 17). The species is distributed in the Chilson Member of the Lakota Formation in South Dakota and Wyoming.

Geographic distribution.—South Dakota; Butte County; map loc. 1, USGS colln. 30995, USNM 242910.

Meade County; map loc. 4, USGS colln. 25647, USNM 242921; map loc. 8, Roth's type-locality, pl. 1, figs. 6–9, and USGS colln. 30997, USNM 242911, associated with *Limnocypridea morrisonensis* (Roth, 1933) and *Cypridea* (*Pseudocypridina*) *piedmonti* (Roth, 1933).

Lawrence County; map loc. 3, Harper and Sutton's type-locality and USGS colln. 30998, USNM 242912, associated with *Cypridea* (*Pseudocypridina*) *piedmonti* (Roth, 1933); USGS colln. 30999, USNM 242913, associated with *Limnocypridea morrisonensis* (Roth, 1933); USGS colln. 31009, USNM 242914.

Fall River County; map loc. 13, USGS colln. 30986 (? identification), USNM 242915, associated with *Cypridea* (*Pseudocypridina*) *piedmonti* (Roth, 1933); map loc. 17, USGS colln. 31007, USNM 242916, associated with *T. rothi* n. sp., and

Cypridea (*Pseudocypridina*) *henrybelli* n. sp.; map loc. 16, USGS colln. 30987, USNM 242916.

Wyoming, Crook County; map loc. 6, USGS colln. 25643, pl. 1, figs. 12–17, USNM 242917; USGS colln. 26939 (? identification), USNM 242918; map loc. 7, USGS colln. 26940, USNM 242919; 26941, pl. 2, figs. 30–32, USNM 242920.

***Trapezoidella rothi* Sohn, n. sp.**

Plate 1, figures 1–5, 10; plate 2, figures 7–29, 33, 34–36

Name.—In honor of Dr. Robert Roth, Wichita Falls, Tex., who was the first to describe the Mesozoic ostracodes from the Black Hills, S. Dak.

Holotype.—USNM 242861.

Paratypes.—USNM 242836–242838, 242851–242860, 242862–242864.

Type-locality.—Map loc. 13, SE¼ sec. 11, T. 8 S., R. 3 E., Flint Hill quadrangle, Fall River County, S. Dak.

Other localities.—See geographic distribution.

Type level.—Upper part of the Chilson Member of the Lakota Formation, USGS colln. 30985.

Diagnosis.—Convex dorsal margin and gently curved lateroventral ridge on left valve, smaller right valve with shallow horizontal lobe below and subparallel to straight hingeline, delineated ventrally by a horizontal shallow sulcus.

Description.—The lateral outline of the carapace is subhemicircular, with a convex dorsal margin, a straight to slightly concave ventral margin, curved end margins with the posterior margin more broadly rounded than the anterior margin. The left valve overlaps the right, and overreaches it along a straight-hinge margin; it bears a gently curved ridge near its ventral margin, and a narrow groove subconcentric to the curved dorsal outline. This groove gives the impression of the dorsal margin having been pinched along its perimeter. The smaller right valve is subtrapezoidal in lateral outline, with a straight-hinge margin that is overreached by the left valve, and with a shallow horizontal lobe below the hinge margin. This lobe has below it a shallow sulcus that sets it off from the convexity of the valve.

Discussion.—This species was called "Genus F" in my reports to the field geologists who were mapping in the Black Hills and appears as such in their faunal lists.

Geographic distribution.—South Dakota, Fall River County; map loc. 9, USGS colln. 30993, pl. 1, figs. 1, 2, pl. 2, figs. 34–36; map loc. 10, USGS colln. 26468, pl. 2, fig. 21, USNM 242922; USGS colln. 26469, USNM 242923; map loc. 11, USGS colln. 30994, pl. 2, fig. 23, associated with *Cypridea*

(*Pesudocypridina*) *piedmonti* (Roth, 1933); map loc. 13, USGS colln. 30985, pl. 2, figs. 7-9, 22, 24-29, 33, USNM 242924; USGS colln. 30989, USNM 242025; USGS colln. 31002, USNM 242928; USGS colln. 31003, USNM 242929, associated with *C. (P.) henrybelli* n. sp.; USGS colln. 31004, USNM 242930; USGS colln. 31005, USNM 242987, associated with *C. (P.) inornata* (Peck, 1941); map loc. 14, USGS colln. 30990, pl. 2, figs. 10, 11, USNM 242926; USGS colln. 30991, USNM 242927; USGS colln. 31237, USNM 242959, associated with *C. (P.) inornata* (Peck, 1941), and *C. (P.) henrybelli* n. sp.; USGS colln. 31238, USNM 242960, associated with *C. (P.) inornata* (Peck 1941); map loc. 16, USGS colln. 26100, USNM 242933, associated with *C. (P.) inornata* (Peck, 1941); USGS colln. 30988, pl. 2, figs. 12-15, USNM 242934; USGS colln. 31006, pl. 2, figs. 16, 17, USNM 242935; map loc. 17, USGS colln. 31007, pl. 2, fig. 20, associated with *T. trapezoidalis* (Roth, 1933) and *C. (P.) henrybelli* n. sp.; USGS colln. 31008, USNM 242932.

Genus LIMNOCYPRIDEA Lübmova, 1956

Limnocypridea Lübmova, 1956a, in Kiparisova, Markovsky, and Radchenko, Materialy po paleontologii, VSEGEI, Materialy, new ser., no. 12, p. 106; Lübmova, 1956b, VNIGRI, Trudy, no. 93, p. 9; Lübmova, Mandelstam, and Schneider, 1960, Osnovy paleontologii, v. 8, p. 353; Swain and others, in Moore, 1961, Treatise on invertebrate paleontology, Part Q, Arthropoda 3, Crustacea, Ostracoda, p. Q237; Mandelstam and Schneider, 1963, VNIGRI, Trudy, no. 203, p. 112.

Bythocypris (*Bairdiocypris*) Kegel. Roth, 1933, Jour. Paleontology, v. 7, p. 401; Harper and Sutton, 1935, Jour. Paleontology, v. 9, p. 627; Loranger, 1951, Am. Assoc. Petroleum Geologists Bull., v. 35, no. 11, p. 2359; Loranger, 1954, Western Canada sedimentary basin—A symposium, p. 286.

Type-species (original designation).—*Limnocypridea abscondida* Lübmova, 1956a, p. 108, pl. 26, figs. 2a-c, text figs. 27a, b. Dzunbain Formation (Barremian), SE Mongolia, U.S.S.R., nonmarine.

Diagnosis.—Carapace thick walled, subtriangular, suboval or trapezoidal, with rounded ends, greatest convexity in middle or ventral part of valves. Left valve overlaps right, greatest overlap along venter, dorsal margin overreaches; hingeline approximately straight, of variable length. Vestibule large, radial pore canals straight or slightly curved; surface smooth or pitted, with or without elongate nodes on ventral part.

Discussion.—The following description is modified from the original description and discussion, which has been translated from Lübmova (1965a, p. 106), and from that given in Moore (1961, p. Q237).

Carapaces large (length 1.2 to 1.8 mm), thick walled, suboval to trapezoidal with rounded corners, with the greatest convexity in the middle or posteroventral part of the valve. The left valve markedly larger than right and overlaps the latter all around: particularly strong overlap is expressed on the dorsal and ventral margins. Occasionally the dorsal part of the left valve is noticeably raised above the dorsal margin of the right valve and markedly overlaps [overreaches] longitudinally the entire dorsal margin.

Anterior and posterior margins of equal height or the anterior is slightly higher than the posterior. Both ends are bevelled in their upper part and are roundly curved below, somewhat lower downward. Dorsal margin straight. Ventral margin concave in the middle. Valves pitted, with one or two [nodes] protuberances in the ventral part, sometimes smooth. Inner margin of the valves does not coincide with the outer. Pore-canal zone wide, well developed on anterior and posterior ends, and on the ventral side. Pore canals straight or somewhat curved, extend [from the] sinuous line of concrescence. Sometimes branched pore canals are observed. On the anterior and posterior ends are well developed structureless plates [calcified part of the inner lamella].

Hinge straight-ridged, equaelemental, of sufficiently simple construction. The right valve has a ridge, widening towards the ends [particularly toward the front] and curving in its own marginal parts, tapers [merges] imperceptibly to anterior and posterior ends. Hinge of left valve has the opposite structure, i.e., consists of a shallow groove, also slightly widening towards the ends and dying out at the anterior and posterior where it flattens out.

Reason for separating genus: Hinge of described genus is generally similar to the hinge of the genus *Cyprideamorphella* erected by Mandelstam for Lower Cretaceous representatives from eastern Zabaikal. Differs from it in simpler construction, namely: absence in the anterior portion of the ridge, the thickened curved tooth, and in the anterior portion of the groove and expanded socket that opens into the groove. In addition, the arrangement of the hinge elements of the described genus are reversed: ridge on right valve and groove on left, and in the related genus *Cyprideamorphella* the ridge on the left valve and the groove on the right. The overlap is also different in the two genera.

Members of the genus *Limnocypridea* are characterized by left overlapping valves, well-developed pore-canal zone, peculiar hinge structure, and also characteristic trapezoidal outline of the carapace and elevated margin of the dorsal part of the valve, which characterize the new genus.

The type-species, *L. abscondida* Lübmova, 1956, is nonreticulated and has no nodes or ridges; in the same year, Lübmova (1956b) described four additional species, two of which, *L. tumulosa* and *L. bitumulosa*, have subventral nodes and are finely reticulated, and two, *L. subplana* and *L. grammii*, are smooth. Several species in North America that belong to *Limnocypridea* conform with the original concept of the genus as defined in the U.S.S.R. There are, however, additional species that do not fit within the genus as originally defined. This situation is not unique because, in practice, genera are

usually erected before all the species that belong to the taxon are known.

Van Morkhoven (1963, p. 61) considered *Limnocypridea* as a synonym of *Lineocypris* Zalani, 1929. The two genera differ in type and amount of overlap on the dorsal margin and in details of the muscle-scar pattern.

Key to the species of Limnocypridea

1	Lateral surface with nodes or ridges -----	2
1a	Lateral surface without nodes or ridges -----	3
2(1)	One subventral node on each valve -----	
	----- <i>tumulosa</i> Lübmova, 1956b	
2a	Two subventral nodes on each valve -----	
	----- <i>bitumulosa</i> Lübmova, 1956b	
3(1a)	Dorsal margin straight -----	4
3a	Dorsal margin curved -----	8
4(3)	Ventral margin concave -----	
	----- <i>abscondida</i> Lübmova, 1956a	
4a	Ventral margin straight -----	5
5(4a)	Height of left valve one half or less greatest length -----	
	----- <i>albertensis</i> (Loranger, 1951)	
5a	Height of left valve more than one half greatest length -----	6
6(5a)	Greatest height of right valve anterior to midlength -----	7
6a	Greatest height of right valve at midlength -----	
	----- <i>grammi</i> Lübmova, 1956b	
7(6)	Anterior margin of right valve broader than posterior margin -----	
	----- <i>celtiformis</i> (Harper and Sutton, 1935)	
7a	Anterior margin of right valve narrower than posterior margin -----	
	----- <i>subplana</i> Lübmova, 1956b	
8(3a)	Greatest height behind midlength -----	
	----- <i>morrisonensis</i> (Roth, 1933)	
8a	Greatest height in front of midlength -----	
	----- <i>equalis</i> (Harper and Sutton, 1935)	

The divisions shown in the key are tentative because some of the species described from Mongolia may be conspecific. *Cypridopsis parallela* Hanai, 1951, from the Middle and Upper Cretaceous of central Manchuria may belong in *Limnocypridea* but is not included in the key because of the uncertainty.

L. equalis (Harper and Sutton, 1935) is recognized here as a valid species, and the variation in lateral outline of *L. morrisonensis* (Roth, 1933), is described and illustrated.

***Limnocypridea morrisonensis* (Roth, 1933)**

Plate 1, figures 11, 18-30; plate 3, figures 26-29

Bythocypris (*Bairdiocypris*) *morrisonensis* Roth, 1933, Jour. Paleontology, v. 7, no. 4, p. 401, pl. 48, figs. 4a-c; Harper and Sutton, 1935, Jour. Paleontology, v. 9, p. 627.

Bythocypris (*Bairdiocypris*) *morrisonensis* var. *equalis* Harper and Sutton, 1935 (part), Jour. Paleontology, v. 9, no. 8, p. 627, pl. 76, figs. 22-23 (not fig. 21=*L. equalis*).

Diagnosis.—Large, as much as 2.7 mm or more in greatest length; smooth; lateral outline of left valve

varies from subtriangular to subovate, dorsal margin curved to acuminate; greatest height behind approximate midlength, greatest length below midheight; hingeline straight, one-half or less greatest length, closer to posterior than anterior end, below overreaching left valve; anterior margin always narrower than posterior, dorsoanterior margin always longer than dorsoposterior, ventral margin straight to gently concave; dorsal margin coincides with hingeline.

Discussion.—Harper and Sutton (1935, p. 627) described the new variety *equalis* because "Roth did not mention variations in *B. morrisonensis* * * *." They illustrated three specimens, the first of which (pl. 76, fig. 21) is here designated as the lectotype of *L. equalis* (Harper and Sutton, 1935), and the other two (pl. 76, figs. 22, 23) are synonyms of *L. morrisonensis*. Specimens from Roth's type-locality (topotypes) (pl. 1, figs. 18, 24) that are undoubtedly conspecific with the holotype (pl. 1, figs. 22, 25-28) are 2.3 mm in greatest length. Other topotype specimens range in greatest length from 2.2 mm (pl. 1, fig. 21) to 2.7 mm (pl. 1, fig. 20). The smallest representative of this species that I found is 1.8 mm long in a group of nested valves (pl. 1, fig. 11).

I cannot explain the absence of younger instars because the nesting indicates quiet water that would preclude size sorting by currents. Specimens of *T. trapezoidalis* (Roth, 1933) as small as 0.85 mm are associated with this species.

I consider all the specimens illustrated on plate 1, figures 11, 18-30, to be conspecific. The variation in lateral outlines of the specimens illustrated on figures 18-29 is gradational; the specimen illustrated on figure 30, and the one on plate 3, figures 26-29, differ from the rest in lateral outline and are considered to be males of the species. This inference is based on the dimorphism found in living *Candona* Baird, 1845 (McGregor and Kesling, 1969a, b) in which the valves of the females as determined by soft parts have a dorsoposterior truncation (pl. 3, fig. 30). This truncation is similar to the specimens illustrated on plate 1, figures 18-29. The valves of male *Candona* have a rounded posterior (pl. 3, fig. 31) similar to those specimens of *L. morrisonensis* illustrated on plate 1, figure 30; plate 3, figures 26-29. The magnification of plate 1, figure 28, is approximately $\times 30$ in order to compare the size of this species with the sizes of the other species illustrated on this plate that are also approximately $\times 30$.

Geographic distribution.—South Dakota, Meade

County; map loc. 4, Roth's type-locality, pl. 1, figs. 22, 25-28, and map loc. 8, USGS colln. 30997, pl. 1, figs. 11, 18-21, 23, 24, 29, 30; pl. 3, figs. 26-29, USNM 242936, associated with *Trapezoidella trapezoidalis* (Roth, 1933), and *Cypridea* (*Pseudocypridina*) *piedmonti* (Roth, 1933).

Lawrence County; map loc. 3, Harper and Sutton's type-locality and USGS colln. 30999, USNM 242937, associated with *T. trapezoidalis* (Roth, 1933).

***Limnocypridea?* albertensis (Loranger, 1951)**

Plate 2, figures 1-6

Bairdiocypris albertensis Loranger, 1951, Am. Assoc. Petroleum Geologists Bull., v. 35, no. 11, p. 2360, pl. 2, figs. 7, 8, 16, 17, 21, 28, 36, 37. Blairmore Formation (Aptian-Albian), Alberta, Canada; Loranger, 1954, Western Canada sedimentary basin—A symposium, p. 286, pl. 2, figs. 7, 8, 16, 17, 21, 28, 36, 37; Howe and Laurencich, 1958, Introduction to the study of Cretaceous Ostracoda, p. 78.

Diagnosis.—Small, less than 0.9 mm in greatest length, smooth, dorsoanterior margin longer than dorsoposterior margin.

Discussion.—Loranger included in her description of this species the following: "Surface ornament commonly consists of straight ridge or false keel on left valve parallel to the ventral margin." She very kindly sent me four out of the five illustrated specimens. The four syntypes that I examined do not have a ventrolateral ridge; consequently, this species is referred here to *Limnocypridea?* rather than to *Trapezoidella*.

The original of Loranger's figure 28 (pl. 2, figs. 4-6) is here designated as the lectotype; it and the three paralectotypes are deposited in the Geological Survey of Canada (nos. 48735-48738). I am grateful to Dr. F. L. Staplin, Imperial Oil Limited, for permission to deposit these specimens with the Geological Survey of Canada.

According to Stelck (1975, p. 438, fig. 10), the Blairmore Formation is late Aptian-early Albian in age.

Family CYPRIDEIDAE Martin, 1940

I agree with Hartmann and Puri (1974, p. 57) in elevating the Cyprideinae to family category. My discussion of this subfamily (Sohn, 1969, p. B3) would now be applicable to the family. More than 300 species have been recorded in the genus *Cypridea* Bosquet, 1852, and its subgenera, making this an unwieldy taxon with which to deal. For practical purposes, it would be easier to deal with this group if it were divided into smaller taxonomic

units; the elevation of some of the subgenera to generic category would accomplish this.

In a previous study (Sohn, 1969, p. B4), I proposed a key to the subgenera of *Cypridea* in which I differentiated the subgenus *Pseudocypridina* from the subgenus *Cypridea* on the basis of the presence of a ventrolateral ridge on the left valve of the former and the absence of such a ridge on the latter. I now know that this was not a valid criterion. Although some species that I now refer to *Cypridea* (*Pseudocypridina*), do have a ventrolateral ridge in common with the type-species, *C. (P.) piedmonti* Roth, 1933, other species do not have that ridge. The other subgenera in that key are here elevated to generic status.

Key to the genera in the Cyprideinae

1	Nonsulcate	2
1a	Sulcate	6
2(1)	Left valve larger	4
2a	Right valve larger	3
3(2a)	Lateral outline ovoid, rostrum insignificant, alveolus obsolescent, surface without nodes or spines	<i>Paracypridea</i> Swain, 1946
3a	Lateral outline subtriangular, rostrum and alveolus well developed	<i>Ullwellia</i> Anderson, 1939
4(2)	Lateral outline subovoid	5
4a	Lateral outline subrectangular or subtriangular, rostrum, alveolus, and cyathus well developed, surface with subcentral spine, with or without tubercles	8
5(4)	Surface with or without nodes or ridges, without tubercles or spines, rostrum reflexed, alveolus obsolescent, cyathus lunate	<i>Cypridea</i> (<i>Pseudocypridina</i>) Roth, 1933
5a	Surface with tubercles or spines, without nodes or ridges, rostrum, alveolus, and cyathus usually well developed	<i>Cypridea</i> (<i>Cypridea</i>) Bosquet, 1852
6(1a)	One sulcus	7
6a	Two sulci	<i>Bisulcoeypridea</i> Sohn, 1969
7(6a)	With two nodes	<i>Morinia</i> Anderson, 1939
7a	With three nodes	<i>Morinioides</i> Krömmelbein, 1962
8(4a)	Lateral outline subrectangular, surface with tubercles or small spines	n. gen. (" <i>Cypridea</i> " sp. 1)
8a	Lateral outline subtriangular, surface without tubercles or small spines	<i>Longispinella</i> n. gen.

Genus CYPRIDEA Bosquet, 1852

Cypridea Bosquet, 1852, Belgium, Acad. Royale Sci., Lettres, Beaux-Arts, Mem. Couronnés et Mem. Savantes Etrangères, v. 24, p. 47; Sylvester-Bradley, 1949, Geologists' Assoc. Proc., v. 60, pt. 2, p. 130.

Cypridea (part) of authors.

Type-species (subsequent designation).—*Cypris granulosa* Sowerby, 1836, by Sylvester-Bradley 1947, p. viii.

Discussion.—Sylvester-Bradley (1949) redefined the genus and designated a neotype for *Cypridea granulosa* (Sowerby, 1836), the type-species, from the lower part of the middle Purbeckian of England. On the basis of Sylvester-Bradley's description and illustrations, *Cypridea* is closer to *Pseudocypridina* Roth, 1933, than to a large number of species that have been described as or referred to the genus *Cypridea*. His assignment of both as subgenera is accepted in this study. The major differences between the two subgenera are: (1) well-developed rostrum, and alveolus in *Cypridea*, and reflexed rostrum, obsolescent alveolus in *Pseudocypridina*; and (2) the presence of relatively large tubercles on the lateral surface of *Cypridea* and of fewer and smaller tubercles on *Pseudocypridina*. Most of the species that have been assigned to *Cypridea* differ from *Cypridea* as redefined by Sylvester-Bradley in size, lateral outline, surface ornament, and sculpture, and in the development of the alveolus and the cyathus (fig. 3).

In this paper I am illustrating in open nomenclature as "*Cypridea* sp. 1" a carapace from the Lakota Formation that shows many of the above differences. The reason for the open nomenclature is that I have found only one good carapace in one collection and five very poorly preserved carapaces in a second collection.

Although I had previously stated (Sohn, 1969, p. B2) that dimorphism in *Cypridea* is unknown, I have since observed dimorphism in width of posterior in cypridinid ostracodes (this paper, pl. 5, figs. 9, 12). Hanai (1951, p. 411, figs. 2-7) discussed and illustrated males and females of *Cypridea subvaldensis* Hanai, 1951, from the Middle Cretaceous of Manchuria, and Andreev (*in* Andreev and Mandelstam, 1968, p. 80) illustrated dimorphism in *Cypridea gissarensis* Andreev, 1968, from the upper Aptian of Tadzhikistan.

Anderson (*in* Anderson, Bazley, and Shephard-Thorn, 1967, p. 202) established the basis for discriminating between the genera in the Cyprideinae by naming and illustrating characters in the shell morphology of "*Cypridea*" (fig. 3). This major contribution provides criteria to split the taxon into component genera. Such a revision, however, is beyond the scope of this paper.

Subgenus CYPRIDEA Bosquet, 1852 emend. Sylvester-Bradley, 1949

Type-species.—Same as the genus.

Diagnosis.—Relatively large cypridinids, to about 2 mm in greatest length, subovoid, with or without

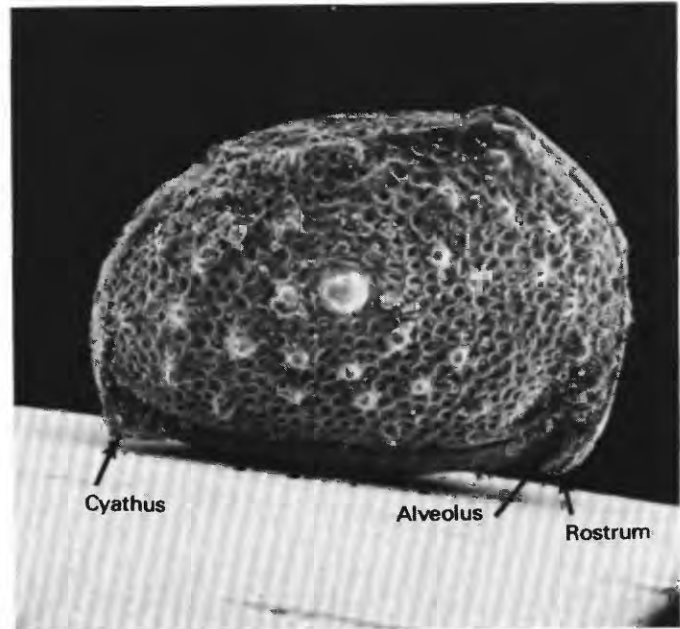


FIGURE 3.—Some of the characters in the shell morphology of Cyprideidae used in this paper, modified from Anderson (*in* Anderson, Bazley, and Shephard-Thorn, 1967, p. 202).

distinct angulation at junction of dorsal and anterior margins; surface finely punctate, with large tubercles, without reticulations or large spines; rostrum well developed, cyanthus usually lunate; hinge margin incised.

Stratigraphic range.—Upper Jurassic-Upper Cretaceous.

Subgenus PSEUDOCYPRIDINA Roth, 1933

Pseudocypridina Roth, 1933, Jour. Paleontology, v. 7, no. 4, p. 404; Howe and Laurencich, 1958, Introduction to the study of Cretaceous Ostracoda, p. 480.

Langtonia Anderson, 1939, Annals Mag. Nat. History, ser. 11, v. 3, no. 15, p. 304.

Cypridea (Pseudocypridina) Roth. Sylvester-Bradley, 1949, Geologists' Assoc. Proc., v. 60, pt. 2, p. 146; Swain *in* Moore, 1961, Treatise on invertebrate paleontology, Part Q, Arthropoda 3, Crustacea, Ostracoda, p. Q242; Kneuper-Haack, 1966, Beih. Geol. Jahrb., v. 44, p. 187.

Type-species (monotypy). — *Pseudocypridina piedmonti* Roth, 1933, Lakota Formation (Lower Cretaceous), South Dakota.

Diagnosis.—Relatively large cypridinids, to about 2 mm in greatest length, subovoid, without distinct angulation at junction of dorsal and anterior margins on larger left valve; surface finely punctate, with or without scattered tubercles, smaller than combined diameters of two punctae, usually near end margins, never with large spines or tubercles; with or without nodes or lateral ridges; rostrum poorly developed, alveolus obsolescent, cyanthus

lunate or indistinct; hinge margin incised.

Stratigraphic range.—Upper Jurassic–Upper Cretaceous.

Discussion.—The holotype of *P. piedmonti* Roth, 1933, is probably a male; it is here reillustrated (pl. 6, figs. 23–27). Many of the species assigned to *Cypridea* Bosquet, 1852, should be referred to the subgenus *C. (Pseudocypridina)*. The following species have been described in, referred to, or are here referred to *Pseudocypridina*:

- Cypridea acutituberculata* Galeeva, 1955, Barremian (Lower Cretaceous), Asia.
- Cypridea (Pseudocypridina) alacaramae* Kneuper-Haack, 1966, upper Purbeckian (Upper Jurassic), Europe.
- Cypridea alta alta* Wolburg, 1959, upper Purbeckian and Valanginian (Upper Jurassic–Lower Cretaceous), Europe.
- C. alta formosa* Wolburg, 1959, middle and upper Wealden 3 (Upper Jurassic–Lower Cretaceous), Europe.
- C. altissima* Martin, 1940, Wealden (Lower Cretaceous), Europe.
- C. altissima rotunda* Wolburg, 1959, lower to middle Wealden 2 (Upper Jurassic), Europe.
- C. amisia* Wolburg, 1959, Wealden 2 (Upper Jurassic), Europe.
- C. baidarensis* Bischoff, 1963, probably Hauterivian–Barremian (Lower Cretaceous), Asia Minor.
- C. binodosa* Martin, 1940, Purbeckian (Upper Jurassic), Europe.
- C. brevirostrata* Martin, 1940, Wealden (Lower Cretaceous), Europe.
- C. consulta* Mandelstam in Lübmova, Kaz'mina, and Reshetnikova, 1960, Barremian (Lower Cretaceous), Asia.
- C. (Pseudocypridina) demandae* Kneuper-Haack, 1966, upper Purbeckian (Upper Jurassic), Europe.
- C. dolabrata angulata* (Martin). Wolburg, 1959, Wealden 3 (Upper Jurassic), Europe.
- C. dolabrata dolabrata* (Anderson). Wolburg, 1959, Wealden 3 (Upper Jurassic), Europe.
- ?*C. (Pseudocypridina) ellipseloides* Hou, 1958, Lower Cretaceous, China.
- ?*C. (P.) extenda* Hou, 1958, Lower Cretaceous, China.
- C. fasciata* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. fasciculata* (Forbes in Lyell). Wolburg, 1959, Wealden 1 & 2 (Upper Jurassic), Europe.
- C. inaequalis* Wolburg, 1959, Wealden 2 & 3 (Upper Jurassic), Europe.
- C. laevis* Galeeva, 1955, Barremian (Lower Cretaceous), Asia.
- C. laevigata fairlightensis* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. laevigata hawkhurstensis* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. laevigata leonardi* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. laevigata philpottsii* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. laevigata subquadrata* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. laevigata wadhurstensis* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. lata* Martin, 1940, Purbeckian–Wealden (Upper Jurassic–Lower Cretaceous), Europe.
- C. (Cyamocypris) latiovata* Hou, 1958, Lower Cretaceous, China.
- C. (C.) sp. A* Hou, 1958, Lower Cretaceous, China.
- C. (C.) sp. B* Hou, 1958, Lower Cretaceous, China.
- C. (Pseudocypridina) magna* Hou, 1958, Cretaceous, China.
- C. (P.) moneta* Kneuper-Haack, 1966, upper Purbeckian (Upper Jurassic), Europe.
- C. (P.) moneta logronana* Kneuper-Haack, 1966, upper Purbeckian (Upper Jurassic) Europe.
- C. nannorostrata* Krömmelbein, 1962, Lower Cretaceous, South America.
- ?*C. obesa* Peck, 1951, Cloverly Formation (Lower Cretaceous), Wyoming, U.S.A.
- C. (Cyamocypris) ovatiformis* Hou, 1958, Lower Cretaceous, China.
- C. parallela* Martin, 1940, Wealden (Lower Cretaceous), Europe.
- C. (Pseudocypridina) parallela* Hou, 1959 (not Martin, 1940) Lower Cretaceous, China.
- C. posticalis* Jones, 1885, Purbeckian (Upper Jurassic), Europe.
- C. prognata* Lübmova, 1956, Barremian(?) (Lower Cretaceous), Asia.
- C. profusa* Lübmova, 1956, Upper Cretaceous, Asia.
- ?*C. quadrata* Peck, 1951, Cloverly Formation (Lower Cretaceous), Utah and Wyoming, U.S.A.
- C. rotundata* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. salvadorensis nodifer* Krömmelbein, 1962, Wealden (Lower Cretaceous), South America.
- C. salvadorensis salvadorensis* Krömmelbein, 1962, Wealden (Lower Cretaceous), South America.
- Pseudocypridina sambaensis* Grekoff, 1957, Wealden (Lower Cretaceous), Africa.
- Cypridea (Pseudocypridina) setina* (Anderson, 1939), upper Purbeckian (Upper Jurassic), Europe.
- C. (P.) setina acerata* Anderson, 1962, Wealden 5 (Lower Cretaceous), Europe.
- C. (P.) setina camelodes* Anderson, 1962, lower and middle Wealden 4 (Upper Jurassic), Europe.
- C. (P.) setina dotica* Anderson, 1962 Wealden 3 (Upper Jurassic), Europe.
- C. (P.) setina erumna* Anderson, 1962, Wealden 3, (Upper Jurassic), Europe.
- C. (P.) setina fiteriensis* Kneuper-Haack, 1966, middle Purbeckian (Upper Jurassic), Europe.
- C. (P.) setina rectidorsata* Sylvester-Bradley, 1949, upper Purbeckian (Upper Jurassic), Europe.
- C. sowerbyi* Martin, 1940, Purbeckian (Upper Jurassic), Europe.
- ?*C. spinigera* Lübmova, 1956 (= *C. lubimovae* Sohn, 1969), Barremian (Lower Cretaceous), Asia.
- C. (Pseudocypridina) subcentrinoda* Hou, 1958, Cretaceous, China.
- C. subtilis* Krömmelbein, 1965, Wealden (Lower Cretaceous), South America.
- C. subvaldensis* Hanai, 1951, Cretaceous, Manchuria.
- C. tenuis* Anderson, 1967, Wealden (Lower Cretaceous), Europe.
- C. trita* Lübmova, 1956, pre-Barremian (Lower Cretaceous), Asia.

- C. unicastata* Galeeva, 1955, Barremian (Lower Cretaceous), Asia.
C. (Cypridea) unimoda Hou, 1958, Lower Cretaceous, China.
C. valdensis (Sowerby, 1836). Anderson, 1967, Wealden (Lower Cretaceous), Europe.
C. vidrana Wolburg, 1959, Wealden 2 (Upper Jurassic), Europe.
C. vitimensis Mandelstam in Lüdimova, 1956, Barremian and older (Lower Cretaceous), Asia.
C. (Cypridea) yumenensis Hou, 1958, Lower Cretaceous, China.
C. (Pseudocypridina) spp. Hou, 1958, Lower Cretaceous, China.

Some of these species may be synonyms of each other, but without comparative specimens, it would be imprudent to classify them as such.

Cypridea (Pseudocypridina) piedmonti Roth, 1933

Plate 6, figures 1-47

- Pseudocypridina piedmonti* Roth, 1933, Jour. Paleontology, v. 7, no. 4, p. 404, pl. 48, figs. 7a-h; Peck, 1951, Jour. Paleontology, v. 25, no. 3, p. 319, pl. 48, figs. 16-18; Sohn, 1958, Wyoming Geol. Assoc., Guidebook, Thirteenth Ann. Field Conf., p. 123, pl. 1, figs. 5-8.
Cypridea piedmonti (Roth). Harper and Sutton, 1935, Jour. Paleontology v. 9, no. 8, p. 625, pl. 76, figs. 12-15.
 not *Cypridea (Pseudocypridina) piedmonti* Roth. Swain, 1946, Jour. Paleontology, v. 20, no. 6, p. 550, pl. 83, figs. 10-12=*Cypridea? salvadorensis salvadorensis* Krömmelbein, 1962.
 not *Cypridea (Pseudocypridina) piedmonti* (Roth). Wicher, 1959, Geol. Jahrb., v. 77, p. 47, pl. 9, fig. 6 (juvenile? of indet. sp.).

Diagnosis.—A species of *Pseudocypridina* with a ventrolateral ridge on left valve, with few, small (less than twice the diameter of punctae), subdued, scattered tubercles, near end margins.

Discussion.—This species is similar to *C. (P.) unicastata* (Galeeva, 1955), described from the Barremian of Mongolia, from which it differs in having a higher posterior margin, and a less defined rostrum. The holotype of *P. piedmonti* has a narrower posterior in dorsal outline than Galeeva's species. Although I do not consider the two species to be conspecific, this feature is interpreted to represent a male carapace and Galeeva's specimen, a female carapace. A ventrolateral ridge on the overlapping valve is present in several other species in the subgenus *Pseudocypridina* as well as in some species belonging to other taxa in the Cypridininae. All the ventrolateral ridged species in *Pseudocypridina* differ from *C. (P.) piedmonti* and *C. (P.) unicastata* in lateral outline and lack the scattered small tubercles. Three species from the Barremian of Mongolia and Siberia have small tubercles but lack the ventrolateral ridge: *C. (P.) acutituberculata* (Galeeva, 1955), *C. (P.) consulta*

(Mandelstam) in Lüdimova, Kaz'mina, and Reshetnikova, 1960, and *C. (P.) vitimensis* (Mandelstam) in Lüdimova, 1956b.

Stratigraphic age.—Roth (1933) assumed that the ostracode assemblage that includes *P. piedmonti* was from rocks in the Morrison Formation. However, as previously indicated, the faunule is from Lower Cretaceous rocks and belongs in the Chilson Member of the Lakota Formation, probably Unit 2.

Geographic distribution.—South Dakota, Mead County; map loc. 8, Roth's type-locality, pl. 6, figs. 23-27, and USGS colln. 30997, pl. 6, figs. 5-7, 10-13, USNM 242938, associated with *Trapezoidella trapezoidalis* (Roth, 1933), and *Limnocypridea morrisonensis* (Roth, 1933); USGS colln. 31171, pl. 6, figs. 1-4, 8, 9, USNM 242939; 31172, USNM 242940.

Lawrence County; map loc. 3, Harper and Sutton's type-locality and USGS colln. 30998, USNM 242957, associated with *T. trapezoidalis* (Roth, 1933).

Fall River County; map loc. 13, USGS colln. 30986, USNM 242041, associated with *T. trapezoidalis* (Roth, 1933); map loc. 11, USGS colln. 30994, USNM 242958, associated with *T. rothi* n. sp.; map loc. 17, USGS colln. 26098, pl. 6, figs. 28-37, 41-47, USNM 242942, associated with *Cypridea (Pseudocypridina) inornata* (Peck, 1941), "*Cypridea*" sp. 1, and *Longispinella asymmetrica* n. sp.

Cypridea (Pseudocypridina) inornata (Peck, 1941)

Plate 3, figures 18-23; plate 7, figures 2-4

- Cypridea inornata* Peck, 1941, Jour. Paleontology, v. 15, no. 3, p. 301, pl. 44, figs. 33-36. Kootenai Formation, Montana.
Pseudocypridina inornata (Peck). Peck, 1951, Jour. Paleontology, v. 25, no. 3, p. 319, pl. 48, figs. 8-11. Minnewaste Limestone Member of the Lakota Formation, Fall River County, S. Dak., and Kootenai Formation, Montana.
Cypridea inornata? Peck. Sohn, 1958, Wyoming Geol. Assoc. Guidebook, 13th Ann. Field Conf., pl. 1, figs. 17, 18. Lakota Formation, Crook County, Wyo.

Diagnosis.—Differs from *C. (P.) piedmonti* Roth, 1933, in lacking a ventrolateral ridge on the larger valve.

Discussion.—Peck (1951, pl. 48, fig. 9) illustrated a carapace from the Lakota Formation of South Dakota that differs from the carapace that I am illustrating (pl. 3, fig. 22) in that the anterodorsal curvature on Peck's specimen meets the dorsal margin at a point farther back from the anterior margin than in my specimen, but the holotype, from the Kootenai Formation of Montana, illustrated by Peck (1941, pl. 44, fig. 33), more closely resembles the same view of my specimen (pl. 3, fig. 23).

Geographic distribution.—South Dakota, Fall River County; map loc. 13, USGS colln. 30985, USNM 242968, associated with *T. rothi* n. sp.; USGS colln. 31005, USNM 242988, associated with *T. rothi* n. sp.; map loc. 14, USGS colln. 31237, USNM 242964, associated with *T. rothi* n. sp. and *Cypridea* (*Pseudocypridina*) *henrybelli* n. sp.; USGS colln. 31238, USNM 242965, associated with *T. rothi* n. sp.; map loc. 15, USGS colln. 30996, USNM 242982; map loc. 16, USGS colln. 26100, USNM 242963, associated with *T. rothi* n. sp.; map loc. 17, USGS colln. 26098, USNM 242962, associated with *C. (P.) piedmonti* (Roth, 1933), "*Cypridea*" sp. 1, and *Longispinella assymetrica* n. sp.; USGS colln. 25460, USNM 242976, associated with *C. (P.) henrybelli* n. sp., "*Cypridea*" sp. 1, and *L. assymetrica* n. sp.; map loc. 18, USGS colln. 31239, USNM 242983, associated with *L. longispina* (Roth, 1941).

Lawrence County; map loc. 2, USGS colln. 25646, USNM 242986.

Wyoming, Crook County; map loc. 5, USGS colln. 25645, pl. 3, figs. 18–23, pl. 7, figs. 2–4, USNM 242961, associated with *C. (P.) laeli* n. sp.; USGS colln. 25644, USNM 242968, associated with *L. longispina* (Peck, 1941).

***Cypridea* (*Pseudocypridina*) *laeli* Sohn, n. sp.**

Plate 3, figures 1–13, 24, 25, 32; plate 7, figure 1;
plate 8, figures 26–30

Name.—In honor of Master Lael Schooler, Washington, D.C., a budding young scientist.

Holotype.—USNM 129644

Paratypes.—USNM 242865–242871, 242908

Type-locality.—Map loc. 5, USGS colln. 25645, NE $\frac{1}{4}$ sec. 20, and NW $\frac{1}{4}$ sec. 21, T. 51 N., R. 65 W., Crook County, Wyo.

Other localities.—See geographic distribution.

Type level.—Lakota Formation, shale near top.

Diagnosis.—Subovate, with arched dorsal margin, ventrolateral ridge and dorsoanterior node on larger left valve; right valve with curved irregular ridge subparallel and slightly removed from dorsal margin. Surface finely punctate, with scattered minute spinelets more common on anterior and posterior quarters than on center.

Description.—The carapace is subovate, with an arched dorsal margin, gently convex ventral margin, broadly rounded end margins, and a distinct rostral incisure on both valves. The left valve has a distinct ridge near the ventral margin that starts behind the rostrum and expands posteriorly along the valve surface for about three-fourths of the greatest length, and a distinct but low moundlike subellipti-

cal node at the dorsoanterior. In ventral view, this ridge has an abrupt posterior termination (pl. 3, fig. 13). In most specimens, the surface of the valve is smooth along the dorsal margin; in some, a crude delineation of a thin ridge borders the dorsal edge of the valve (pl. 3, figs. 2, 11). The right valve has an irregular ridge subparallel and slightly removed from the hinge contact. In some specimens, this ridge is variable and starts as a subelliptical node approximately opposite the node on the left valve and becomes stronger as it extends backward to just before the approximate junction of the posterior and dorsal margins. In other specimens, it has a series of constrictions along its backward route. The hingeline is slightly incised; a straight double ridge on the right valve fits into a groove and ridge on the left valve (pl. 3, fig. 32). The surface is finely punctate. The left valve overlaps on all margins. The overlap along the venter is straight along the posterior two-thirds of the length; at that point it has a distinct bend towards the rostrum. Dorsal and ventral outlines are subelliptical; the greatest width is at or slightly behind the midlength. The end outlines are subelliptical, truncated along the venter by the ridge on the left valve, and along the dorsum by the ridge and incised hinge; the greatest width is at the approximate midheight.

Discussion.—*C. (P.) laeli* resembles in lateral outline and surface ornament the *Cypridea fasciculata*-group of Wolburg (1959, p. 243) from the middle and upper Purbeckian, and also the *Cypridea alta*-group of Wolburg (1959, p. 262) from the upper Purbeckian-Berriasian, both from Germany. The node on the left valve and dorsal ridge on the right valve could have evolved from similar structures on *C. (P.) alta formosa* (Wolburg, 1959) of Purbeckian age (Wolburg, 1959, p. 264, pl. 3, figs. 2a–c, 11, 12). The ventrolateral ridge on the left valve is present on a specimen illustrated by Wolburg (1959, pl. 2, fig. 5) as a tuberculate variety of *C. (P.) dolabrata angulata* (Martin, 1940) from the lower or middle Wealden 3 (Purbeckian). This specimen differs from *C. (P.) laeli* in having the ridge closer to the rostrum and in tapering backwards. An almost identical dorsal ridge on the right valve is present on *C. (P.) fasciculata* (Forbes in Lyell, 1855), illustrated by Wolburg (1959, pl. 1, fig. 3) from the middle Purbeckian; this species has nodes that are much larger than the spinelets on *C. (P.) laeli* scattered on the anterior and posterior surfaces of the punctate valves.

Wolburg (1962, pl. 29) illustrated a gradational series beginning with the tuberculate *C. (P.) fasci-*

culata in the Jurassic Wealden 1, through less tuberculated individuals of the same species in Wealden 2, to a nontuberculated species in Wealden 2, which he identified as *Cypridea altissima* Martin. He illustrated two specimens (pl. 29, figs. 7, 8) that are not conspecific with *C. (P.) altissima* (Martin, 1940, pl. 4, figs. 45, 47) recorded by Martin from the Lower Cretaceous (Martin, 1940, pl. 13). The reduction in number and ultimate loss of nodes through time in this species group and the affinities of *C. (P.) laeli* enumerated above suggest that *C. (P.) laeli* may be younger than the lower Valanginian.

Geographic distribution.—Wyoming, Crook County; map loc. 5, USGS colln. 31001, pl. 3, figs. 1–9, 24, 25, 32; pl. 7, fig. 1; pl. 8, figs. 26–30, USNM 242966; USGS colln. 25645, pl. 3, figs. 10–13, USNM 242967.

***Cypridea (Pseudocypridina) henrybelli* Sohn, n. sp.**

Plate 3, figures 14–17; plate 8, figures 1–25

Name.—In honor of Henry Bell III, U.S. Geological Survey, who introduced me to the ostracodes from the Black Hills.

Holotype.—USNM 129645.

Paratypes.—USNM 242901–242907.

Type-locality.—Map loc. 17, Buck Canyon, SE $\frac{1}{4}$ sec. 15, T. 8 S., R. 4 E., Flint Hill quadrangle, Fall River County, S. Dak. USGS colln. 25460.

Other localities.—See geographic distribution.

Type-level.—Chilson Member of Lakota Formation, Unit 2, about 5 feet (1.5 m) above the base.

Diagnosis.—Straight backed, with anterodorsal angulation, finely punctate; commonly with distinct nodes at midheight on anterior and posterior quarters of each valve; sometimes one or both nodes may be smaller, more subdued, or entirely missing on the right valve.

Description.—The carapace is elongate-ovate, with a straight dorsal margin that is one-half or slightly less than one-half the greatest length, a gently convex ventral margin, a distinct beak, a rounded anterior margin that is higher than the rounded posterior margin and that meets the dorsal margin at a distinct angulation at about one-third the greatest length. The hinge is incised. The dorsal outline is elliptical with the greatest width at approximately midlength; the lateral nodes, when present, cause the dorsal outline to have a hexagonal appearance, with convex lateral sides. The left valve overlaps on all margins except the hingeline. The lateral surface is finely punctate. The lateral nodes vary in size, shape, and height among specimens

(compare pl. 8, figs. 1, 4, 7, 10, 12, 21); the right valve of some specimens does not have any nodes.

Discussion.—On the basis of the lateral outline and rostrum *C. (P.) henrybelli* belongs in the *parallela*-line of the *Cypridea valdensis-parallela*-group of Wolburg (1959, p. 267). The *Cypridea parallela*-line was recorded by Wolburg (1959, p. 227, fig. 2) as ranging stratigraphically from Wealden 4 to Wealden 6 (Berriasian–lower Valanginian). The lateral nodes relate *C. (P.) henrybelli* to *C. (P.) binodosa* (Martin, 1940) from the middle Purbeckian of Germany, and to *C. (P.) salvadorensis nodifer* (Krömmelbein, 1962) from the upper part of the Candeias and the lower part of the Ilhas Formations of Brazil. The species differs from *C. (P.) binodosa* in lacking a ventrolateral ridge on the left valve (Martin, 1940, pl. 3, fig. 42), and from *C. (P.) salvadorensis nodifer* in that the nodes are closer to the end margins and in having a more distinct rostrum. *C. (P.) subtilis* (Krömmelbein, 1965) from the middle to upper part of the Candeias Formation of Brazil also has two lateral nodes and a well-developed rostrum, but the nodes on *C. (P.) henrybelli* are closer to the end margins as well as to the ventral margin. Krömmelbein (1966, p. 115) considered the Candeias and Ilhas Formations to be at least partly younger than the Lower Cretaceous Wealden Beds of Europe.

It may be significant that *C. (P.) salvadorensis nodifer* (Krömmelbein, 1962) is associated with *C. (P.) salvadorensis salvadorensis* (Krömmelbein, 1962), from which it differs only in having lateral nodes, and that the type-series of *C. (P.) henrybelli* contains specimens without nodes on the right valve. *C. (P.) baidarensis* (Bischoff, 1963), from the Lower Cretaceous (probably pre-Hauterivian to Hauterivian-Barremian) of southern Lebanon, was described and illustrated as having a single node near the posterior of the left valve. These morphologically related species suggest an age younger than lower Valanginian for the new species.

Geographic distribution.—South Dakota, Fall River County; map loc. 13, USGS colln. 31003, USNM 242971, associated with *Trapezoidella rothi* n. sp.; map loc. 14, USGS colln. 31129, USNM 242985; USGS colln. 31130, pl. 8, figs. 1–25, USNM 242970, associated with *Longispinella asymmetrica* n. sp.; USGS colln. 31237, USNM 242973, associated with *T. rothi* n. sp. and *Cypridea (Pseudocypridina) inornata* (Peck, 1941); map loc. 17, USGS colln. 25460, pl. 3, figs. 14–17, USNM 242975, associated with *C. (P.) inornata* (Peck, 1941), "*Cypridea*" sp. 1, and *L. asymmetrica* n. sp.; USGS colln. 31007 (? identification), USNM 242972, asso-

ciated with *T. trapezoidalis* (Roth, 1933) and *T. rothi* n. sp.

New genus undescribed
"Cypridea" sp. 1

Plate 7, figures 8-12

Discussion.—A single well-preserved carapace (USNM 242900) about 0.9 mm in greatest length was found in a collection from the Lakota Formation, Fall River County, S. Dak. (USGS colln. 26098, map loc. 17). This specimen is reticulated, has a large subcentral spine, numerous surface tubercles, and resembles *Cypridea* (*C.*) *propunctata* Sylvester-Bradley, 1949, in lateral outline and in the development of the rostrum, alveolus, and cyathus. Although five additional, poorly preserved carapaces were found in the same area (USGS colln. 25460 (USNM 242978)), the available material is inadequate to describe the taxon. This taxon differs markedly from *Cypridea* Bosquet, 1852, as represented by *Cypridea granulosa* (Sowerby, 1836), and also from *Pseudocypridina* Roth, 1933, as illustrated in this paper. Species described in *Cypridea* that are similar to "*Cypridea*" sp. 1 should be segregated in a separate genus. The specimens described and illustrated by Swain and Brown (1972, p. 14, pl. 1, figs. 19, 20; pl. 3, fig. 1) as *Cypridea* (*C.*) *wyomingensis* Jones, 1893, from the Lower Cretaceous of the Atlantic Coastal region are referable to this genus, probably as a new species.

Genus *Longispinella* Sohn, n. gen.

Type-species.—*Longispinella asymmetrica* Sohn n. sp.

Name.—For the long lateral spine on each valve.

Diagnosis.—Relatively small, to 1 mm in greatest length, subtriangular in lateral outline; surface punctate, with one subcentral large spine, without nodes, small spines or ridges; rostrum and alveolus well developed, cyathus usually subtriangular. Dimorphic in width of posterior.

Discussion.—This genus is established for those species previously referred to *Cypridea* Bosquet, 1852, that have a robust lateral spine on each valve and that do not have accessory smaller spines. The following additional species are here assigned to *Longispinella*:

- C. armata* Krömmelbein, 1962, Lower Cretaceous, Brazil.
- C. longispina* Peck, 1941, Kootenai Formation, Lower Cretaceous, Montana.
- C. tucanoensis* Krömmelbein, 1965, Lower Cretaceous, Brazil.

Stratigraphic range.—Lower Cretaceous.

***Longispinella asymmetrica* Sohn, n. sp.**

Plate 4, figures 7-20; plate 5, figures 1-7, 13-16

Name.—Asymmetrical ornament on left valve.

Holotype.—USNM 242882

Paratypes.—USNM 242877-242881, 242883

Type-locality.—Map locality 14, Upper Chilson Canyon, T. 8 S., R. 3 E., Flint Hill quadrangle, Fall River County, S. Dak. USGS colln. 31130.

Other localities.—See geographic distribution.

Type-level.—Sandy layer above paper shale in Chilson Member of Lakota Formation, about 5 feet (1.5 m) above base of member.

Diagnosis.—Subtriangular, with well-developed rostrum, alveolus, and triangular cyathus; with robust lateral spine in approximate center of posterior third of each valve; short perpendicular shallow sulcus bounded anteriorly by a rounded ridge at approximate midheight, just behind the upper part of the alveolus on left valve.

Description.—The carapace is small, less than 0.9 mm in greatest length. The lateral outline is subtriangular; the anterior and dorsoanterior margins form a continuous curve from the tip of the rostrum to the approximate mid-length. The hinge line is straight, incised; it slopes downward to a point about halfway between the curve of the posterior margin and the lateral spine. The posterior margin is gently curved; it extends as the outside of the triangular downward-pointing cyathus. The ventral margin of the right valve is straight; the ventral margin of the left, overlapping, valve is gently curved to straight. The dorsal outline is subelliptical, with the posterior end wider than the anterior end, but the greatest width is subcentral. The rostrum is well defined; it points straight down to below the ventral margin, and it is separated from the valve surface by a subdeltoid-shaped alveolus. The alveolus extends upwards about halfway to the curve of the anterior margin; it has a horizontal ridge at its base. This rounded ridge connects the rostrum to the valve surface.

A single robust lateral spine is about one third of the greatest length from the posterior margin, and about halfway between the ventral and dorsal margins. The valves are punctate, except the areas of the rostrum and alveolus. The left valve has a smooth, shallow, vertical, short sulcus, whose bottom is at approximately the same distance above the ventral margin as the spine. This sulcus is separated from the alveolus by a rounded smooth ridge. The right valve does not have this sulcus and ridge, but the area in that position is smooth. The left

valve overlaps the right along all the margins except the incised hinge margin.

Discussion.—This species belongs in a group of species previously assigned to *Cypridea* that have in common a robust lateral spine and a subtriangular lateral outline. It differs from *L. longispina* (Peck, 1941) by having the peculiar sulcus bounded by a ridge on the left valve. Peck (1951, pl. 48, fig. 12) illustrated a specimen from the lower 15 feet of the Lakota Formation, Fall River County, S. Dak. as *C. longispina*. The illustration of this specimen suggests that it does not belong in *L. longispina*, but because the right side of the carapace is illustrated, it cannot be referred to *L. asymmetrica*. Peck (1941, p. 301) related *C. longispina* with *C. brevicornis* Peck, 1941, from the Draney Formation (upper Aptian) of Idaho and Wyoming and to *C. spinigera* (Sowerby, 1836) from the Wealden (Lower Cretaceous) of England. The latter two species are not subtriangular in lateral outline; consequently, they are not included in *Longispinella*.

Geographic distribution.—South Dakota, Fall River County; map loc. 12, USGS colln. 31153, USNM 242979, associated with *L. longispina* (Peck, 1941); map loc. 14, USGS colln. 31130, pl. 5, figs. 1-7, 13-16, associated with *L. longispina* (Peck, 1941); map loc. 17, USGS colln. 26098, pl. 4, figs. 7-20, USNM 242974, associated with *Cypridea* (*Pseudocypridina*) *piedmonti* (Roth, 1933), *C. (P.) inornata* (Peck, 1941), and "*Cypridea*" sp. 1; USGS colln. 25460, USNM 242977, associated with *C. (P.) inornata* (Peck, 1941), *C. (P.) henrybelli* n. sp., and "*Cypridea*" sp. 1.

***Longispinella longispina* (Peck, 1941)**

Plate 4, figures 1-6; plate 5, figures 8-12, 17-23;
plate 7, figures 5-7

Cypridea longispina Peck, 1941, Jour. Paleontology, v. 15, p. 300, pl. 43, figs. 6-9. Kootenai Formation, Montana; Peck, 1951, Jour. Paleontology, v. 25, p. 312, pl. 48, figs. 12-15. Lakota Formation, Fall River County, S. Dak., Cloverly Formation, Fremont County, Wyo.

Cypridea longispina? Peck. Sohn, 1958, Wyoming Geol. Assoc. Guidebook, 13th Ann. Field Conf., pl. 1, figs. 1-4. Lakota Formation, Crook County, Wyo.

Diagnosis.—Differs from *L. asymmetrica* in smaller and narrower size, in more pointed end in dorsal outline, and in either having a smaller perpendicular shallow sulcus bounded anteriorly by a rounded ridge behind the alveolus of the left valve, or not having that structure.

Discussion.—Peck (1941) illustrated the left view of the holotype, and two right views and the ventral view of three paratypes. The same view of

the holotype was republished by Peck (1951, pl. 48, fig. 15), as well as a right view of a carapace from the Lakota Formation and the right and ventral views of a carapace from the Cloverly Formation. I obtained from Dr. Peck three specimens from the type-locality in Montana and am illustrating two presumed males mainly to show the dorsal and ventral outlines and the poor state of preservation (pl. 4, figs. 1-6). One of these specimens (pl. 4, fig. 4) has a faint suggestion of the ridge and sulcus on the left valve, although Peck's drawing of the holotype does not show that feature. The specimens illustrated here from Crook County, Wyo. (pl. 7, figs. 5, 7), and from Peck's locality in Fall River County, S. Dak. (pl. 5, figs. 20, 21), have that structure, which is smaller than that on *L. asymmetrica*. Other specimens, however, do not have that structure (pl. 5, figs. 11, 18).

Dimorphism in width of posterior in dorsal and ventral outlines is inferred in this species because the specimen illustrated by Peck in 1941 (pl. 43, fig. 9) is narrower in ventral outline than is the carapace illustrated by him in 1951 (pl. 48, fig. 14); likewise, the carapaces illustrated here in pl. 4, figs. 3, 5; pl. 5, figs. 9, 19; pl. 7, fig. 6 are narrower in dorsal and ventral outlines than are the specimens illustrated herein on pl. 5, figs. 12, 22. Presumably the ones with the wider posteriors represent females, and those with narrower posteriors represent males.

It is noteworthy that the left valve of the holotype from the Kootenai Formation, Montana, has a knoblike structure near the posterior end of the left valve and that a somewhat similar structure, not quite as well defined, can be seen on the left valve of the specimen from the Lakota Formation, Wyoming, illustrated here (pl. 5, figs. 18 and 20). This structure is absent on all the other specimens illustrated; consequently, it is probably of no diagnostic significance, but it lends a certain amount of credence to my identification of this species.

I have no data to confirm that the stratigraphic age of the Kootenai Formation in Montana and the Cloverly Formation in Wyoming, both of which have been assigned to the Aptian, are older than Aptian, although I now consider the Lakota Formation to be pre-Aptian in age.

Geographic distribution.—Montana, Cascade County; Peck's (1941, p. 288) loc. 23.

South Dakota, Fall River County; map loc. 12, USGS colln. 31154, pl. 5, figs. 8-12, USNM 242980; USGS colln. 31153, pl. 5, figs. 17, 23, USNM 242981, associated with *L. asymmetrica* n. sp.; map loc. 18,

USGS colln. 31239, USNM 242984, associated with *Cypridea* (*Pseudocypridea*) *inornata* (Peck, 1941).

Wyoming, Crook County; map loc. 5, USGS colln. 25644, pl. 7, figs. 5-7, associated with *C. (P.) inornata* (Peck, 1941).

Wyoming, Fremont County; Peck's (1951, p. 310) loc. 32.

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PLATES 1-8

Contact photographs of the plates in this report are available at cost, from
U.S. Geological Survey Library, Federal Center, Denver, Colorado 80225

PLATE 1

FIGURES 1-5, 10. *Trapezoidella rothi* Sohn, n. sp. (p. 9).

1, 2. Outside and inside views of right valve approx. \times 30. Paratype USNM 242836, Lakota Formation, Edgemont quadrangle, Fall River County, S. Dak. USGS colln. 30993, map loc. 9.

3-5. Right, posterior, and left views of carapace approx. \times 30. USNM 242837, Chilson Member of Lakota Formation, Flint Hill quadrangle, Fall River County, S. Dak. USGS colln. 30986, map. loc. 13.

10. Outside view of right valve approx. \times 30. Paratype USNM 242838, same collection as above.

6-9, 12-17. *Trapezoidella trapezoidalis* (Roth, 1933) (p. 9).

6-9. Right, dorsal, left, and posterior views of juvenile carapace approx. \times 30. Holotype USNM 74470. Lakota Formation, 3 miles (4.8 km) south of Piedmont, Meade County, S. Dak.

12-15. Right, dorsal, left, and posterior views of larger carapace approx. \times 30. Figured specimen USNM 242839. Lakota Formation, Crook County, Wyo. USGS colln. 25643, map loc. 6.

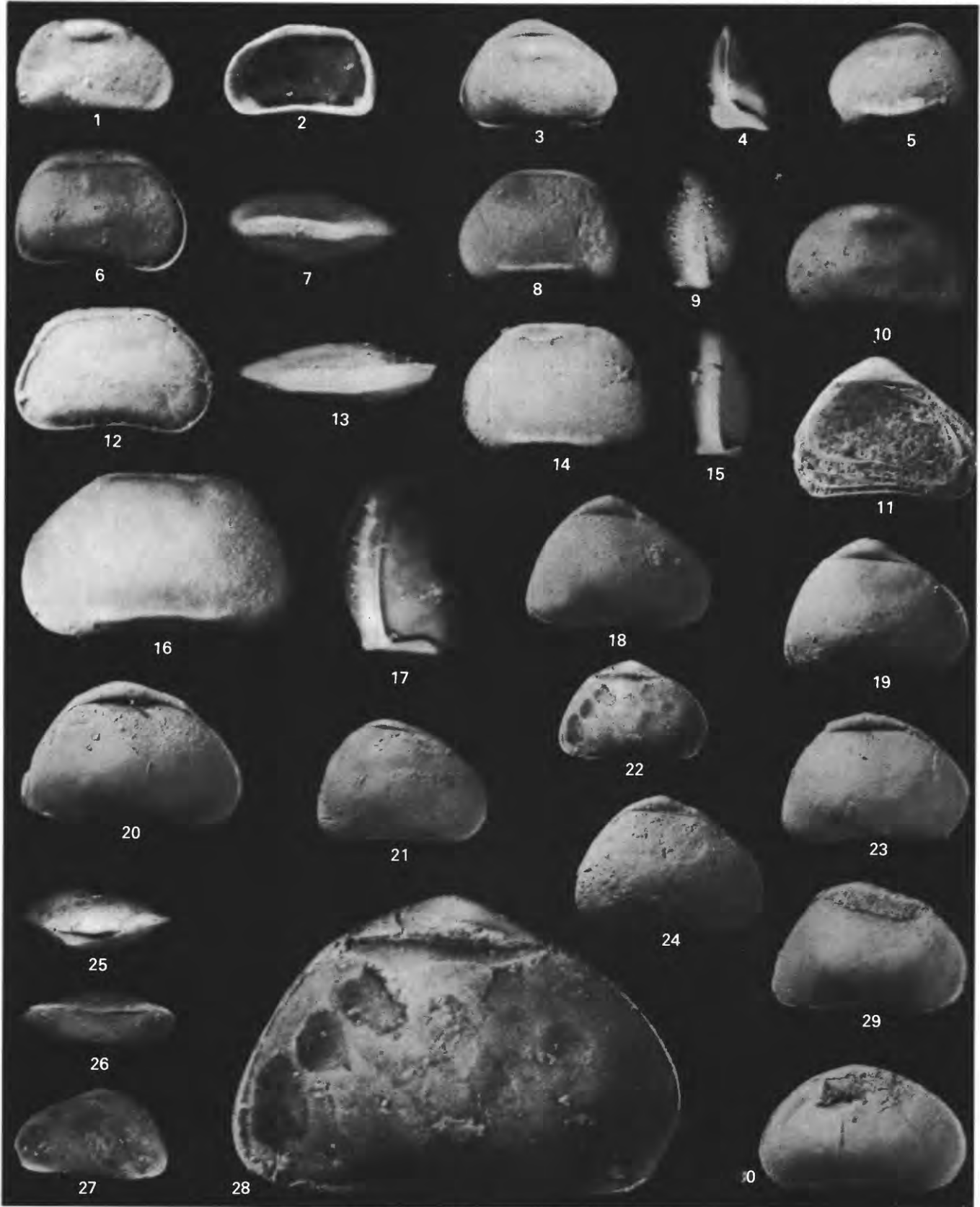
16, 17. Left and posterior views of still larger carapace approx. \times 30. Figured specimen USNM 242840. Same as collection above.

11, 18-30. *Limnocypridea morrisonensis* (Roth, 1933) (p. 11).

11. Inside view of nested valves, approx. \times 15. Figured specimen USNM 242841. Probably topotypes from Roth's type-locality, USGS colln. 30997, map loc. 8.

18-21, 23, 24, 29, 30. Right views of eight carapaces showing variation in lateral outlines approx. \times 15. Figured specimens USNM 242842-242849. Lakota Formation, probably topotypes from Roth's type-locality, 3 miles (4.8 km) south of Piedmont, S. Dak. USGS colln. 30997, map loc. 8.

22, 25-28. Right, dorsal, ventral, and left views of holotype approx. \times 10, and right view approx. \times 30 for relative size to other species on plate. Holotype USNM 74469. Roth's type-locality.

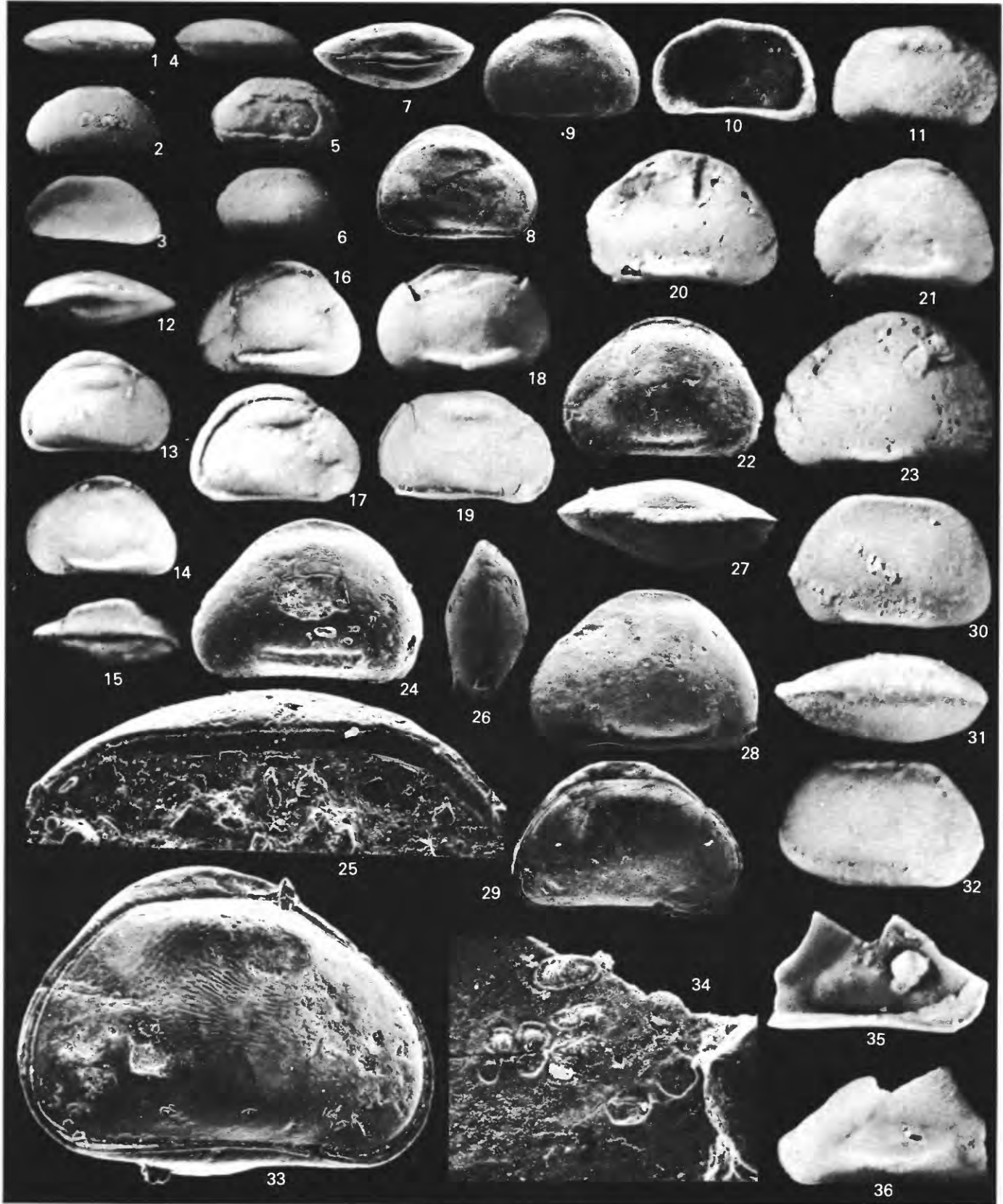


TRAPEZOIDELLA, LIMNOCYPRIDEA

PLATE 2

[SEM means scanning electron micrograph]

- FIGURES 1-6. *Limnocypridea? albertensis* (Loranger, 1951) (p. 12).
- 1-3. Ventral, left, and right views of carapace approx. $\times 30$, original of Loranger's pl. 2, fig. 21. Paralectotype, Geol. Survey of Canada No. 48736. Blairmore Formation (Aptian-Albian), Imperial's Deville No. 1 well, 3,402-3,416 feet (1,037-1,041 m).
 - 4-6. Dorsal, right, and left views of carapace, approx. $\times 30$, original of Loranger's pl. 2, fig. 28. Lectotype, Geol. Survey of Canada No. 48735. Blairmore Formation (Aptian-Albian), Imperial's Looma No. 1 well, core at 3,947-3,978 feet (1,203-1,212 m).
- 7-29, 33. *Trapezoidella rothi* Sohn, n. sp. (p. 9).
- 7-9. Dorsal, right, and left views of carapace, SEM approx. $\times 30$. Paratype USNM 242851. Upper part of Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln. 30985, map loc. 13.
 - 10, 11. Inside and outside views of right valve, approx. $\times 30$. Paratype, USNM 242852. About 10 feet (3 m) above base of Chilson Member of Lakota Formation, Fall River County, S. Dak., USGS colln. 30990, map loc. 14.
 - 12-15. Dorsal, right, left, and ventral views of carapace, approx. $\times 30$. Paratype USNM 242853. Unit 2 of Chilson Member of Lakota Formation, AEC Diamond Drill Hole RE-17, core at 289.5 feet (88 m), Fall River County, S. Dak. USGS colln. 30988, map loc. 16.
 - 16, 17. Left and right views of crushed carapace, approx. $\times 30$. Paratype USNM 242854. Same unit and drill hole as above, core at 283.5 feet (86.4 m). USGS colln. 31006, map loc. 16.
 - 18, 19. Left and right views of partly broken carapace, approx. $\times 30$. Paratype USNM 242855. Unit 2 of Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln., 30986, map loc. 13.
 - 20. Left view of crushed carapace, approx. $\times 30$. Paratype USNM 242856. Unit 2 of Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln. 31007, map loc. 17.
 - 21. Left view of carapace, approx. $\times 30$. Paratype USNM 242857, Lakota Formation, Fall River County, S. Dak. USGS colln. 26468, map loc. 10.
 - 22. Left view of carapace, SEM approx. $\times 30$. Paratype USNM 242858. Upper part of Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln. 30985, map loc. 13.
 - 23. Left view of carapace, approx. $\times 30$. Paratype USNM 242859. Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln. 30994, map loc. 11.
 - 24, 25. Outside view of left valve SEM approx. $\times 30$, hinge view, SEM approx. $\times 100$. Paratype USNM 242860. Same collection and locality as fig. 22.
 - 26-29. Posterior, dorsal, left, and right views of carapace, SEM approx. $\times 30$. Holotype, USNM 242861. Same collection and locality as fig. 22.
 - 33. Right view of carapace, SEM approx. $\times 75$. Paratype USNM 242862. Same collection and locality as fig. 22.
- 30-32. *Trapezoidella trapezoidalis* (Roth, 1933) (p. 9).
- Left, dorsal, and right views of carapace, approx. $\times 30$. Paratype USNM 242863. Lakota Formation, Crook County, Wyo. USGS colln. 26941, map loc. 7.
- 34-36. *Trapezoidella rothi* Sohn, n. sp. (p. 9).
- Detail of adductor muscle attachment scar, SEM approx. $\times 180$, inside and outside views of fragment of left valve approx. $\times 30$. Figured specimen USNM 242864. Lakota Formation, Fall River County, S. Dak. USGS colln. 30993, map loc. 9.



LIMNOCYPRIDEA?, *TRAPEZOIDELLA*

PLATE 3

[SEM means scanning electron micrograph]

- FIGURES 1-13. *Cypridea* (*Pseudocypridina*) *laeli* Sohn, n. sp. (p. 16).
1-4. Ventral (anterior to left) dorsal (anterior to right), right, and left views of four carapace approx. \times 30. Paratypes USNM 242865-242868. Lakota Formation, Crook County, Wyo. USGS colln. 31001, map loc. 5.
5-7. Dorsal (anterior to left), right, and ventral (anterior to left) views of carapace, SEM approx. \times 30. Paratype USNM 242869. Same collection as above.
8, 9. Dorsal (anterior to right), and left views of carapace, SEM approx. \times 30. Paratype USNM 242870. Same collection as above.
10-13. Left, dorsal (anterior to left), right, and ventral (anterior to right), views of carapace. Holotype USNM 129644. Lakota Formation, Crook County, Wyo. USGS colln. 25645, map loc. 5. Same specimen as Sohn, 1958, p. 1, figs. 9-12.
- 14-17. *Cypridea* (*Pseudocypridina*) *henrybelli* Sohn, n. sp. (p. 17).
Left, dorsal (anterior to right), right, and ventral (anterior to right) views of carapace, approx. \times 30. Holotype USNM 129645. USGS colln. 25460, map loc. 17. Same specimen as Sohn, 1958, pl. 1, figs. 13-15.
- 18-23. *Cypridea* (*Pseudocypridina*) *inornata* (Peck, 1941) (p. 15).
18, 19. Dorsal (anterior to right) and right views of carapace, instar, approx. \times 30. Figured specimen USNM 242873. Same collection as figs. 1-9.
20, 21. Dorsal and right views of carapace, adult, approx. \times 30. Figured specimen USNM 129647. Same collection as figs. 10-13. Same specimen as Sohn, 1958, pl. 1, figs. 17, 18.
22, 23. Right and left views of carapace, approx. \times 30. Figured specimen USNM 242874. Same collection as figs. 1-9.
- 24, 25. *Cypridea* (*Pseudocypridina*) *laeli* Sohn, n. sp. (p. 16).
Ventral (anterior to left), and left views of carapace, SEM approx. \times 30. Paratype USNM 242871. Same collection as figs. 1-9.
- 26-29. *Limnocypridea morrisonensis* (Roth, 1933) (p. 11).
Dorsal (anterior to right), left, posterior, and right views of presumed male carapace, approx. \times 15. Figured specimen USNM 242850. Lakota Formation, Roth's type locality, Meade County, S. Dak. USGS colln. 30997, map loc. 8.
- 30, 31. *Candona* sp. (p. 11).
Left lateral views of female and male valves, approx. \times 30. Figured specimens USNM Crustacea 168192, 168193. Collected alive in Kenilworth Aquatic Gardens, Washington, D.C.
32. *Cypridea* (*Pseudocypridina*) *laeli* Sohn, n. sp. (p. 16).
Left valve hinge approx. \times 130. Paratype (broke during removal from stub) USNM 242872. Same collection as figs. 1-9.



CYPRIDEA (PSEUDOCYPRIDINA), LIMNOCYPRIDEA, CANDONA

PLATE 4

[Scanning electron micrographs (SEM) approx. $\times 90$, except fig. 14 which is approx. $\times 200$, reduced 1/3 for publication]

FIGURES 1-6. *Longispinella longispina* (Peck, 1941) (p. 19).

1-3. Left, right, and dorsal views of carapace, presumed male. Figured specimen, topotype USNM 242875. Kootenai Formation, T. 18 N., R. 4 E., Cascade County, Mont. Peck's colln. 23 (1941, p. 288).

4-6. Left, ventral, and right views of carapace, presumed male. Figured specimen, topotype USNM 242876. Same collection as above.

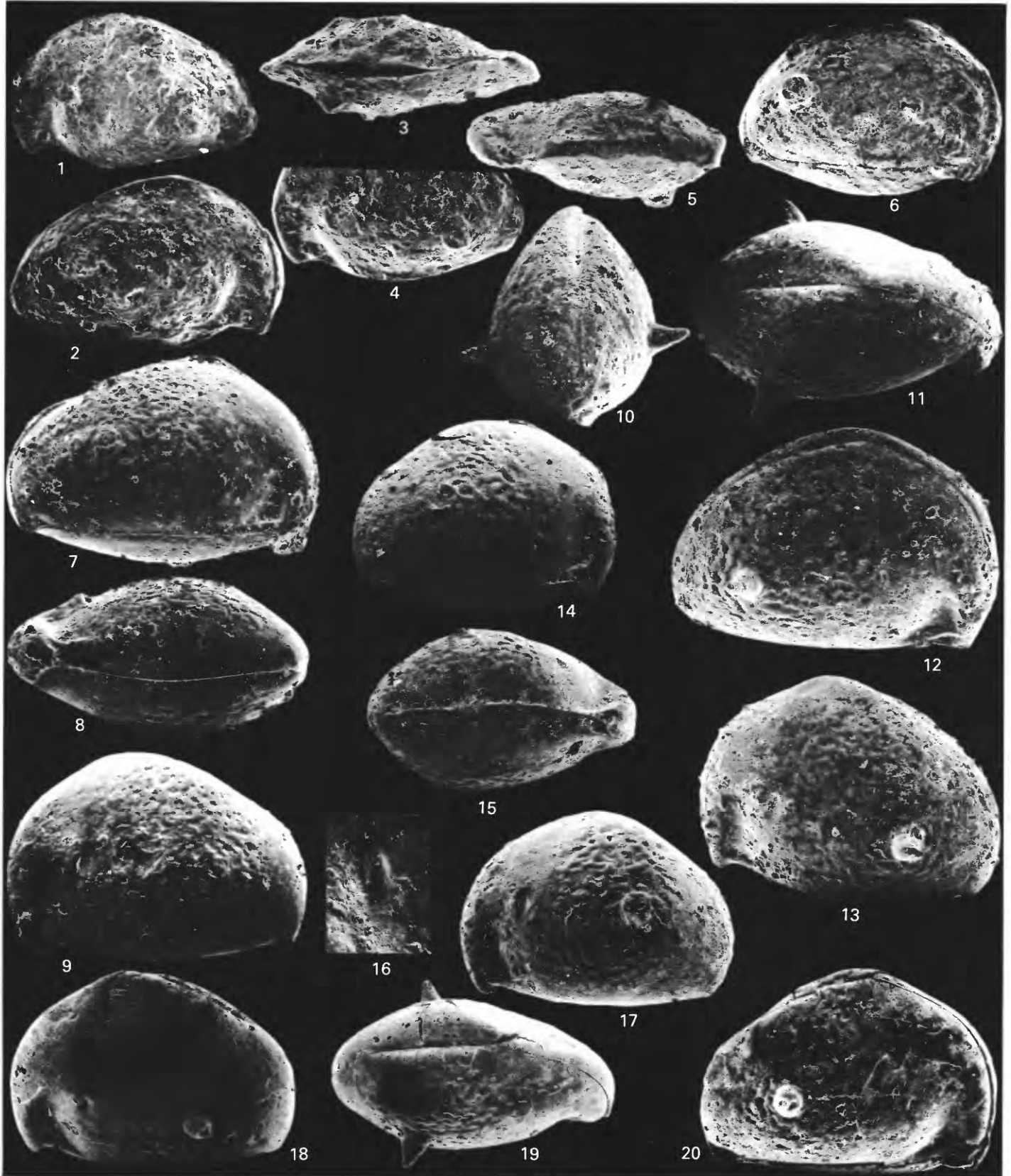
7-20. *Longispinella asymmetrica* Sohn, n. gen., n. sp. (p. 18).

7-9. Right, ventral (anterior to left), and left views of carapace. Paratype USNM 242877. Unit 2 of Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln. 26098, map. loc. 17.

10-13. Posterior oblique, dorsal, right, and left views of carapace. Paratype USNM 242878. Same collection as above.

14-17. Right, ventral, detail of left anterior, and left views of carapace. Paratype USNM 242879. Same collection as above.

18-20. Left, dorsal, and right views of carapace converted to fluoride. Paratype USNM 242880. Same collection and locality as above.

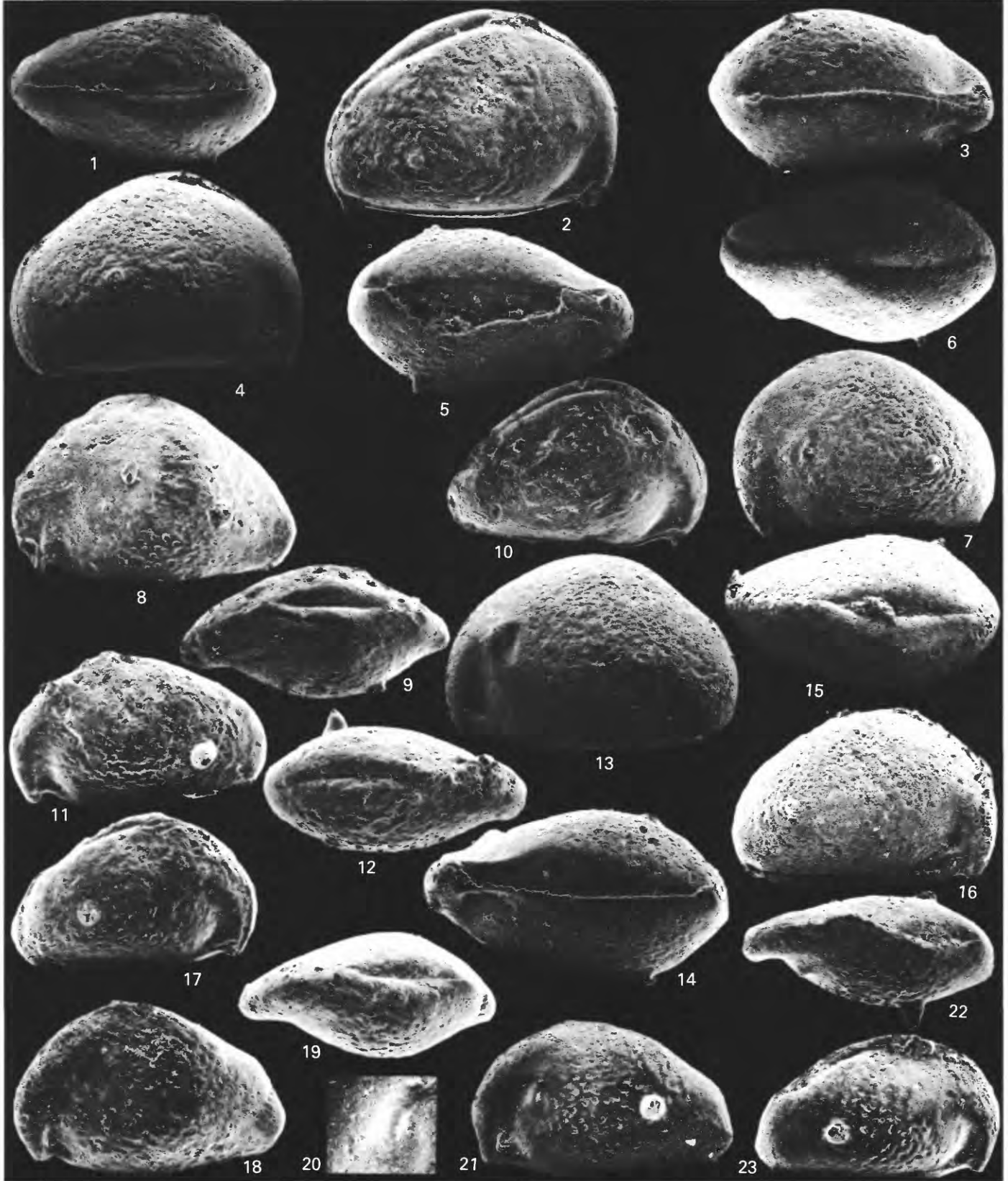


LONGISPINELLA

PLATE 5

[Scanning electron micrographs approx. $\times 90$, except fig. 20 which is approx.
 $\times 250$, reduced 1/3 for publication]

- FIGURES 1-7. *Longispinella asymmetrica* Sohn, n. sp. (p. 18).
1-3. Dorsal, right, and ventral views of carapace. Paratype USNM 242881. Unit 1 of Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln. 31130, map loc. 14.
4-7. Right, ventral, dorsal, and left views of carapace. Holotype USNM 242882. Same collection as above.
- 8-12. *Longispinella longispina* (Peck, 1941) (p. 19).
8-10. Left, dorsal, and right views of carapace, presumed male. Figured specimen USNM 242884. Lowermost part of Lakota Formation, Fall River County, S. Dak. USGS colln. 31154, map loc. 12.
11, 12. Left and dorsal views of carapace, presumed female. Figured specimen USNM 242885. Same collection as above.
- 13-16. *Longispinella asymmetrica* Sohn, n. sp. (p. 18).
Left, ventral, dorsal, and right views of carapace. Paratype USNM 242883. Same collection as figs. 1-7.
- 17-23. *Longispinella longispina* (Peck, 1941) (p. 19).
17-19. Right, left, and dorsal views of carapace, presumed male. Figured specimen USNM 242886. Lower part of Lakota Formation, Fall River County, S. Dak. USGS colln. 31153, map loc. 12.
20-23. Detail of anterior of left valve, left, dorsal, and right views of carapace, presumed female. Figured specimen USNM 242887. Same collection as above.



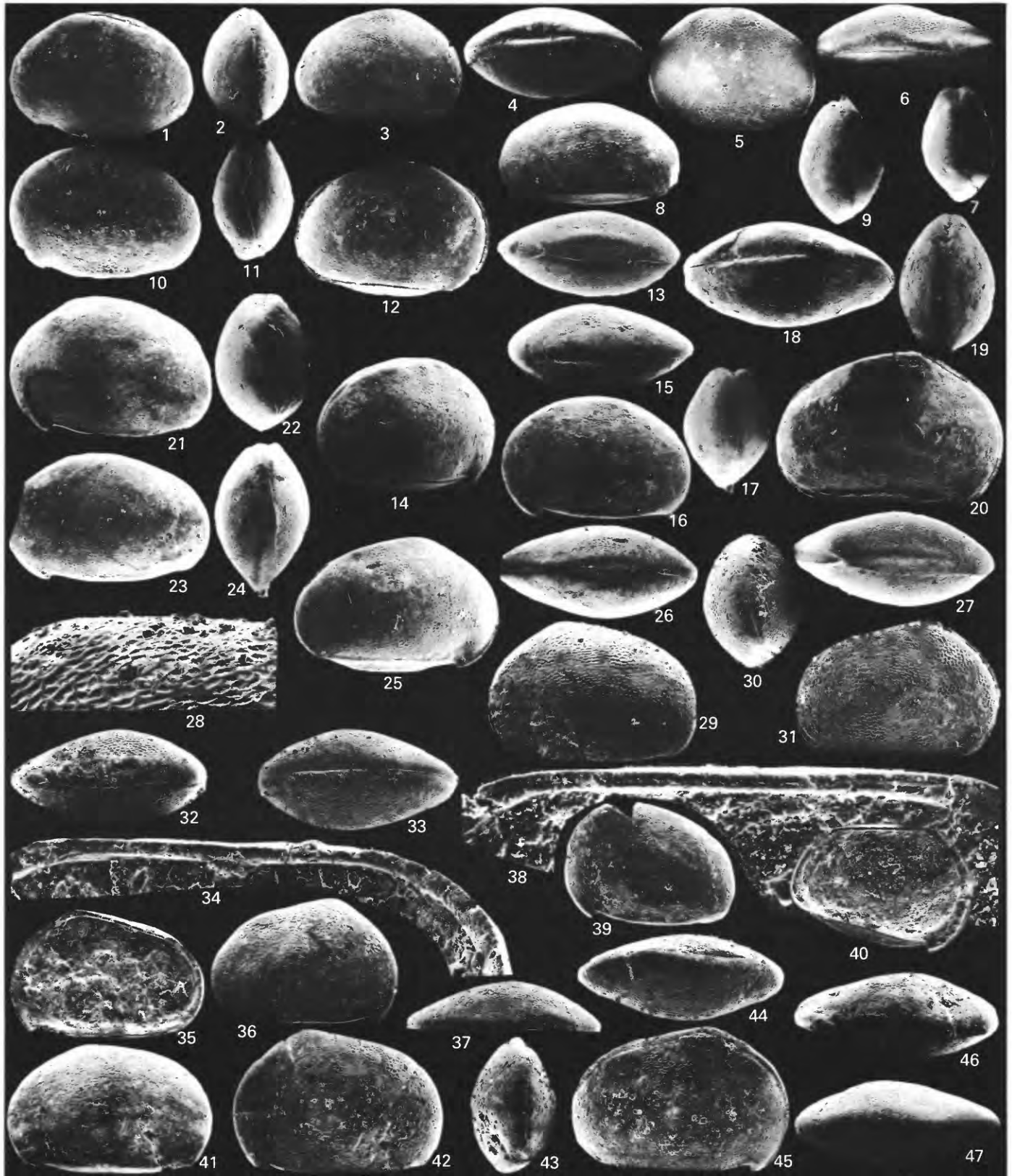
LONGISPINELLA

PLATE 6

[Scanning electron micrographs (SEM) taken approx. $\times 60$,
and where indicated larger, reduced 1/2 for publication]

FIGURES 1-47. *Cypridea* (*Pseudocypridina*) *piedmonti* Roth, 1933 (p. 15).

- 1-4. Left, posterior, right, and dorsal (anterior to right) views of carapace. Figured specimen USNM 242888. Probably Unit 2 of Chilson Member of Lakota Formation, Meade County, S. Dak. USGS colln. 31171, map loc. 8.
- 5-7. Left, dorsal (anterior to right), and posterior views of carapace. Figured specimen topotype USNM 242889. Probably Unit 2 of Chilson Member of Lakota Formation, Meade County, S. Dak. USGS colln. 30997, map loc. 8.
- 8, 9. Left valve and posterior of carapace. Figured specimen USNM 242890. Same collection as figs. 1-4.
- 10-13. Left, posterior, right, and ventral (anterior to left) views of carapace. Figured specimen, topotype USNM 242891. Same collection as figs. 5-7.
- 14-17. Right, dorsal (anterior to right), left, and posterior views of carapace. Figured specimen USNM 242892. Same collection as figs. 1-4.
- 18-20. Dorsal, posterior, and right views of carapace. Figured specimen USNM 242893. Same collection as figs. 1-4.
- 21, 22. Left and posterior views of carapace. Figured specimen USNM 242894. Same collection as figs. 1-4.
- 23-27. Left (anterior imbedded in mounting medium), posterior, right, dorsal (anterior to left), and ventral (anterior to left) views of carapace. Holotype USNM 74473. Probably Unit 2 of Chilson Member of Lakota Formation, Meade County, S. Dak. Roth's type-locality, map loc. 8.
- 28-33. Detail of dorsoanterior approx. $\times 50$, left, posterior, right, ventral (anterior to left), and dorsal (anterior to right) views of carapace. Figured specimen USNM 242895. Unit 2 of Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln. 26089, map loc. 17.
- 34-37. Right valve, detail of hinge approx. $\times 50$, inside, outside, and dorsal views. Figured specimen USNM 242896. Same collection as figs. 28-33.
- 38-40. Left valve, detail of hinge approx. $\times 75$, outside and inside views. Figured specimen USNM 242897. Same collection as figs. 1-4.
- 41-47. Ventral oblique, left, posterior, dorsal oblique (anterior to left), right, ventral (anterior to left), and dorsal (anterior to right) views of carapace. Figured specimen USNM 242898. Same collection as figs. 28-33.



CYPRIDEA (PSEUDOCYPRIDINA)

PLATE 7

[Scanning electron micrographs (SEM) not reduced for publication]

- FIGURE 1. *Cypridea (Pseudocypridina) laeli* Sohn, n. sp. (p. 16).
Dorsal view of carapace, approx. $\times 75$. Same specimen as pl. 3, figs. 24, 25.
Chilson Member of Lakota Formation, Crook County, Wyo.
- 2-4. *Cypridea (Pseudocypridina) inornata* (Peck, 1941) (p. 15).
Ventral (anterior to left), posterior, and right views of carapace, approx.
 $\times 60$. Figured specimen USNM 242899. Lakota Formation, Crook County,
Wyo. USGS colln. 25645, map loc. 5.
- 5-7. *Longispinella longispina* (Peck, 1941) (p. 19).
Detail of anterior portion of left valve, approx. $\times 300$, dorsal and left views
of carapace, approx. $\times 90$. Figured specimen, presumed male, USNM
12943. Limestone near middle part of Lakota Formation, Crook County,
Wyo. USGS colln. 25644, map loc. 5. The same specimen was illustrated
by Sohn (1958, pl. 1, figs. 1-4).
- 8-12. "*Cypridea*" sp. 1 (p. 18).
Dorsal, posterior, anterior, left, and right views of carapace, approx. $\times 90$.
Figured specimen USNM 242900. Unit 2 of Chilson Member of Lakota
Formation, Fall River County, S. Dak. USGS colln. 26098, map loc. 17.



CYPRIDEA (PSEUDOCYPRIDINA), LONGISPINELLA, "CYPRIDEA"

PLATE 8

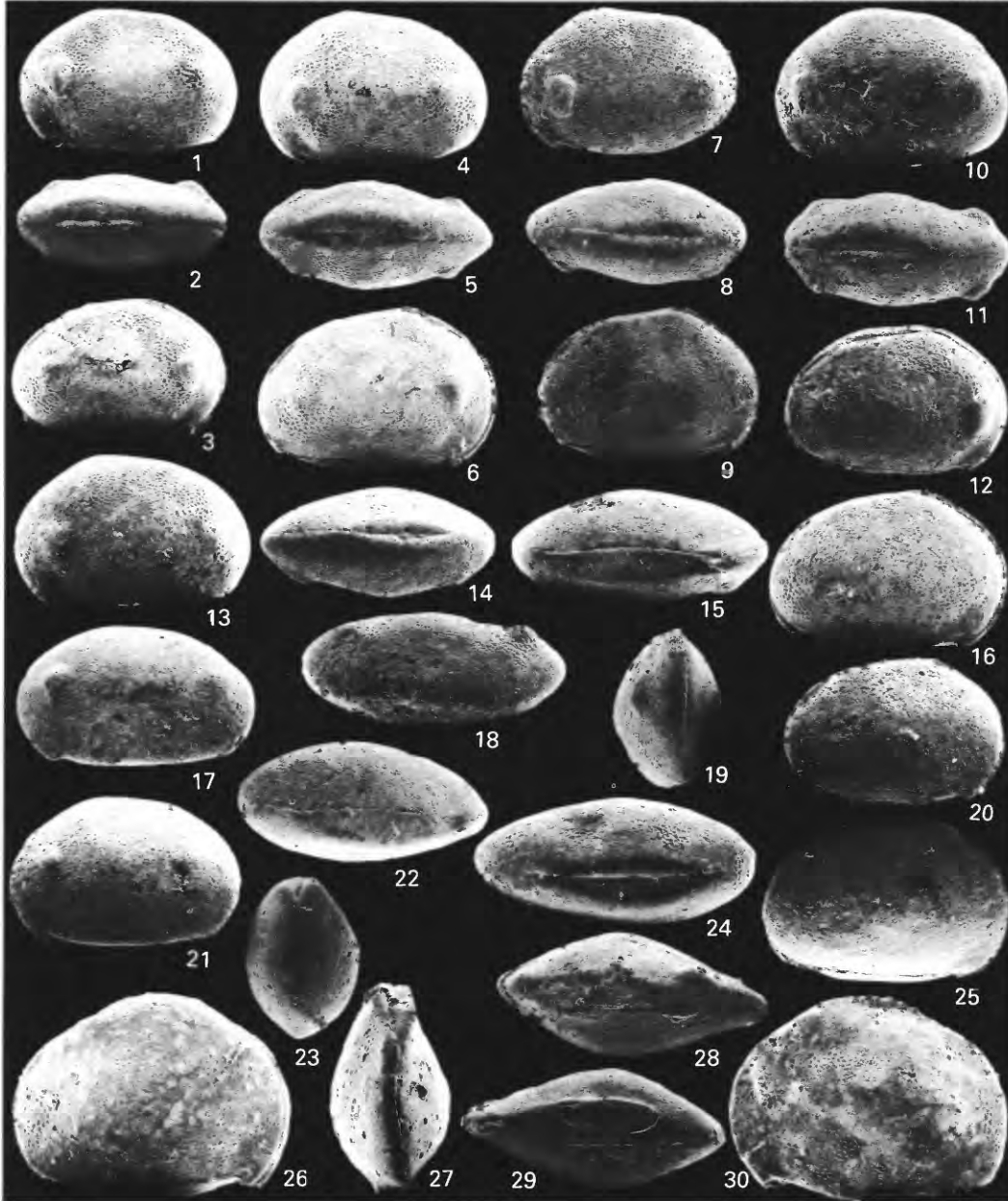
[All scanning electron micrographs (SEM), photographed approx. $\times 90$, reduced 1/2 for publication]

FIGURES 1-25. *Cypridea* (*Pseudocypridina*) *henrybelli* Sohn, n. sp. (p. 17).

- 1-3. Left, dorsal (anterior to right), and right views of carapace with two nodes on each valve. Paratype USNM 242901. Unit 1 of Chilson Member of Lakota Formation, Fall River County, S. Dak. USGS colln. 31130, map loc. 14.
- 4-6. Left, dorsal (anterior to right), and right views of carapace with two nodes on each valve. Paratype USNM 242902. Same collection as above.
- 7-9. Left, dorsal (anterior to left), and right views of carapace with two nodes on each valve. Paratype USNM 242903. Same collection as above.
- 10-12. Left, dorsal (anterior to right), and right views of carapace with two nodes on each valve. Paratype USNM 242904. Same collection as above.
- 13-16. Left, dorsal (anterior to left), ventral (anterior to right), and right views of carapace with two nodes only on left valve. Paratype USNM 242905. Same collection as above.
- 17-20. Left, dorsal oblique (anterior to right), posterior, and right views of carapace with two nodes only on left valve. Paratype USNM 242906. Same collection as above.
- 21-25. Left, ventral (anterior to right), posterior, dorsal oblique (anterior to right), and right views of carapace with one node only on anterior part of left valve. Paratype USNM 242907. Same collection as above.

26-30. *Cypridea* (*Pseudocypridina*) *laeli* Sohn, n. sp. (p. 16).

- Right, posterior, dorsal (anterior to right), ventral (anterior to left), and left views of carapace. Paratype USNM 242908. Lakota Formation, Crook County, Wyo. USGS colln. 31001, map loc. 5.



CYPRIDEA (PSEUDOCYPRIDINA)