

Late Cenozoic Ostracoda From Midway Island Drill Holes

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By JOHN C. HOLDEN

GEOLOGY OF THE MIDWAY AREA, HAWAIIAN ISLANDS

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*A description of ostracode assemblages
from two cored holes through the
reef cap of Midway atoll*



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GEOLOGY OF THE MIDWAY AREA, HAWAIIAN ISLANDS

LATE CENOZOIC OSTRACODA FROM MIDWAY ISLAND DRILL HOLES

By JOHN C. HOLDEN

ABSTRACT

Two drill holes 6.5 km apart on Midway atoll penetrated 157 and 385 m, respectively, of Cenozoic sediment containing a rich collection of ostracodes. The reef hole, the deeper of the two, contains nine ostracode faunas; the lower faunas are earliest Miocene or latest Oligocene in age. An early Miocene age is favored to agree with foraminiferal ages. The Sand Island hole contains five faunas, of which the upper three are questionably assigned a Pleistocene age and are correlative with the upper reef hole faunas. All indicate shallow water for the sediments in which they occur, and some are interpreted as cooler water faunas (cooler than tropical). One fauna in the Sand Island hole is characterized by a great abundance of *Cyprideis beaconnensis*, indicating local brackish environmental condition.

Of the 115 taxa recorded, 25 are described as new, 10 as new subspecies, and 50 are described under open nomenclature. The paleobiogeographic affinities are diverse. The lower Miocene section of the reef hole and, to a lesser extent, the upper Miocene sections of both holes are clearly linked to Caribbean middle Tertiary ostracode faunas, whereas the post-Miocene sections are dominated by Holocene tropical insular Pacific species. Some elements with affinities to the Japanese region are also present in the late and post-Miocene faunas.

INTRODUCTION

Midway atoll is about 2,700 km (kilometres) northeast of the Island of Hawaii and about three-quarters of the way along the Hawaiian Ridge. This ridge is a fairly straight chain of tholeiitic volcanic mountains running from Hawaii at its southeast extremity to Kanmu Seamount at long 175° E., lat 32° N. Interest in the Hawaiian Ridge has increased in recent years because of rapid progress in tectonic theories. The ridge may prove to be of paramount importance in deciphering the geologic history of the Pacific basin (Wilson, 1963; Morgan, 1972).

In the summer of 1965, two holes were drilled on Midway atoll under the sponsorship of the Hawaii Institute of Geophysics, with financial support from the National Science Foundation. One hole was drilled on Sand Island (fig. 1) and penetrated 157 m (metres) of sedimentary rock before reaching basalt. The second hole was placed about 6.5 km to

the northeast, just behind the reef at the north end of the atoll. It was drilled from a barge resting on the lagoon floor and penetrated 385 m of sedimentary rock above a basalt basement. Sampling began at about 9 m in the Sand Island hole and at 21 m in the reef hole and continued to basement; recovery was 72 and 92 percent, respectively. Most of the samples were cores, but in a few short intervals only cuttings were recovered. Limestones are dominant, with minor amounts of tuffaceous limestones, clays, and marls. A summary of the rock types found is shown above the species charts for each of the holes (figs. 2 and 3), and a detailed account of the drilling operation and general geology of the cores can be found in Ladd, Tracey, and Gross (1970).

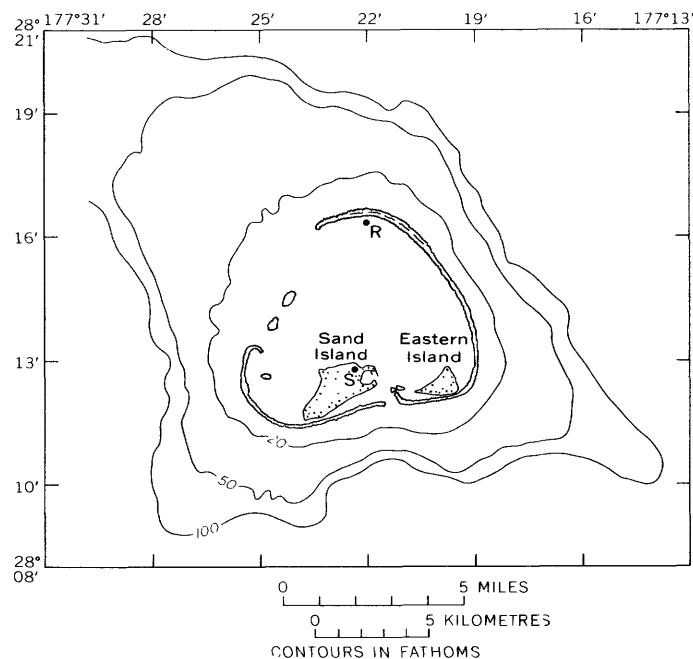


FIGURE 1.—Midway atoll, showing location of drill holes. S, Sand Island hole; R, reef hole. From Ladd, Tracey, and Gross (1970).

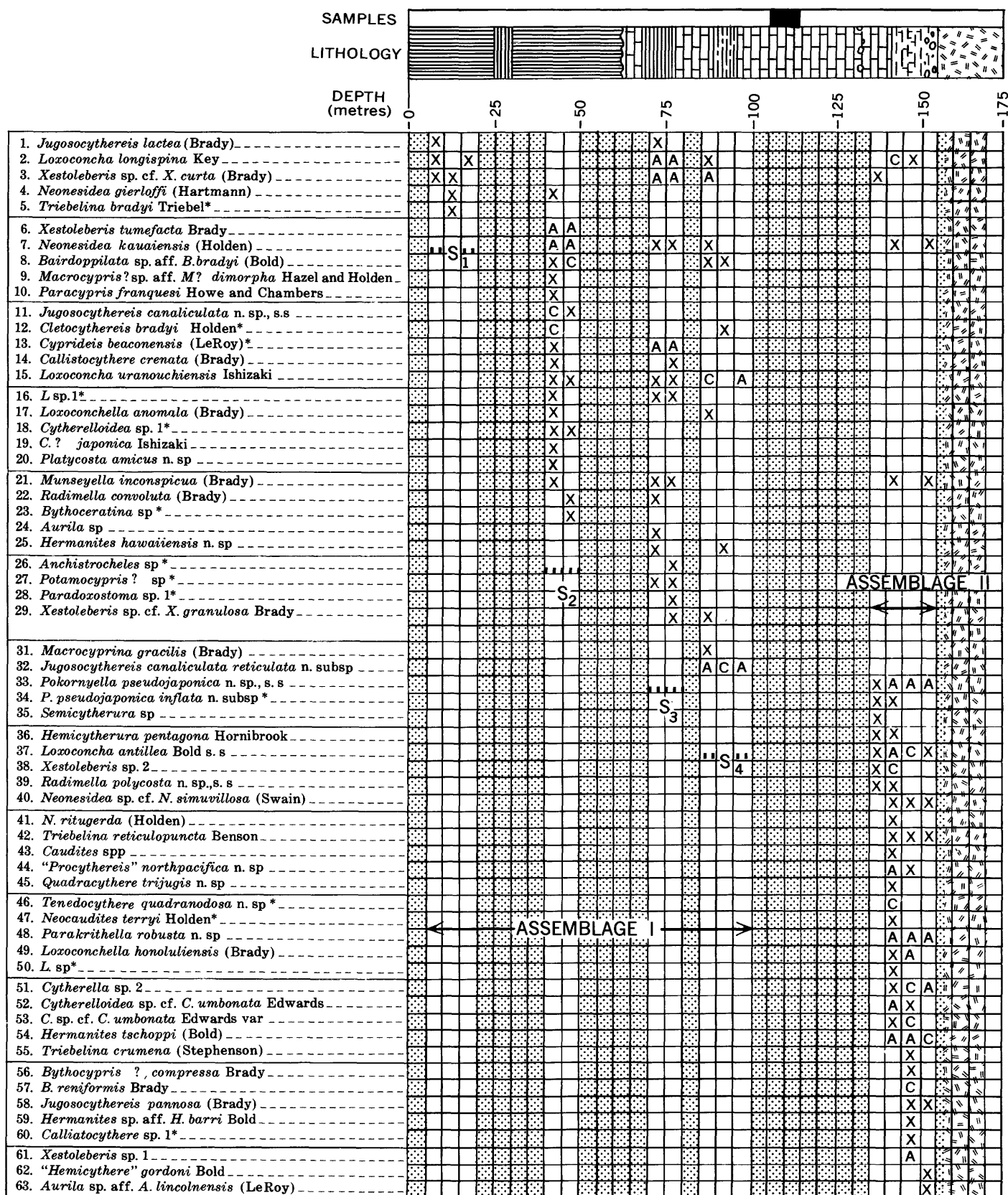


FIGURE 2.— (See facing page for explanation.)

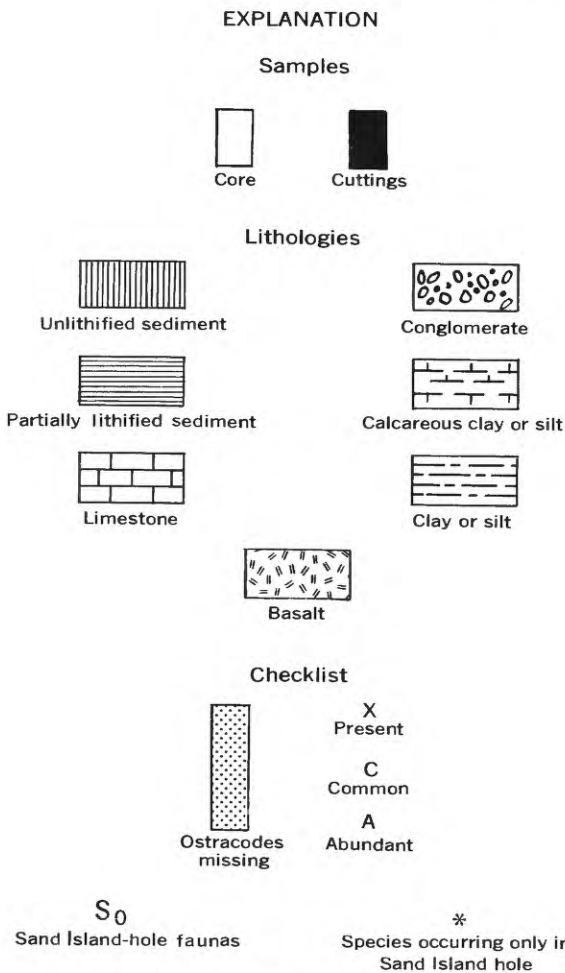


FIGURE 2.—Species checklist for the Sand Island hole.

The ostracodes from the two holes are usually well preserved. In approximately 50 percent of the Sand Island cores and 25 percent of the reef hole cores, ostracodes were either lacking or so poorly preserved that they were not extracted. At several levels in both holes, ostracodes are very abundant, numbering scores of individuals per sample.

A total of 115 taxa are treated here, of which 25 are described as new species, 10 as new subspecies, and 50 are described under open nomenclature. Most are shallow-water forms. In none of the sections where ostracodes occur is there a fauna that could be considered representative of deep water, that is, deeper than about 100 m.

Acknowledgments.—Most of the work on the ostracodes was done at the National Oceanographic and Atmospheric Administration (NOAA), Atlantic Oceanographic and Meteorological Laboratories, Miami, Fla., during 1971 and 1972. To the laboratory and to my supervisor, Robert S. Dietz, I wish to express my thanks. The ostracodes were supplied

by Harry S. Ladd and Joseph E. Hazel, who loaned the material from the Midway drill holes and supplied the photographs that compose plates 1–6. Without their cooperation this report would not have been possible. Rosalie Maddocks and Willem A. van den Bold have offered substantial assistance concerning various taxonomic problems. J. Wyatt Durham, Donald Hall, Joseph E. Hazel, and the late Nathan J. Ayer, Jr., critically read the manuscript and offered many helpful suggestions.

MAJOR ASSEMBLAGES

Interestingly, the stratigraphic distribution of the ostracodes in the reef and Sand Island holes is unlike that of the foraminifers studied by Todd and Low (1970). The ostracodes tend to be limited within the sections to distinct intervals. Sometimes this clustering is the result of evolutionary change, but for the most part it is probably the result of environmental preference. Whatever the cause, the ostracodes may be grouped roughly into three major assemblages within the two holes. Because the earliest assemblage is exclusively early Miocene, the reef hole has all three represented, whereas the Sand Island hole has only two. Though some of the taxa are erratic in their distribution patterns, being found in one hole and not in the other, most of the taxa within a given assemblage are found in both holes.

Assemblage I.—Most of the taxa here are either the same as or closely allied with living tropical Pacific species. The age is Pleistocene(?) and post-Miocene on the basis of the known ranges of *Cypriideis beaconnensis*, *Radimella convoluta*, and foraminiferal data (Todd and Low, 1970; Cole, 1969). The assemblage is more diverse in the Sand Island hole, which contains 31 taxa, of which 11 are found only there. The same assemblage in the reef hole numbers 19 taxa, of which 14 are also found in the Sand Island hole. Typical constituents are:

Neonesidea kauaiensis (Holden)
Bairdoppilata sp. aff. *B. bradyi* (Bold)
Loxococoncha longispina Keij
Neonesidea gierloffii (Hartmann)
Loxococoncha uranouchiensis Ishizaki
Xestoleberis sp. cf. *X. granulosa* Brady
X. sp. cf. *X. curta* Brady
Jugosocythereis canaliculata n. sp.

Assemblage II.—The interval from 150 to 250 m in the reef hole and 135 to 155 m in the Sand Island hole is distinct from the preceding assemblage and shares several taxa with the older assemblage III. It is late Miocene in the Sand Island hole and early and late Miocene in the reef hole (age based on the

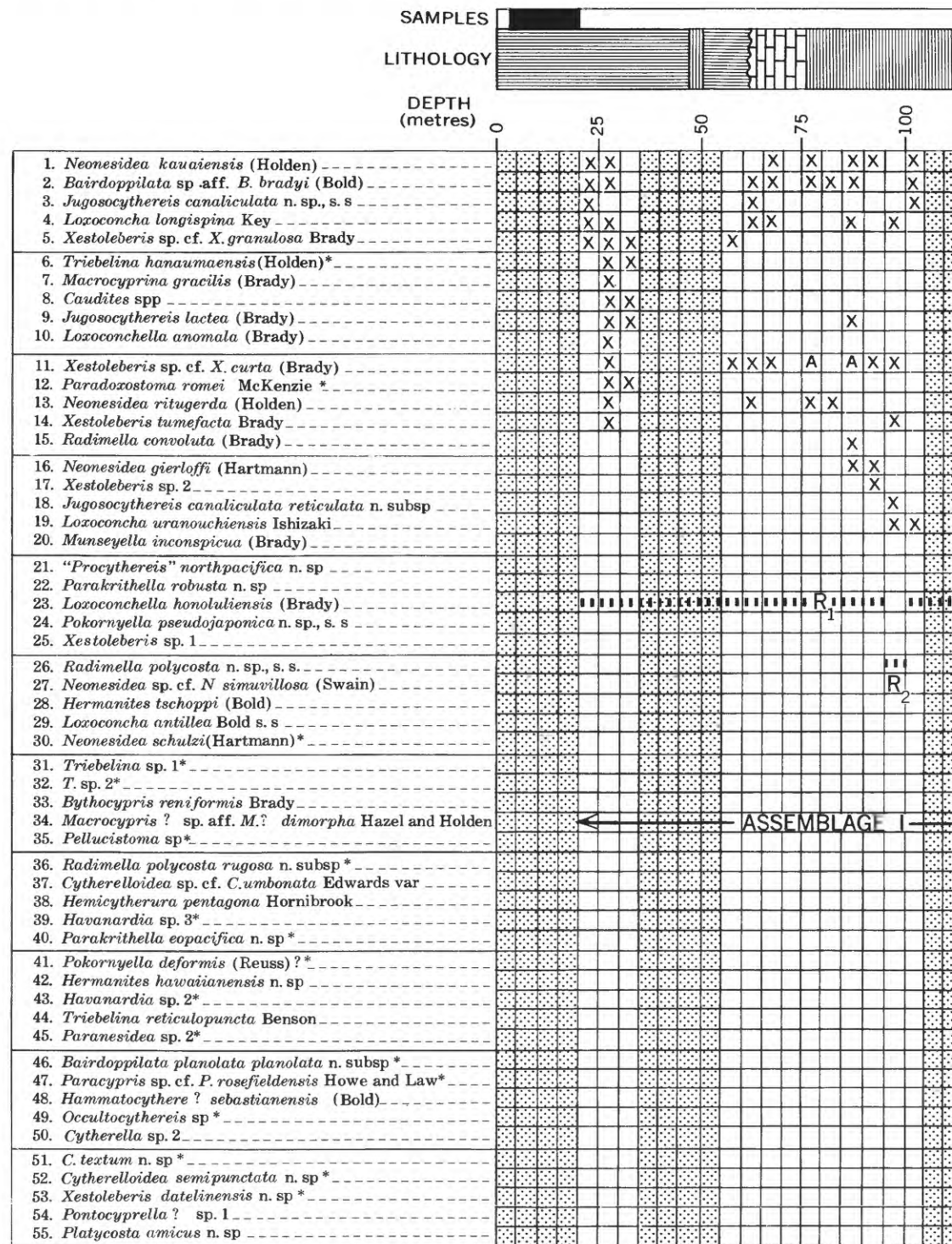
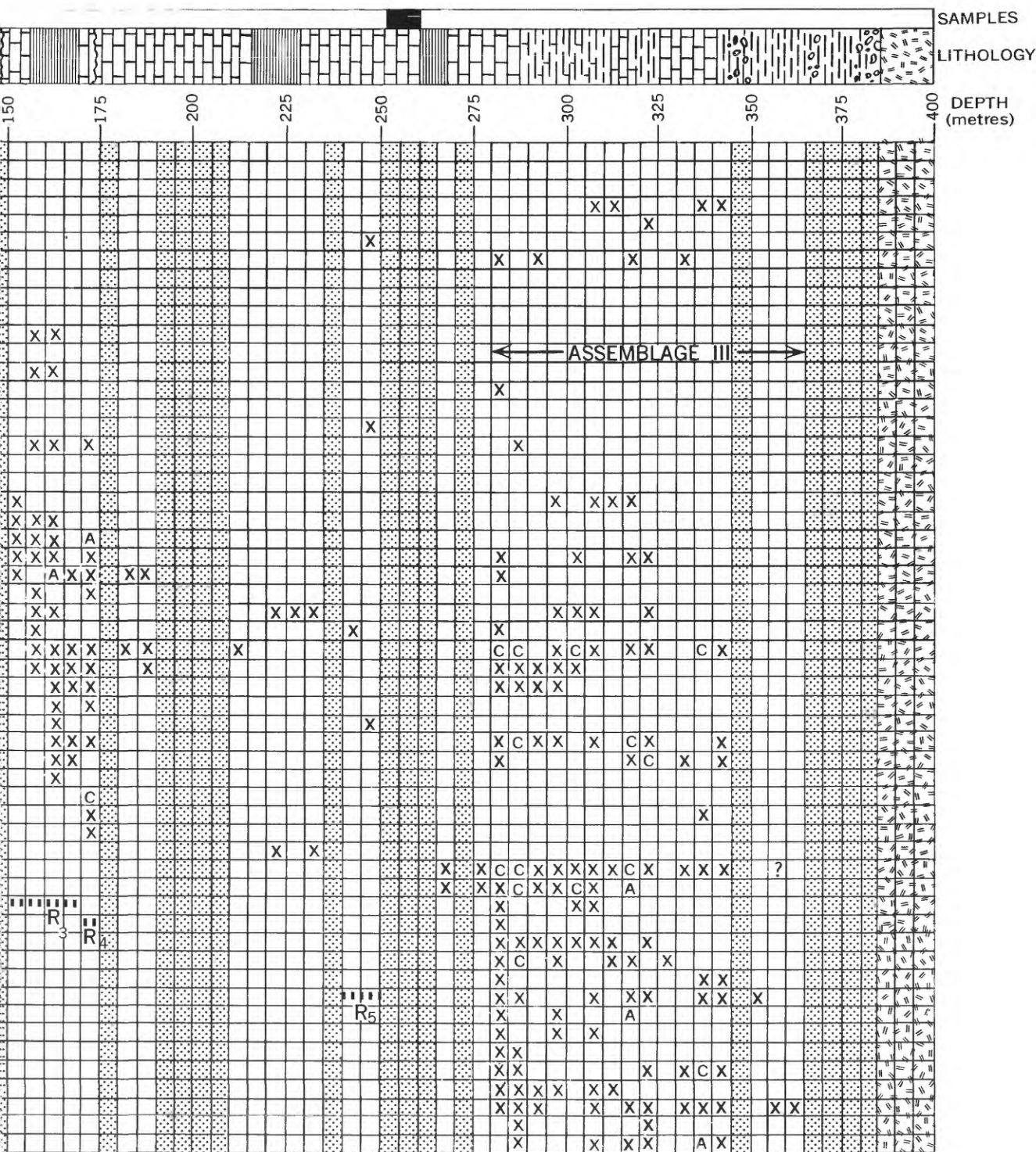


FIGURE 3.—Species checklist for the reef hole.

foraminifers). The ostracodes show a wide variety in their geographic affinities and ecological preferences. "*Procythereis*" *northpacific* and *Parakrithella robusta* are closely allied to temperate Pacific species, and *Bythocypris reniformis* Brady suggests cool and (or) deep water. *Hemiccytherura pentagona*

is a New Zealand-Japanese species (Hornibrook, 1952; Hanai, 1957). On the other hand, other species in the assemblage are clearly tropical types. The more commonly occurring taxa present in both holes are "*Procythereis*" *northpacific* n. sp., *Parakrithella robusta* n. sp., *Hemiccytherura pentagona* Horni-



(For numbers 56-99 see following pages.)

brook, and *Xestoleberis* sp. 1. In addition to these, the species *Hermanites tschoppi* (Bold) *Radimella polycosta* n. sp., *Loxoconchella honoluluensis* (Brady), and *Bythocypris reniformis* Brady are common to both assemblages II and III.

Assemblage III.—The earliest assemblage is exclusively early Miocene (age based on foraminifers and ostracodes) and is present only in the reef hole from 283 m to the base of the fossiliferous section at about 362 m. It is composed of four distinct

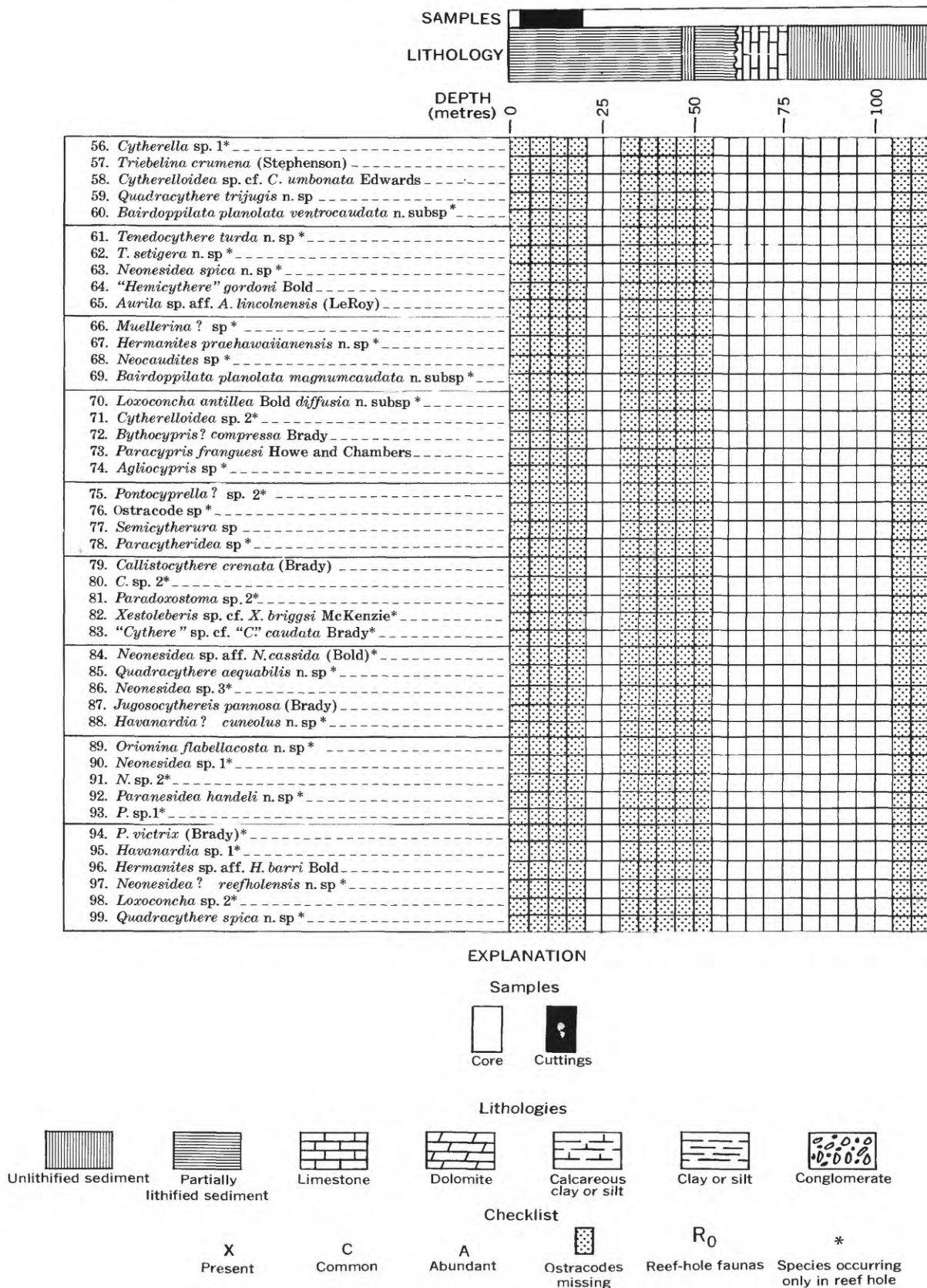
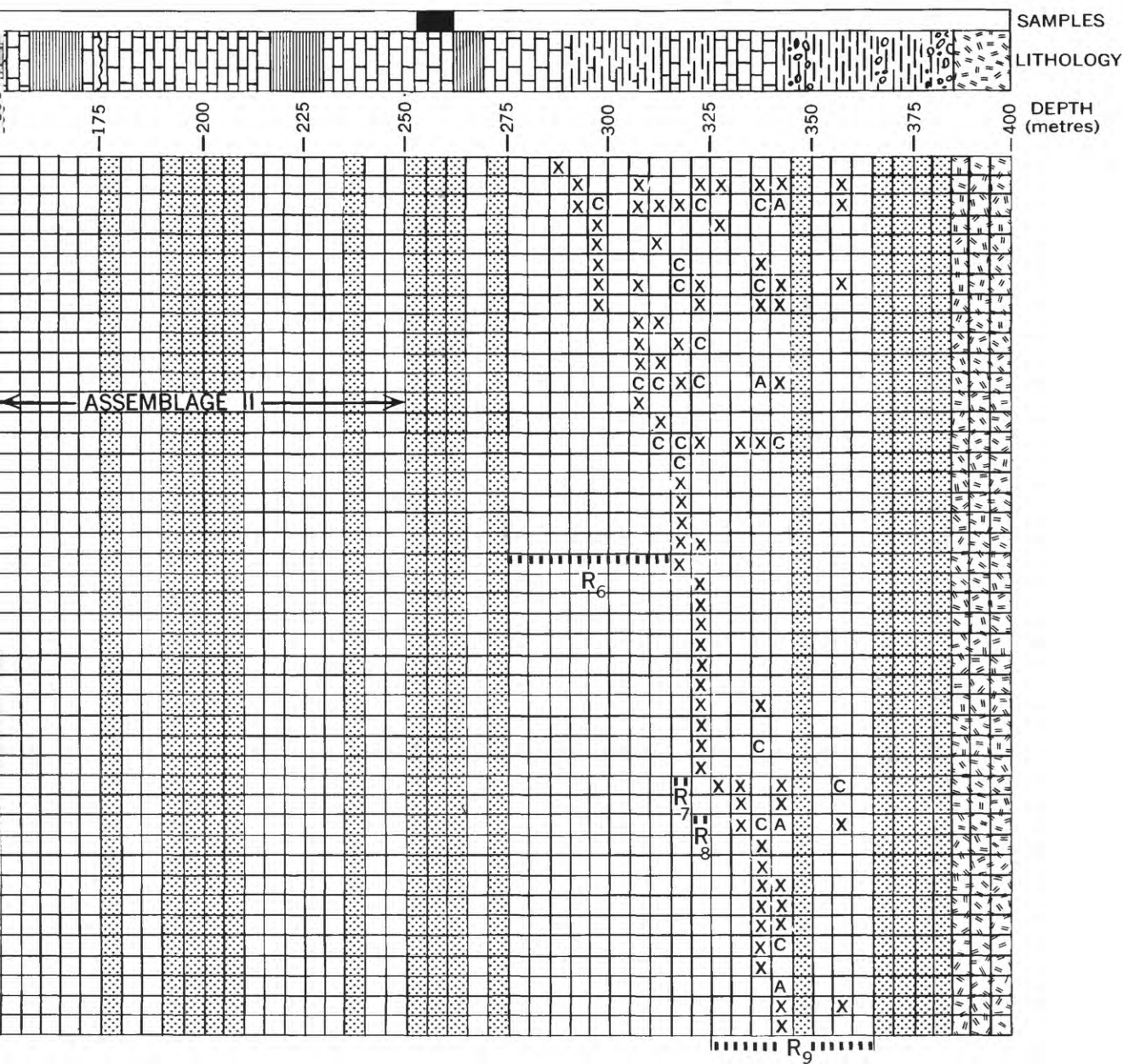


FIGURE 3.—Continued.



faunas, each of which contains 25–30 species. It has strong Caribbean geographic affinities, including:

Triebelina crumena (Stephenson)
T. reticulopuncta Benson
"Hemicythere" gordonii Bold
Paracypris franquesi Howe and Chambers
Pokornyella deformis (Reuss)?
Hammatocythere? sebastianensis (Bold)
Neonesidea sp. cf. *N. cassida* (Bold)
Jugosocythereis pannosa (Brady)
Cytherelloidea sp. cf. *C. umbonata* Edwards
Hermanites tschoppi (Bold)

The last five species are among some of the most abundant species in this section. The other species

that define assemblage III are:

Paracypris sp. cf. *P. rosefieldensis* Howe and Law
Cytherella textum n. sp.
Xestoleberis datelinensis n. sp.
Tenedocythere setigera n. sp.
Hermanites prae-hawaiianensis n. sp.
Parakrithella eopacifica n. sp.

THE FAUNAS

REEF HOLE

Fauna R₁.—Sampling in the reef hole began at 21 m. From this level to almost 130 m, with faunal

breaks from 31.5 to 56.2 m and 104.9 to 123.8 m, the section contains a bairdiid-rich fauna that has tropical Pacific characteristics.

Fauna R₂.—The interval between 96.0 and 101.8 m contains no bairdiids, which is anomalous, for in material that is highly recrystallized, the larger ostracodes are usually better preserved than the smaller forms. This interval contains only species of *Loxoconcha* and *Xestoleberis* and a different subspecies of *Jugosocythereis canaliculata* than occurs in fauna R₁.

Fauna R₃.—No ostracodes were available from 130 to 151 m and an unconformity is present at about 149 m (Ladd and others, 1970). At 151 m an abrupt change in the fauna occurs; only three of the 20 taxa from the shallower interval recur. This fauna is dominated by "*Procythereis*" *northpacifica*, *Parakrithella robusta*, *Hermanites tschoppi*, *Loxoconcha antillea*, and *Bythocypris reniformis*. There is some evidence to indicate that the fauna represents a deeper or cooler water environment, or both, than the previous ones. "*Procythereis*" *northpacifica* is closely related to an undescribed species from Bass Strait, southern Australia, and *Parakrithella robusta* and *Pokornyella pseudojaponica* are related to southern Japanese species. In addition, the genus *Cytherelloidea* is completely missing from fauna R₃, but is abundant in the more diversified but contemporaneous fauna S₅ in the Sand Island hole. According to Sohn (1962), the great majority of species in this genus are known from depths shallower than 92 m.

Fauna R₄.—The brief interval between 172 and 173 m contains great abundance of *Parakrithella robusta* and the only occurrence of *Radimella polycosta rugosa*, a subspecies with heavily calcified lateral ridges. It is also the only interval in assemblage II where the genus *Cytherelloidea* is found. Except for containing fewer taxa, fauna R₄ is much like the late Miocene fauna S₅ in the Sand Island hole.

Fauna R₅.—Another brief interval between about 243 and 246 m contains only four species, but all of them are bairdiids, indicating a shallower and (or) warmer environment than faunas R₃ or R₄. *Triebelina hanaumensis* Holden, which is a shallow-water species now living in Hanauma Bay, Hawaii (Holden, 1967), occurs only there and in fauna R₁. Just above the section containing this fauna is a sparsely fossiliferous one from about interval 120 to 135 m containing *Radimella polycosta* and a species of *Havanardia*. These species are not assigned to a fauna.

The third major assemblage contains four recognizable faunas on the basis of the occurrences and abundances of their constituents and first appears at about 283 m with the diverse and abundant fauna R₆.

Fauna R₆.—Besides the typical assemblage III species, the following taxa are found only here:

Havanardia sp. 2
Cytherella sp. 2
Cytherella sp. 1
Quadracythere trijugis n. sp.
"*Hemicythere*" *gordoni* Bold
Muellerina? sp.
Neocaudites sp.
Bairdoppilata planolata n. sp. *magnumcaudata* n. subsp.

Fauna R₇.—A very brief interval between 317.37 and 318.82 m beneath fauna R₆ contains a great abundance of *Hammatocythere? sebastianensis* (Bold) along with several species from fauna R₆. *Hammatocythere* is similar in shape and ornamentation to the genus *Patagonacythere*. Living species of that genus are known only from high latitudes; hence, fauna R₇ may be indicative of relatively cool conditions. In support of cooling conditions (cool temperate?) is the common occurrence of *Bythocypris reniformis* Brady, a deep- or cool-water species of the present Pacific (Brady, 1880), and the general lack of bairdiids. Only one bairdiid species appears in this diverse fauna—two specimens of *Paranesidea* sp. 2 at 317.37 m.

Fauna R₈.—The interval beneath that of fauna R₇, between about 320 to 324 m, is considered tropical. The three bairdiid species, *Triebelina reticulopuncta*, *Neonesidea spica*, and *N. sp. cf. N. cassida*, though not common, are consistently present in the samples in this interval. *Hammatocythere? sebastianensis*, so common in fauna R₇, is completely absent here. Species that are peculiar to the fauna include: *Semicytherura* sp.
Paracytheridea sp.
Callistocythere sp. 2
Paradoxostoma sp. 2
Xestoleberis sp. cf. *X. briggsi* McKenzie
Neonesidea sp. aff. *N. cassida* (Bold)

Callistocythere crenata, also present in fauna S₁ (post-Miocene) in the Sand Island hole, recurs in fauna R₈.

Fauna R₉.—The earliest fauna is characterized by the absence of many of the later assemblage III species and by the presence of several species whose duration in the area was apparently short. Among the later, *Orionina flabellacosta*, *Havanardia* sp. 1, and *Paranesidea handeli* dominate. Of the 34 taxa, 12 are bairdiid species whose diversity and abundance indicate a tropical environment.

SAND ISLAND HOLE

Assemblage I in the Sand Island hole is more diverse and is composed of more faunas than it is in the reef hole. Each fauna is separated by a sometimes large unfossiliferous interval. Smaller foraminifers are equally sparse (Todd and Low, 1970). These barren intervals may represent long time spans and slow rates of deposition resulting from lower sea-level stands. However, other factors may be responsible, such as postdepositional erosion or slow rates of deposition because of low biological productivity.

Fauna S₁.—Ostracodes are very rare from 9 to 20 m, though well preserved. The fauna is characterized mostly by the lack of the common and abundant elements in other assemblage I faunas, with the exception of *Triebelina bradyi* Triebel, which is found only here.

Fauna S₂.—From 42 to 46 m most of the specimens are young individuals, possibly indicating redeposition of the smaller valves. Preservation, however, is very good and the redeposition, if such was the case, was probably from contemporary nearby sites. Two adult individuals of *Cyprideis beaonensis* (LeRoy) show that here, or nearby, the water was probably brackish. The fauna is a diverse one, containing 19 species, of which *Xestoleberis tumefacta* and *Neonesidea kauaiensis* (Holden) are the most abundant.

Fauna S₃.—From 73 to 79 m the brackish-water *Cyprideis beaonensis* (LeRoy) dominates, though the significant numbers of other normal marine ostracodes suggest that these others were living in the same area, especially *Xestoleberis* sp. cf. *X. curta* (which has here replaced the abundant *X. tumefacta* of fauna S₂) and *Loxoconcha longispina*. Concerning the environment of this fauna, the discussion by Resig (1969), p. 26) on the Pleistocene *Cyprideis beaonensis* fauna of Hawaii is pertinent:

The frequent association of *Loxoconcha* and *Xestoleberis* with *Cyprideis* in the Ewa material has its counterpart in Recent assemblages of inner Pearl Harbor and Kaneohe Bay. This environment (is) characterized by salinity reduction of limited duration and dependent upon rainfall***"

Cyprideis beaonensis occurs in great abundance only at two levels, 73.91 and 78.88 m. Elsewhere it is represented by a few to several, mostly young valves. Considering these data, it is unlikely that the lagoon was entirely enclosed and freshened as is the case today at Clipperton Island (Allison and Holden, 1971).

Fauna S₄.—Ostracodes are extremely abundant between 85.19 and about 88 m. From the outset to the end of the fossiliferous section at 97.84 m,

Jugosocythereis canaliculata reticulata is in great abundance. Toward the bottom of the section only this species and abundant *Loxoconcha uranouchiensis* are present. Throughout the interval, ostracode diversity is low, and bairdiids are rare and occur only in the upper part.

Fauna S₅.—Ostracodes are missing, or were not picked, presumably because they were too rare, through a thick section extending from about 98 to 136 m. Smaller foraminifers do occur, however, *Amphistegina madagascarensis* and miliolid fragments predominating (Todd and Low, 1970). A coarse conglomerate of basaltic cobbles occurs between 130 and 135 m and at the lower depth *A. madagascarensis* is last found. Deeper than about 136 m most of the samples contain sparse to abundant ostracodes, all representing a single diverse fauna dominated by abundant *Parakrithella robusta*, *Pokornyyella pseudojaponica*, and common *Hermanites tschoppi* (Bold) and *Loxoconcha antillea* Bold.

CORRELATION

Figures 2 and 3 show the distribution and abundance of the taxa in the Sand Island and reef holes, respectively. The taxa are arranged in order of their first occurrences, allowing them to be grouped into their faunas and assemblages, which are noted with the same symbols used in the text. Those marked with an asterisk occur only in that hole. The taxa are numbered consecutively; these numbers also appear in the text under the species descriptions to facilitate locating each on the charts.

Major assemblages I and II afford good general correlations between the Sand Island and reef holes. In both holes, unfortunately, a large unfossiliferous section divides assemblages I and II. This paleontological gap may represent all of Pliocene time.

In assemblage I, fauna R₁ (21–96 m) and faunas S₂ and S₃ (42–78 m) both contain *Radimella convoluta*, and R₂ (96–102 m) and S₄ (85–98 m) both contain *Jugosocythereis canaliculata reticulata*. These taxa are restricted to these faunas and are interpreted as being contemporaneous. As fauna R₂ begins at 96 m and S₃ ends at 78 m, this level in the reef hole represents an 18-m greater water depth than that in the Sand Island hole.

In the late Miocene assemblage II, faunas R₃ and R₄ (151–173 m) collectively correlate well with fauna S₅ (136–152 m). The taxa restricted to and shared by these faunas include *Parakrithella robusta*, "*Procythereis*" *northpacific*, *Xestoleberis* sp. 1, *Cytherelloidea* sp. cf. *C. umbonata* variation, and *Hemicytherura pentagona* Hornibrook. The differ-

ences between first and last occurrences of these taxa in the two holes averages about 15 m, again the interval in the reef hole being the deeper.

AGE

Three lines of evidence point to a possible Pleistocene age (noted herein as "Pleistocene?") assignment for the sediments down to about 95 m in the reef hole and 80 m in the Sand Island hole. The first of these involves the abnormal composition of some of the faunas, namely fauna R₂ of the reef hole and S₄ of the Sand Island hole. These faunas, so far as is known, have no counterparts in modern tropical reef or lagoonal faunas, but the literature describing the ostracode assemblages from these environments is insufficient to verify this fact. These assemblages are characterized by their lack of bairdiid ostracodes and contain the distinctive subspecies *Jugosocythereis canaliculata reticulata*, which only occurs in these faunas. These faunas are inferred to represent cooler water than those immediately superadjacent and subadjacent. The presence of *Loxconcha uranouchiensis* Ishizaki within fauna R₂ and its abundance in fauna S₄ support this interpretation. This species is living today in bays of northern and southern Honshu, Japan.

Secondly, *Radimella convoluta* which is found in faunas S₂ and S₃ in the Sand Island hole, and the correlative fauna R₁ of the reef hole, is known from the Pleistocene of Oahu, Hawaiian Islands (Resig, 1969).

Thirdly, *Cyprideis beaonensis* (LeRoy) of faunas S₂ and S₃ is known only from the Pleistocene to Holocene, though its geographic distribution is quite wide (Sandberg, 1964).

The early and late Miocene age of the sediments in the Midway cores is based on the study of the Foraminifera. According to Todd and Low (1970), who studied the smaller foraminifers, upper Miocene (Tertiary *g*) is first found at 136 m in the Sand Island hole and 153 m in the reef hole. Lower Miocene is reached at 278 m in the reef hole. Cole (1969), in his studies of the larger foraminifers, recognized lower Miocene (Tertiary *e*) at 180 m in the reef hole.

Macrocypris? sp. aff. *M.?* *dimorpha* Hazel and Holden from Tonga (Hazel and Holden, 1971) is an Eocene species. The Pleistocene(?) to early Miocene Midway form is closely related to it. Another long-ranging species, *Jugosocythereis pannosa*, is late Eocene to Holocene in the gulf coast-Caribbean region. It occurs in the lower Miocene of the reef hole and upper Miocene of the Sand Island hole.

Several assemblage III species that are relatively short-ranging in the Caribbean-gulf coast region offer an age determination for the lower stratigraphic interval in the reef hole below about 280 m. All these species extend back into the Oligocene, or Oligocene-Miocene (where there is doubt about the boundary), except for *Pokornyella deformis* Reuss?, which appears to be confined to lower to middle Miocene rocks in the Caribbean (Bold, 1966b). These species are:

Paracypris rosefieldensis (Oligocene-Miocene)

Loxconcha antillea (early Miocene)

Hermanites tschoppi (early to middle Miocene)

"*Hemicythere*" *gordoni* (Oligocene-Miocene)

Hammatocythere? sebastianensis (Bold, which is the major constituent of fauna R₇ and which commonly occurs throughout fauna R₆, is otherwise known only from the Oligocene of Puerto Rico (Bold, 1965). Also occurring only in the rocks of this stratigraphically short interval is *Paracypris franquesi* known from the Caribbean Eocene and Oligocene. These species, together with *Neonesidea* sp. aff. *N. cassida*, which bears a resemblance to *Bairdia cassida* Bold from the Oligocene of Cuba, suggest that the lower part of the reef hole may correlate with the Caribbean Oligocene. This correspondence cannot be definitely asserted, however, as these species occur with the Miocene *Pokornyella deformis*. Because of this discrepancy and because of the foraminiferal ages assigned by Todd and Low (1970), and by Cole (1969), an early Miocene age is favored.

BIOGEOGRAPHIC AFFINITIES OF THE FAUNAS

Cole (1969) presented a strong argument for a westward migration, to Midway from the Indopacific region, of the larger Foraminifera accompanying the ostracode faunas. All the larger Foraminifera, including both the fossil and Holocene, are Indopacific species.

The early Miocene assemblage III ostracode faunas contain several species known only from the Caribbean. Some of these also occur in the late Miocene assemblage II in both holes. Why the ostracode faunas have affinities to the Caribbean whereas the other invertebrates do not is an intriguing problem. Unfortunately, Miocene or earlier Tertiary ostracodes have not previously been described from the tropical insular Pacific. The Ostracoda described from the Funafuti drill holes were originally believed to be as old as Miocene (Chapman, 1914) but are now known to be Pleistocene to Holocene (Ladd and others, 1970). The sparse literature from the

East Indies, including the works of Kingma (1948), LeRoy (1939, 1941), Fyan (1916), and Guha (1968), and from India, including Guha (1965a, b), indicate no biogeographic connection between these areas and Midway during the Miocene.

To date, about 65 Holocene ostracode species have been described from the "Pacific Realm" of Benson (1964), encompassing the open Pacific islands (excluding the East Indies, Funafuti, Samoa, Fiji, New Caledonia, and New Zealand, which are considered part of the "Indopacific Realm" by Benson). In the Caribbean (excluding the Gulf of Mexico region) perhaps as many as 130 species have been described. Apart from the Clipperton Island fauna containing six Caribbean ostracode species, only one other shallow-water species is known to be shared between these provinces—*Munseyella inconspicua* (Brady) (Teeter, 1966). Hence, it appears that the present Pacific ostracode faunas have little in common with those of the Caribbean, but in the Miocene a distinct connection existed between these two regions.

Allison and Holden (1971) noted the Caribbean affinities of Holocene Clipperton Island ostracodes and suggested that during the time that middle America was a seaway, surface currents swept out from east to west, as do the North Atlantic and North Pacific Equatorial currents today. This circulation pattern also could explain the Caribbean affinities of some of the elements in assemblages II and III. Regardless of whether the species migrated east to west or vice versa, it appears clear that a biogeographic connection existed.

Some affinities to Japan and Okinawa are noted in that the genus *Parakriothella* is known previously only from that area. Because in Asia the genus is Pliocene to Holocene and in Midway it is early Miocene to post-Miocene, it would appear that migration was from east to west. A somewhat clearer Japanese influence is seen in the late Miocene assemblage II and post-Miocene assemblage I with the introduction of *Pokornyella pseudojaponica*, *Loxoconcha uranouchiensis*, and *Cytherelloidea? japonica*. Probably these and many other species made their way to the atoll via the Kuroshio Current.

SYSTEMATIC PALEONTOLOGY

In the following pages, stratigraphic horizon designations include the abbreviations "R" and "S" for the reef and Sand Island holes, respectively. For example, S-140.21 m indicates a depth of 140.21 m in the Sand Island hole. KR and MR stand for

Kure atoll lagoon and Midway lagoon, respectively. RV signifies right valve, LV, left valve. *L* stands for length, *H* for height, and *W* for width. Under the heading "Distribution" the number of specimens found is recorded in parentheses. The number in parentheses under "Species No." refers to the checklists (figs. 2, 3). All figured types have been deposited at the U.S. National Museum (Natural History) (USNM), Washington, D.C. Some secondary types are at the Museum of Paleontology, University of California, Berkeley (UCB). All measurements are in microns.

Subclass OSTRACODA Latreille, 1806
Order PODOCOPIDA Muller, 1894
Suborder PODOCOPINA Sars, 1865
Superfamily BAIRDIACEA Sars, 1888
Family BAIRDIIDAE Sars, 1888
Subfamily BAIRDIINAE Sars, 1888
Genus NEONESIDEA Maddocks, 1969

Neonesidea gierloffii (Hartmann)

Plate 7, figure 1

Bairdia crosskeiana Brady. Brady, 1880, Rept. *** Voyage *** Challenger, Zoology, v. 1, p. 58, pl. 9, figs. 3a-c.

Holden, 1967, Pacific Sci., v. 21, no. 1, p. 12, 13, text-figs. 3h-l.

Not Brady, 1866, Zool. Soc. London Trans., v. 5, p. 366, pl. 57, figs. 10a-d.

Triebelina gierloffii Hartmann, 1959, Kieler Meeresforschungen, v. 15, no. 2, p. 214-217.

Type and dimensions.—Hypotype USNM 184298. Adult RV. S-44.20 m. *L*=758, *H*=383, *W*=150.

Distribution.—Pleistocene (?): Sand Island hole (6), reef hole (5); Post-Miocene: reef hole (2).

Species No.—S(4), R(16).

Discussion.—The forms dealt with by Brady (1880) and Holden (1967) under *Bairdia crosskeiana* are conspecific with *Neonesidea gierloffii*. *Bairdia crosskeiana* of Brady (1866) from the Levant (eastern Mediterranean) is distinct. Brady's (1866) original description is brief, but his illustrations show a species much higher in side view and more centrally inflated, as seen from above, than any of those so far reported from the Pacific.

The species is living widespread in the Pacific. It is found in the Admiralty Islands north of New Guinea at 32 m (Brady, 1880), off Hawaii at 44 m (Holden, 1967) to 80 m (Brady, 1880), and off El Salvador at 2-12 m (Hartmann, 1959).

Neonesidea sp. aff. *N. cassida* (Bold)

Plate 7, figures 2-4

Types and dimensions.—

		Depth (m)	<i>L</i>	<i>H</i>	<i>W</i>
Specimen					
USNM	184299.	Adult carapace	R-320.95	800	452 364
Specimen					
USNM	184300.	Adult carapace	R-321.72	858	490 393
Specimen					
USNM	184301.	Adult carapace	R-321.72	850	502 373
Specimen					
UCB	40504.	Adult carapace	R-321.87	884	498 396

Distribution.—Lower Miocene: reef hole (11).

Species No.—R (84).

Discussion.—This species is like the Cuban Oligocene *Neonesidea cassida* (Bold, 1946), but is much smaller, is relatively wider, and has a blunter anterior margin. Its range at Midway was short, between R-320.64 m and R-321.86 m.

Neonesidea sp. cf. N. simuvillosa (Swain)

Plate 7, figures 5–8

Types and dimensions.—

Specimen		Depth (m)	L	H	W
USNM 184302.	Adult carapace	S-147.37	873	473	385
USNM 184303.	Adult RV	S-147.37	900	440	170

Distribution.—Lower Miocene: reef hole (1). Upper Miocene: reef hole (1); Sand Island (6).

Species No.—S (40), R (27).

Discussion.—The species has the general morphology of *Neonesidea simuvillosa* from the west coast of Mexico (Swain, 1967) and Clipperton Island (Allison and Holden, 1971), but it has a higher anterior margin and is serrated along the posteroventral margin; because of these differences it cannot be definitely assigned to *N. simuvillosa*. Benson's (1959) "*Bairdia sp.*" included by Swain in the synonymy of *N. simuvillosa*, was compared with *Neonesidea verdesensis* (LeRoy); "*Bairdia sp.*" primarily differs from *N. verdesensis* by lacking posteroventral serrations. Despite the presence of serrations on *N. verdesensis* and its implied similarity to *N. simuvillosa*, specimens of *N. verdesensis* from San Diego or San Pedro (Timms Point Silt Member) and Santa Barbara Formations of southern California observed by the writer do not resemble the Midway specimens.

Neonesidea ritugerda (Holden)

Bairdia ritugerda Holden, 1967, Pacific Sci., v. 21, no. 1, p. 12, 13, figs. 6a–g.

Diagnosis.—See Holden (1967).

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype USNM 184304.	Adult LV	R-67.67	964	529	285
Hypotype UCB 40505.	Adult LV	R-78.33	1045	623	302

Distribution.—Upper Miocene: reef hole (3); Sand Island hole (1). Post-Miocene: reef hole (3).

Species No.—S (41), R (13).

Discussion.—The Midway specimens are nearly identical with *Neonesidea ritugerda*, a late Cenozoic fossil from submerged terraces in the Hawaiian Islands.

Neonesidea schulzi (Hartmann)

Plate 7, figures 9–11

Triebelina schulzi Hartmann, 1964, Kieler Meeresforschungen, v. 20, p. 44–46, pls. 4, 5: figs. 14–22.

Maddocks, 1969, U.S. Natl. Mus. Bull. 295, p. 20–24, figs. 4a–m, 5, 6.

Species BA, Maddocks, 1966, Kansas Univ. Paleont. Contr., Paper 12, p. 47, fig. 22.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype USNM 184305.	Adult carapace	R-295.05	972	542	450
Hypotype UCB 40506.	Young carapace	R-183.46	816	469	372

Distribution.—Lower Miocene: reef hole (66). Upper Miocene: reef hole (6).

Species No.—R (30).

Discussion.—The species is found only in the reef hole between R-295.81 m and R-161.24 m. These specimens are more streamlined than those figured by Maddocks (1969) from Nosy Bé, Madagascar, and by Hartmann (1964) from El Salvador, but otherwise appear morphologically assignable to the species.

Neonesidea kauaiensis (Holden)

Figure 4

Bairdia amygdaloides Brady, 1880, Rept. *** Voyage *** Challenger, Zoology, v. 1, p. 54–55, pl. 9, figs. 5a–f.

Bairdia kauaiensis Holden, 1967, Pacific Sci., v. 21, no. 1, p. 8–11, text-figs. 3a–i.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype UCB 40507.	Adult LV	S-45.11	1049	648	288
Hypotype UCB 40508.	Adult LV	S-45.11	1145	704	334
Hypotype USNM 184306.	Adult LV	S-44.20	1095	637	295
Hypotype USNM 184307.	Penultimate LV	S-45.11	865	507	236
Hypotype USNM 184308.	3d from last instar	S-45.11	624	362	249
Hypotype USNM 184309.	4th from last instar	S-45.11	494	249	118
Hypotype USNM 184310.	5th from last instar	S-45.11	411	250	115

Distribution.—Pleistocene(?): Sand Island hole (109); reef hole (25). Post-Miocene: Sand Island hole (50); reef hole (11).

Species No.—S (7), R (1).

Discussion.—Brady (1880, p. 54) described the surface as "smooth, often finely punctate." Puncta on the Midway specimens, as well as on those from Hawaii (Holden, 1967) can be seen only after staining. This invisible pitting places the taxon in *Neonesidea*. General carapace shape and nature of the adductor muscle-scar pattern confirm this generic assignment.

Neonesidea spica Holden, n. sp.

Plate 7, figures 12–14

Diagnosis.—Carapace compressed, greatest width in anterior half; caudal process dorsally humped, with terminal spine on left valve; posteroventer serrate.

Description.—Carapace terminally acuminate, smooth; posteroventer finely serrate in both valves;

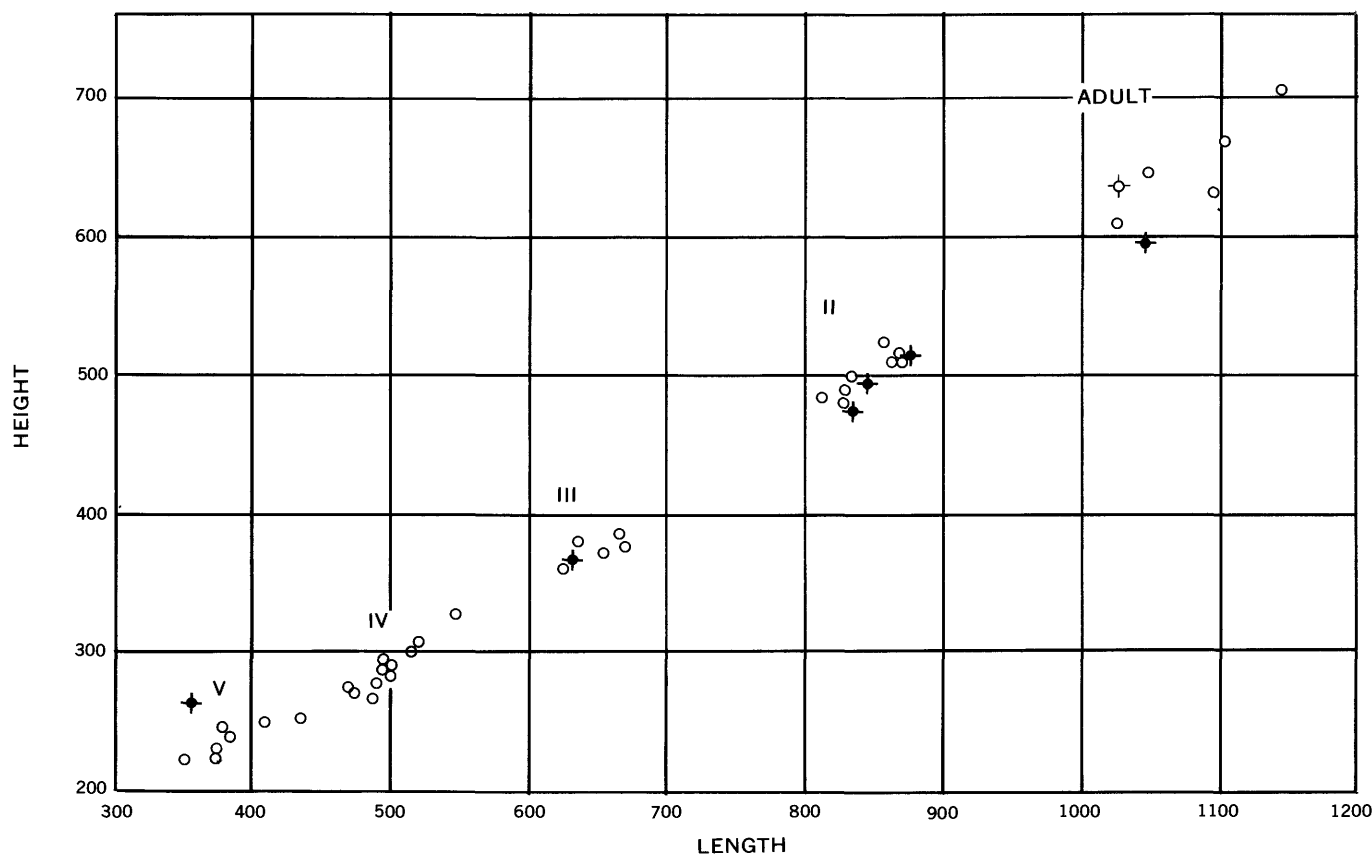


FIGURE 4.—Length-height plot of *Neonesidea kauaiensis* (Holden) from Midway atoll. \circ from R-22.25 m, \blacklozenge from R-31.55 m, \circ from S-45.11 m. Measurements in microns.

dimorphism pronounced, with females (inferred) higher ($L/H=1.65\pm$), males lower ($L/H=1.78\pm$). Caudal process distinctly humped dorsally. Lateral view: highest in anterior half; middorsum gently rounded, posterodorsum concave up, anterodorsum straight, venter flat to slightly rounded, postero-venter straight, anterior margin obliquely rounded tending to subtruncate. Dorsal view: asymmetrical-ly lenticular; greatest width just anterior to mid-length; extremities pointed.

Duplicature of moderate width; vestibules large. Other internal features not observed.

Types and dimensions.—

			Depth (m)	L	H	W
Holotype						
USNM	184311.	Adult ♀ carapace	-----R-320.95	958	541	416
Paratype						
USNM	184312.	Adult ♂ carapace	-----R-338.25	1041	583	416
Paratype						
USNM	184313.	Adult ♂ RV	-----R-338.48	1040	551	182
Paratype						
UCB	40509.	Adult ♀ carapace	-----R-338.12	1080	650	465

Distribution.—Lower Miocene: reef hole (30).

Species No.—R (63).

Discussion.—The species is found only in the reef hole between R-343.30 m and R-295.20 m. In gross morphology, it closely resembles *Neonesidea* sp. cf. *N. simuvillosa* (Swain) of this report, which occurs stratigraphically higher in the reef hole and in the

upper Miocene of the Sand Island hole. The important differences between the two species are the lenticular carapace of *N. spica* and its more pronouncedly humped caudal process that terminates in a prominent spine. The similarity of the two forms and their stratigraphic relationship indicate that *N. spica* is probably the precursor of *N. sp. cf. N. simuvillosa*.

Neonesidea? reefholensis Holden, n. sp.

Plate 8, figures 1-3

Diagnosis.—Carapace bulbously inflated midventrally, width almost equal height; anterolateral and posterolateral surfaces somewhat compressed, giving concave appearance in dorsal view; dorsal margin highly arched.

Description.—Carapace large, smooth, more than 1,000 μ long; heavy, highly inflated, greatest width midventrally. Lateral view: greatest height at mid-length at arched middorsum, anterior and posterior cardinal angles indistinct; anterior margin obliquely subtruncate; ventral margin straight; posterior margin straight beneath somewhat upturned pointed caudal process. Dorsal view: bulbously inflated, anterolateral and posterolateral surfaces gently concave out.

Duplicature of moderate width, vestibules well developed. Other internal features not observed.

Types and dimensions.—

			Depth (m)	L	H	W
Holotype						
USNM	184314.	Adult carapace	-----R-343.30	1170	756	685
Paratype						
USNM	184315.	Adult RV	-----R-341.53	1060	588	280
Paratype						
UCB	40510.	Adult carapace	-----R-343.05	1085	643	590

Distribution.—Lower Miocene: reef hole (34).

Species No.—R (97).

Discussion.—The species occurs only in fauna R₃ between R-343.30 m and R-341.52 m but is locally abundant. Except at the top of its known occurrence, at R-341.52 m, the species is always accompanied by *Havanardia* spp.

Neonesidea sp. 1

Plate 7, figures 15–17

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184316.	Adult carapace	-----R-337.34	1113	729	553
Specimen						
USNM	184317.	Adult carapace	-----R-343.21	1034	624	491
Specimen						
UCB	40511.	Adult carapace	-----R-343.21	1022	616	486

Distribution.—Lower Miocene: reef hole (3).

Species No.—R (90).

Discussion.—Of the three specimens known, the two from R-343.21 m are somewhat lower in height ($L/H = 1.66$) than the single individual from R-337.34 m ($L/H = 1.53$). Whether this difference is caused by sexual dimorphism or genetic variation cannot be determined.

The shape of the species is quite distinctive. In lateral view, the low caudal process is posteriorly extended, thereby accentuating the dorsal hump on the caudal process; in dorsal view, the carapace is bulbously inflated.

Neonesidea sp. 2

Plate 7, figures 20–22

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184318.	Adult carapace	-----R-336.56	1150	681	534
Specimen						
UCB	40512.	Adult LV	-----R-336.27	1137	745	334

Distribution.—Lower Miocene: reef hole (2).

Species No.—R (91).

Discussion.—The two specimens come from R-336.27 m and R-336.56 m, indicating a brief existence for the species at Midway.

The presence of pits on the posterior lateral surfaces of both valves indicates that the species could have been assigned to *Paranesidea*; however, the pits are limited and very faint.

Neonesidea sp. 3

Plate 7, figures 18, 19

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184319.	Adult RV	-----R-321.41	853	453	170
Specimen						
USNM	184320.	Adult LV	-----R-320.34	818	455	199

Distribution.—Lower Miocene: reef hole (6).

Species No.—R (86).

Discussion.—Of the six individuals found, four appear to be young. All come from the reef hole between R-321.41 m and 320.34 m in fauna R₃, indicating a very short existence at Midway Island.

Genus *HAVANARDIA* Pokorný

Havanardia? *cuneolus* Holden, n. sp.

Plate 1, figure 3; plate 8, figures 4, 5

Diagnosis.—Densely pitted; heavy, each valve having a vertical median swelling; diamond shaped in dorsal outline.

Description.—Covered with pits; shell heavy; median enlargement distinctive, consisting of a vertical wedge at midlength on each valve. Lateral view: overlap slight, middorsum flat, horizontal; anterodorsum and posterodorsum straight, sloping at same low angle; ventral margin concave down; anterior margin broadly rounded, posterior margin gently rounded, terminating in pointed caudal process at midheight, entire margin with 12 large projecting spines in left valve, shorter spines in right valve. Dorsal view: diamond shape; posterolateral and anterolateral surfaces flattened; extremities pointed; width equal to height.

Hinge smooth; duplicatures of moderate width, deep vestibules present.

Types and dimensions.—

			Depth (m)	L	H	W
Holotype						
USNM	184321.	Adult carapace	-----R-342.90	883	528	566
Paratype						
USNM	184322.	Adult carapace	-----R-343.21	938	583	592

Distribution.—Lower Miocene: reef hole (70).

Species No.—R (88).

Discussion.—The assignment of the species to *Havanardia* is made with some reservations. The venter is superficially flattened because of the ventrally extended enlargement, but it is not flattened as much as in other *Havanardia*. Quite possibly the taxon warrants a new genus, as no other bairdiids show this distinctive vertical midswelling.

Havanardia sp. 1

Plate 8, figures 6–8

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184323.	Adult carapace	-----R-343.30	1132	690	842
Specimen						
USNM	184324.	Broken adult carapace	R-343.30	--	723	856
Specimen						
UCB	40513.	Adult RV	-----R-343.30	1200	643	469

Distribution.—Lower Miocene: reef hole (3).

Species No.—R (95).

Discussion.—The species is very rare, being found only at R-343.30 m. It is the earliest representative of a group of three *Havanardia* species, including *H. sp. 2* and *3*, that are considered closely related, though morphologically distinct and stratigraphically discontinuous in their distribution. *Havanardia sp. 1* is the largest, is smooth, and has a distinct alar keel, whereas *H. sp. 2* and *3* are smaller, 910 to 950 μ , and lack the strong keel. *Havanardia sp. 3* is covered with small pits. The observed distributions of all three species are limited, *H. sp. 2* being at R-283.46 m and R-284.00 m and *H. sp. 3* found only at R-224.03 m and R-231.65 m. The lateral and dorsal outlines of all three are nearly identical.

Havanardia sp. 2
Plate 8, figure 9

Types and dimensions.—Specimen USNM 184325. Adult carapace. R-284.00 m. $L=910$, $H=506$, $W=590$.

Distribution.—Lower Miocene: reef hole (2).
Species No.—R(43).

Discussion.—See *Havanardia sp. 1* for a discussion of this species.

Havanardia sp. 3
Plate 8, figure 13

Types and dimensions.—

Specimen		Depth (m)	L	H	W
USNM 184326.	Adult carapace	R-231.65	922	519	522
Specimen UCB 40514.	Adult carapace	R-224.03	950	539	556

Distribution.—Lower Miocene: reef hole (2).
Species No.—R(39).

Discussion.—See *Havanardia sp. 1* for a discussion of this species.

Genus *TRIEBELINA* van den Bold, 1946

Triebelina crumena (Stephenson)

Plate 1, figures 5, 6

Bairdia? crumena Stephenson, 1944, Jour. Paleontology, v. 18, no. 2, p. 156, pl. 28, fig. 5.

Triebelina cubensis Bold, 1946, Amsterdam, p. 74, pl. 5, figs. 4a-d.

Glyptobairdia crumena (Stephenson). Stephenson 1946, Jour. Paleontology, v. 20, no. 4, p. 346-347.

Triebelina crumena (Stephenson). Bold, 1965, Micropaleontology, v. 11, no. 4, p. 389, pl. 2, figs. 9a-c.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype USNM 184327.	Adult carapace	R-321.87	572	311	276
Hypotype USNM 184328.	Adult carapace	R-326.65	622	345	295

Distribution.—Post-Miocene: Sand Island hole (1). Lower Miocene: reef hole (20).

Species No.—S(55), R(57).

Triebelina reticulopuncta Benson

Plate 8, figures 10-12

Triebelina reticulopuncta Benson, 1959, Kansas Univ. Paleont. Contr., Arthropoda, Art. 1, p. 44, pl. 2, fig. 1; pl. 8, fig. 4.

Maddocks, 1969, U.S. Natl. Mus. Bull. 295, p. 63, pl. 2, figs. 5, 6; text-figs. 33e-f.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype USNM 184329.	Adult LV	R-283.46	538	310	135
Hypotype USNM 184330.	Adult RV	R-295.50	542	200	119
Hypotype USNM 184331.	Adult carapace	R-295.50	537	279	215
Hypotype USNM 184332.	Adult LV	S-151.79	638	336	179
Hypotype UCB 40515.	Adult RV	S-140.21	547	279	126

Distribution.—Upper Miocene: Sand Island hole (4). Lower Miocene: reef hole (29).

Species No.—S(42), R(44).

Discussion.—The Midway specimens do not have pits quite as large as those on specimens from Baja California described by Benson (1959). Also, the ventrolateral ridge is poorly developed or not present at all. Except for these differences, the Midway specimens are morphologically similar to those from North America.

The species occurs repeatedly in the reef cores between R-321.87 m and R-283.46 m, inclusively, and then stratigraphically higher in the Sand Island cores between S-151.79 m and S-140.21 m. The gap between these occurrences probably reflects non-preservation rather than temporary local extinction.

Triebelina bradyi Triebel

Bairdia truncata (not Kirkby) Brady, 1890, Royal Soc. Edinburgh Trans., v. 35, p. 494-495, pl. 2, figs. 1, 2.

Triebelina bradyi Triebel, 1948, Senckenbergiana, v. 29, p. 18-20.

Key, 1953, Kon. Nederlandse Akad. Wetensch., ser. B, v. 56, p. 158, pl. 1, fig. 5.

Maddocks, 1969, U.S. Natl. Mus. Bull. 295, p. 63, pl. 2, fig. 3; text-figs. 32a, 33a-d.

Non Puri, 1960, Gulf Coast Assoc. Geol. Soc. Trans., v. 10, p. 132, pl. 6, figs. 7, 8.

Type and dimensions.—Hypotype USNM 184333. Adults LV. S-10.82 m. $L=567$, $H=305$, $W=116$.

Distribution.—Pleistocene(?); Sand Island hole (1).

Species No.—S(5).

Discussion.—Originally described by Brady (1890) from Samoa and New Caledonia and subsequently reported from the Holocene and Pleistocene of Indonesia (Key, 1953) and Madagascar (Maddocks, 1969). *Triebelina bradyi* of Puri (1960) is a different species. (See Allison and Holden, 1971.)

Triebelina hanaumaensis (Holden)

Bairdia hanaumaensis Holden, 1967, Pacific Sci., v. 21, no. 1, p. 11, 12, figs. 5a-h.

Type and dimensions.—Hypotype USNM 184334. Penultimate right valve. $L=534$, $H=269$, $W=125$.

Distribution.—Pleistocene(?): reef hole (1). Lower Miocene (1).

Species No.—R(6).

Discussion.—Allowing for growth in accordance with Prisbram's law, the individual from R-31.54 m would have a length of about 760 μ at the next growth stage or would be the same size as the species in the Hawaiian Islands (Holden, 1967). The specimen is a young one, as it has no duplicature.

Triebelina sp. 1

Plate 8, figures 14–16

Types and dimensions.—

Specimen		Depth (m)	L	H	W
USNM 184335.	Adult carapace	R-172.21	633	282	300
USNM 184336.	Adult RV	R-161.39	575	255	145
UCB 40516.	Adult carapace	R-162.46	625	270	294

Distribution.—Lower Miocene: reef hole (1). Upper Miocene: reef hole (2).

Species No.—R(31).

Discussion.—The distribution is clustered on the upper Miocene–lower Miocene boundary from R-172.21 m to R-161.39 m.

The species appears closely related to the smooth *Triebelina hanaumaensis* (Holden, 1967) from the Hawaiian Islands and from higher in the section of the reef hole, but it is smaller, more acuminate posteriorly, flatter ventrally, and the posterior selva more prominently developed to almost tooth-like.

Triebelina sp. 2

Plate 8, figures 17–19

Type and dimensions.—Specimen USNM 184337. Adult carapace. R-161.24 m. $L=512$, $H=266$, $W=174$

Distribution.—Upper Miocene: reef hole (1).

Species No.—R(32).

Discussion.—Unfortunately, more specimens of this interesting species could not be found. It is closely related to *T. rugosa* from Clipperton Island and the Caribbean (Allison and Holden, 1971) differing in that it lacks strong marginal denticles and has continuous ridge structures on the posterolateral and anterolateral surfaces.

Genus *PARANESIDEA* Maddocks, 1969

Paranesidea victrix (Brady)

Plate 9, figures 7–9

Bairdia victrix Brady, 1869, *Fonds de la mer*, v. 1, p. 152, pl. 18, figs. 17, 18.

Brady, 1880, Rept. * * * Voyage * * * *Challenger*, Zoology, v. 1, p. 56, pl. 10, figs. 5a–d.

Puri, 1960, *Gulf Coast Assoc. Geol. Soc., Trans.*, v. 10, p. 131, pl. 6, fig. 13.

Bold, 1966a, *Caribbean Jour. Sci.*, v. 6, p. 45, pl. 1, fig. 6.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184338.	Adult carapace	R-338.94	1082	690	557
Hypotype					
USNM 184339.	Adult RV	R-338.94	1010	584	300
Hypotype					
USNM 184340.	Adult carapace	R-338.94	1068	673	511
Hypotype					
USNM 184341.	Adult LV	R-343.21	1105	703	364
Hypotype					
UCB 40517.	Adult LV	R-343.21	1005	661	333
Hypotype					
UCB 40518.	Adult carapace	R-338.48	1065	681	521

Distribution.—Lower Miocene: reef hole (18).

Species No.—R(94).

Discussion.—The Midway specimens are within the range of variation encountered when comparing one author with another. The distinctive faint puncta usually reported as covering the surfaces of the valves only occur on the midpart in the Midway specimens.

The species is widespread in the Southern Hemisphere, originally being described from off Sydney, Australia, Tristan da Cunha, and Kerguelen, (Brady, 1880), and also throughout the Caribbean region north to the Gulf of Mexico. Benson notes that in the eastern Gulf of Mexico the species is found in depths of 6 to 47 m but is most commonly found deeper than 20 m.

Paranesidea handeli Holden, n. sp.

Plate 8, figures 20–22

Diagnosis.—Anteromarginal and posteromarginal frills well developed; dorsal margin flat, horizontal; centrolateral surfaces flattened and posterolateral surfaces concave out (as seen dorsally).

Description.—Covered by large shallow pits except in areas corresponding to internal duplicatures; frills well developed on both valves along antero-margin and posteromargin; inferred females relatively higher. Lateral view: middorsum straight, horizontal; anterodorsum and posterodorsum slightly concave up; midventrum concave down. Dorsal view: centrolateral surfaces flattened; anterolateral surfaces concave out; ends pointed.

Internal features not observed.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype					
USNM 184342.	Adult carapace	R-343.21	950	545	405
Paratype					
USNM 184343.	Adult carapace	R-343.21	900	524	393
Holotype					
USNM 184344.	Adult carapace	R-343.30	941	519	390
Paratype					
USNM 184345.	Adult carapace	R-342.90	1025	549	416
Paratype					
USNM 184346.	Adult carapace	R-342.90	966	524	398
Paratype					
USNM 184347.	Adult carapace	R-337.72	1127	650	483
Paratype					
UCB 40519.	Adult carapace	R-337.72	1084	589	451
Paratype					
UCB 40520.	Adult LV	R-337.72	1050	663	---

Distribution.—Lower Miocene: reef hole (22).

Species No.—R (92).

Discussion.—Even though internal features were not observed, the distinctive external morphology and ornamentation of the species warrants its description as new.

Paranesidea algocola Maddocks, which is a living species in Madagascar, is closely related, but it differs in that it has a rounded ventral margin, evenly inflated sides, larger pits, and is somewhat smaller. This species is found living in the littoral zone on many varieties of calcareous and noncalcareous algae (Maddocks, 1969).

Named for George Frederick Handel.

Paranesidea sp. 1

Plate 9, figure 5

Types and dimensions.—

Specimen		Depth (m)	L	H	W
Specimen USNM 184348.	Adult LV	R-337.34	894	618	281
Specimen USNM 184349.	Adult carapace	R-341.38	814	524	442
Specimen UCB 40521.	Adult carapace	R-341.38	818	541	433

Distribution.—Lower Miocene: reef hole (4).

Species No.—R (93).

Discussion.—This species is similar to *Paranesidea victrix*, but is smaller and has better developed marginal denticles and a briefer middorsum. In addition, the surfaces of *P. sp. 1* are entirely covered with small shallow pits. The species may be a phenotypic variant of *Paranesidea victrix*.

Paranesidea sp. 2

Plate 9, figures 1-4, 6

Types and dimensions.—

Specimen		Depth (m)	L	H	W
Specimen USNM 184350.	Adult carapace	R-285.90	905	557	433
Specimen USNM 184351.	Adult carapace	R-287.12	896	594	448
Specimen USNM 184352.	Adult carapace (low form)	R-311.35	798	442	325
Specimen USNM 184353.	Adult LV (low form)	R-311.35	766	441	192
Specimen USNM 184354.	Adult carapace (high form)	R-313.64	820	484	350
Specimen UCB 40522.	Adult LV	R-284.68	890	566	284
Specimen UCB 40523.	Adult RV	R-284.68	898	512	241

Distribution.—Lower Miocene: reef hole (32).

Species No.—R (45).

Discussion.—The specimens are confined to two nearly adjacent intervals in the reef hole; from R-284.68 to R-288.65 m and from R-295.50 to R-317.37 m. Specimens from the higher section are larger and have a more evenly rounded dorsum (pl. 9, fig. 6) than those in the lower section (pl. 9, fig. 4). The smaller forms also differ by showing distinct high and low dimorphism. The species is not described because the specimens are poorly preserved.

Genus *BAIRDOPPILATA* Coryell, Sample, and Jennings, 1935

Bairdoppilata sp. aff. *B. bradyi* (Bold)

Plate 1, figures 1, 2; plate 9, figures 20, 21

Types and dimensions.—

		Depth (m)	L	H	W
Specimen USNM 184355.	Adult LV	S-44.20	994	596	277
Specimen USNM 184356.	Adult LV	KR-12.19	1025	635	329
Specimen USNM 184357.	Adult carapace	R-31.55	1065	650	500
Specimen UCB 40524.	Adult carapace (high form)	R-120.70	1066	647	530
Specimen UCB 40525.	Adult carapace (low form)	R-120.70	982	568	434

Distribution.—Holocene: Kure atoll lagoon (1). Pleistocene: Sand Island hole (38), reef hole (17). Post-Miocene: reef hole (4).

Species No.—S (8), R (2).

Discussion.—Bold (1966a) gave a good synonymy of *Bairdia bradyi*. In my opinion, several species are included in this *foveolata-bradyi* complex, but the Midway specimens are more like those described by Brady (1880) from the Pacific than those from the Caribbean described by Bold (1966a), Puri (1960), and Benson and Coleman (1963).

Bairdoppilata planolata Holden, n. sp. sensu stricto

Plate 9, figures 10-12

Diagnosis.—Caudal process narrow, extended, somewhat upturned; midsurfaces of carapace faintly pitted; greatest height in anterior half. Seen dorsally, lateral areas distinctly flattened and anterolateral and posterolateral surfaces straight to slightly concave.

Description.—Surfaces smooth except for small densely packed pits in midlateral areas. Lateral view: anterior margin flattened; ventral margin straight, sometimes having narrow flange in posterior part; anterodorsal and posterodorsal margins concave up; middorsal margin flattened but sloping posteriorly; caudal process pointed and extended; left valve overlap moderate. Dorsal view: sides distinctly flattened, parallel; anterior and posterior lateral areas concave to straight; ends pointed.

Duplication of moderate width; deep vestibules present.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype USNM 184358.	Adult carapace	R-284.00	954	538	393
Holotype USNM 184359.	Adult carapace	R-343.05	861	485	351
Paratype UCB 40526.	Adult RV	R-283.46	883	449	174
Paratype UCB 40527.	Adult LV	R-283.46	868	502	233

Distribution.—Lower Miocene: reef hole (9).

Species No.—R (46).

Discussion.—The three subspecies included under *Bairdoppilata planolata* can best be explained as phenotypic variants representing slight changes in

the environment. None of the three occur with each other in any one given sample, yet all have the same general stratigraphic range. *Bairdoppilata planolata ventrocaudata* only occurs between R-295.81 m and R-313.64 m, which represents the gap in the distribution of *B. p. planolata*.

The species bears a striking resemblance to *Bairdia antillea* (Miocene of Puerto Rico, see Bold, 1965) in side view, but not in dorsal view. *B. antillea* does not have flattened sides and is thinner.

Bairdoppilata planolata ventrocaudata Holden, n. sp., n. subsp.

Plate 9, figures 13-16

Diagnosis.—Larger and with more ventrally situated caudal process than *Bairdoppilata planolata* s.s. or *B. p. magnumcaudata*.

Description.—Carapace smooth. Caudal process very low on ventral margin; pointed and extended. Anterior margin high, up to two-thirds carapace height. Other features essentially like *B. planolata* s.s.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184360.	Adult LV	R-311.35	1190	632	298
Paratype					
USNM 184361.	Adult RV	R-311.35	1100	584	256

Distribution.—Lower Miocene: reef hole (6).

Species No.—R (60).

Bairdoppilata planolata magnumcaudata Holden, n. sp., n. subsp.

Plate 9, figures 17-19

Diagnosis.—Like *Bairdoppilata planolata* s.s., except wider and having very thick caudal process.

Description.—The subspecies closely resembles the type; exceptions are pointed out in the diagnosis above.

Type and dimensions.—Holotype USNM 184362. Adult carapace. R-311.81 m. $L=982$, $H=573$, $W=483$.

Distribution.—Lower Miocene: reef hole (1).

Species No.—R (69).

Discussion.—Only one entire specimen was found, and no internal features were observed. *Bairdoppilata planolata magnumcaudata* is named for its relatively large caudal process.

Subfamily BYTHOCYPRIDINAE Maddocks, 1969

Genus BYTHOCYPRIS Brady, 1880

Bythocypris? compressa Brady

Bythocypris? compressa Brady, 1880, Rept. *** Voyage *** Challenger, Zoology, 1, p. 46-47, pl. 35, figs. 5a-d.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184370.	Adult carapace	S-146.30	538	283	191
Hypotype					
USNM 184371.	Young carapace	S-146.30	466	234	155
Hypotype					
UCB 40530.	Adult carapace	S-146.30	554	268	190

Distribution.—Upper Miocene: Sand Island hole (3). Lower Miocene: reef hole (3).

Species No.—S (56), R (72).

Discussion.—The specimens are comparable with Brady's species from 18 fathoms off Tongabatu, South Pacific, but smaller. Presumably the Midway specimens are adults, but the level of maturity reached is not certain, as internal features were not observed.

Bythocypris reniformis Brady

Plate 1, figures 7, 12, 13, 17, 18

Bythocypris reniformis Brady, 1880, Rept. *** Voyage *** Challenger, Zoology, v. 1, p. 46, pl. 5, figs. 1a-1.

Maddocks, 1969, U.S. Natl. Mus. Bull. 295, p. 88, 90, text-figs 45j-m.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184372.	Adult RV	S-147.83	1180	550	168
Hypotype					
USNM 184373.	Young RV	S-147.83	750	342	142
Hypotype					
USNM 184374.	Adult carapace	R-321.86	1200	621	397
Hypotype					
USNM 184375.	Adult carapace	R-317.60	1150	589	356
Hypotype					
USNM 184376.	Adult carapace	R-172.21	1345	725	485

Distribution.—Upper Miocene: Sand Island hole (18); reef hole (2). Lower Miocene: reef hole (50).

Species No.—S (57), R (33).

Discussion.—The immature specimens have the proportions of *Bythocypris elongata* with a length twice that of the height. They are always associated with the larger *B. reniformis* types (when abundant) and so are considered the young of that species.

Compared with the forms illustrated by Brady (1880) and Maddocks (1969), the Midway specimens have a more obliquely undersloping anterior margin and distinct somewhat flattened tripartite dorsal margin segments; the anterodorsal and posterodorsal segments are symmetrical. In addition, Brady's figure is much more elongate posteriorly.

Genus ANCHISTROCHELES Brady and Norman, 1889

Anchistrocheles sp.

Plate 11, figures 1, 2

Type and dimensions.—Specimen USNM 184627. Adult RV. S-79.19 m. $L=466$, $H=233$, $W=97$

Distribution.—Pleistocene(?): Sand Island hole (1).

Species No.—S (26).

Family MACROCYPRIDIDAE Müller, 1912

Subfamily MACROCYPRIDINAE Müller, 1912

Genus MACROCYPRIUS Brady, 1868

Macrocypris? sp. aff. M.? dimorpha Hazel and Holden

Plate 10, figures 12-14, 19, 20

Macrocypris? dimorpha Hazel and Holden, 1971, U.S. Geol. Survey Prof. Paper 640-D, p. 6, pl. 5, figs. 8, 11, 13, 17, 19.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184363.	Adult carapace	-----R-320.95	593	346	250
Hypotype					
USNM 184364.	Adult carapace	-----R-343.05	680	350	267
Hypotype					
USNM 184365.	Adult carapace	-----S-44.20	652	333	250
Hypotype					
USNM 184366.	Adult carapace	-----R-162.76	672	347	265
Hypotype					
USNM 184367.	Adult carapace	-----R-320.95	590	351	242
Hypotype					
UCB 40528.	Young carapace	-----R-320.50	519	284	203

Distribution.—Pleistocene (?): Sand Island hole (2). Upper Miocene: reef hole (1). Lower Miocene: reef hole (26).

Species No.—S(9), R(34).

Discussion.—In size, general shape, and dimorphism, the species is closely related to the late Eocene (Tertiary *b*) *Macrocypris*? *dimorpha*. There are some consistent morphological differences between the two, the Midway specimens being more dorsally peaked and having a more concave venter. Internal features were not observed in either population, and it is best to group the two into one taxon.

The paleoenvironmental preference of the species at Tonga was considered to be upper bathyal (Hazel and Holden, 1971). The species occurs in various samples, especially between R-317.60 to R-343.81 m, but it is never abundant.

Genus *MACROCYPRINA* Triebel, 1960*Macrocyprina gracilis* (Brady)

Plate 10, figures 6, 7

Pontocypris gracilis Brady, 1890, Royal Soc. Edinburgh Trans., v. 35, p. 491, pl. 1, figs. 5, 6.

Macrocypris gracilis (Brady). Holden, 1967, Pacific Sci., v. 21, p. 16, 17, text-figs. 9a, b.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184368.	Adult carapace	-----R-317.90	970	390	300
Hypotype					
USNM 184369.	Adult carapace	-----R-317.90	924	432	299
Hypotype					
UCB 40529.	Adult RV	-----S-87.63	1015	468	233

Distribution.—Post-Miocene: Sand Island hole (8). Lower Miocene: reef hole (26).

Species No.—S(31), R(7).

Discussion.—The species is widespread in the central Pacific, occurring as a Cenozoic fossil in the Hawaiian Islands and Easter Island (Holden, 1967) and living in Fiji (Brady, 1890).

Post-Miocene adults in the Sand Island holes are larger than the early Miocene adults in the reef hole; however, their proportions are the same.

Superfamily CYPRIDACEA Baird, 1845

Family CYPRIDIDAE Baird, 1845

Subfamily CYPRIDOPSINAE Kaufman, 1900

Genus *POTAMOCYPRIS* Brady, 1870*Potamocypris*? sp.

Plate 10, figures 10, 11

Type and dimensions.—Specimen USNM 184377.

Adult carapace. S=73.46 m. L=580, H=293, W=142.

Distribution.—Pleistocene (?): Sand Island hole (1).

Species No.—S(27).

Discussion.—Only one entire specimen was found and no internal features were observed. On the basis of general morphology, it appears to be a freshwater Cypridid, probably a *Potamocypris*. The specimen occurs with *Cyprideis*, a genus of known euryhaline tolerances, and was probably redeposited by a stream flowing into the lagoon.

Subfamily PARACYPRIDINAE Sars, 1865

Genus *PARACYPRIS* Sars, 1865*Paracypris* sp. cf. *P. rosefeldensis* Howe and Law

Plate 10, figures 3, 4

Types and dimensions.—

		Depth (m)	L	H	W
Specimen					
USNM 184378.	Adult carapace	-----R-320.50	688	283	215
Specimen					
USNM 184379.	Adult carapace	-----R-317.91	694	285	217
Specimen					
UCB 40531.	Adult RV	-----R-320.50	694	285	130

Distribution.—Lower Miocene: reef hole (52).

Species No.—R(47).

Discussion.—The Midway specimens differ from the Vicksburg Oligocene *Paracypris rosefeldensis* primarily by having a concave posterodorsum and blunter anterior as seen dorsally. A similar species, also compared with *P. rosefeldensis*, is known from the Oligocene-Miocene of Puerto Rico (Bold, 1965).

Paracypris franquesi Howe and Chambers

Plate 10, figures 17, 18

Paracypris franquesi Howe and Chambers, 1935, Louisiana Geol. Survey Geol. Bull. 5, p. 10, 11, pl. 3, fig. 13; pl. 4, figs. 15, 19.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184380.	Adult carapace	-----R-320.35	772	300	225
Hypotype					
USNM 184381.	Adult RV	-----R-320.95	767	288	118

Distribution.—Lower Miocene: reef hole (3). Pleistocene (?): Sand Island hole (1).

Species No.—S(10), R(73).

Discussion.—Internally, the Midway specimen (pl. 10, fig. 17) has fewer radial pore canals than do the specimens from the Eocene of Louisiana. The species also occurs in the Oligocene of Cuba (Bold, 1946).

Genus *AGLAIOCYPRIS* Sylvester-Bradley, 1923*Aglaiocypris* sp.

Plate 10, figures 15, 16

Types and dimensions.—

		Depth (m)	L	H	W
Specimen					
USNM 184382.	Adult carapace	-----R-317.90	567	260	187
Specimen					
UCB 40532.	Adult carapace	-----R-317.90	560	258	190

Distribution.—Lower Miocene: reef hole (6).

Species No.—R(74).

Discussion.—This species is similar to *Aglaio-cypris croneisi* Teeter, (1966, p. 57), but is larger and has a flatter dorsum.

Genus PONTOCYPRELLA Lubimova, 1955

Pontocyrella? sp. 1

Plate 10, figures 1, 2

Types and dimensions.—

Specimen		Depth (m)	L	H	W
USNM 184383.	Adult carapace	-----R-321.87	566	228	188
Specimen					
USNM 184384.	Adult carapace	-----R-287.43	594	233	200
Specimen					
UCB 40533.	Adult carapace	-----R-320.96	600	245	283
Specimen					
UCB 40534.	Adult carapace	-----R-321.41	582	239	193

Distribution.—Lower Miocene reef hole (6).

Species No.—R(54).

Pontocyrella? sp. 2

Plate 10, figures 8, 9

Types and dimensions.—

Specimen		Depth (m)	L	H	W
USNM 184385.	Adult carapace	-----R-320.96	496	212	181
Specimen					
USNM 184386.	Adult carapace	-----R-320.96	491	203	174
Specimen					
USNM 184387.	Adult carapace	-----R-317.60	474	202	165
Specimen					
UCB 40535.	Adult carapace	-----R-317.60	471	203	175

Distribution.—Lower Miocene: reef hole (8).

Species No.—R(75).

Superfamily CYTHERACEA Baird, 1850

Family HEMICYTHERIDAE Puri, 1953

Subfamily HEMICYTHERINAE Puri, 1953

Genus HEMICYTHERE Sars, 1925

"Hemicythere" gordonii Bold

Plate 2, figures 3, 4

Hemicythere gordonii Bold, 1965, *Micropaleontology*, v. 11, no. 4, p. 392-393, pl. 5, figs. 7a, b.

Types and dimensions.—

Hypotype		Depth (m)	L	H	W
USNM 184424.	Adult carapace	-----R-308.46	669	344	267
Hypotype					
USNM 184425.	Adult LV	-----R-308.46	598	371	151
Hypotype					
UCB 40539.	Adult LV	-----R-308.46	600	340	150

Distribution.—Lower Miocene: reef hole (5).
Upper Miocene: Sand Island hole (1).

Species No.—S(62), R(64).

Discussion.—The Midway specimens are morphologically identical to *Hemicythere gordonii* figured by Bold (1965) from the Oligocene-Miocene of Puerto Rico except that in those from Midway the greatest width is just posterior to midlength instead of at midlength.

Genus CAUDITES Coryell and Fields, 1937

Caudites spp.

Plate 1, figure 10; plate 10, figure 5

Types and dimensions.—

Specimen		Depth (m)	L	H	W
USNM 184388.	Young RV	-----R-31.55	450	250	80
Specimen					
USNM 184389.	Adult RV	-----S-140.21	641	291	102

Distribution.—Post-Miocene: Sand Island hole (2).

Species No.—S(43), R(8).

Discussion.—In many ways one of these individuals (pl. 1, fig. 10) resembles a species of *Caudites* from the Galapagos Islands.

This genus is not common in the insular Pacific but is fairly widespread in the East Indies, Indian Ocean (McKenzie, 1967a), and the Caribbean.

Genus ORIONINA Puri, 1954

Orionina flabellacosta Holden, n. sp.

Plate 3, figures 5-7; plate 11, figure 6

Diagnosis.—Lateral ridges weakly developed; about five thin ridges flair out from subcentral swelling toward anterior margin; dimorphism pronounced. Duplication atypically lacking pillar structures; radial pore canals abundant, unbranched.

Description.—Lateral view: subquadrate; posterior margin subtruncate; ventral margin straight to slightly concave; dorsal outline undulating because of posterodorsal swelling. Ornamentation of poorly developed lateral ridges and shallow reticula, each of which contains small pits; ventrolateral and posterodorsal ridges best developed; about five thin ridges fanning out from subcentral swelling to anterior margin. Dimorphism pronounced with long (♂) and short (♀) forms. Dorsal view: greatest width in posterior third at posterodorsal swelling; subcentral swelling subdued; anterior blunt because of moderately developed rim.

Hinge holamphidont: left valve median bar smooth. Adductor-scar pattern basic vertical row of four; middle two scars divided; three frontal scars. Normal pores small, moderately abundant. Duplication narrow; many straight unbranched radial pore canals with median enlargements. Vestibules absent.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184390.	Adult♂ carapace	-----R-344.12	824	418	350
Paratype					
USNM 184391.	Adult♀ LV	-----R-343.30	774	468	165
Paratype					
USNM 184392.	Adult♀ LV	-----R-335.09	656	388	162
Paratype					
USNM 184393.	Adult♀ RV	-----R-344.12	655	366	83

Distribution.—Lower Miocene: reef hole (75).

Species No.—R(89).

Discussion.—*Orionina* is characteristically a Caribbean genus but does occur along the west coast of North America and in the Galapagos Islands (McKenzie, 1967a). This species is very distinct from others in the genus.

Genus *POKORNYELLA* Oertli, 1956*Pokornyella deformis* (Reuss)?

Plate 1, figure 4; plate 11, figures 7-9

Aurila deformis (Reuss). Bold, 1963a, Micropaleontology, v. 9, no. 4, p. 386, pl. 7, fig. 4.

Procythereis? deformis (Reuss)? Bold, 1965, Micropaleontology, v. 11, no. 4, p. 396, pl. 5, figs. 4a-b.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184394.	Adult ♂ carapace	-----R-300.59	767	486	375
Hypotype					
USNM 184395.	Adult ♀ carapace	-----R-300.59	641	435	367
Hypotype					
USNM 184396.	Adult ♀ RV	-----R-300.59	658	402	183
Hypotype					
USNM 184397.	Adult ♀ carapace	-----R-317.60	601	383	350
Hypotype					
UCB 40536.	Adult ♂ carapace	-----R-300.23	689	586	363
Hypotype					
UCB 40537.	Adult ♀ carapace	-----R-300.23	513	433	346

Distribution.—Lower Miocene: reef hole (55).

Species No.—R(41).

Discussion.—In the Caribbean the species is known from the lower to upper Miocene of Trinidad (Bold, 1963a) and lower Miocene of Puerto Rico (Bold, 1965). Though the Midway specimens vary considerably, some of them are morphologically identical with specimens of *P. deformis* from Puerto Rico. These specimens are identical with Bold's Caribbean species, but their relationship to *Cypri-dina deformis* Reuss (Reuss, 1850) is uncertain.

Pokornyella pseudojaponica Holden, n. sp. sensu stricto

Plate 2, figures 9-18; plate 11, figures 19-21

Diagnosis.—Highly arched, lenticular, deeply reticulate *Pokornyella* with dorsally overreaching left valve, curved ventral ridge, and brief posterodorsal ridge. Reticula bordering anterior margin especially large.

Description.—Lateral view: left valve broadly and highly arched, overreaching dorsally flattened right valve; caudal process usually small, short, near venter margin, concave above; venter sinuous to slightly rounded. Ornamentation of large deep pits (or small deep reticulations), those paralleling the anterior margin being much larger. Low ventral ridge sometimes posteriorly enlarged as alar structure; brief posterodorsal ridge usually present. Dorsal view: lenticular, ends pointed; greatest width at or just posterior to midlength, alae sometimes projecting.

Nonvestibulate; radial pore canals fairly abundant, about 24 anteriorly, without enlargements, simple, straight. Hinge amphidont, median bar smooth, teeth not heavy; normal pores abundant, coinciding with large internal pits. Four adductor scars, two frontal scars; large muscle-attachment boss dorsal to subcentral area.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184398.	Adult carapace	-----S-147.37	778	473	221
Paratype					
USNM 184399.	Adult carapace	-----R-172.21	749	498	440
Paratype					
USNM 184400.	Adult carapace	-----R-172.21	774	462	468
Paratype					
USNM 184401.	Adult RV	-----R-171.91	680	391	468
Paratype					
USNM 184402.	Adult RV	-----S-147.37	734	419	240
Paratype					
USNM 184403.	Adult RV	-----S-147.37	708	425	250
Paratype					
USNM 184404.	Adult LV	-----S-140.21	716	483	234
Paratype					
USNM 184405.	Adult LV	-----S-149.66	830	549	233
Paratype					
USNM 184406.	Adult carapace	-----R-160.63	783	473	424
Paratype					
USNM 184407.	Adult RV	-----S-140.21	683	388	200
Paratype					
USNM 184408.	Adult carapace	-----R-161.24	636	400	383

Distribution.—Post-Miocene: Sand Island hole (50). Upper Miocene: Sand Island hole (120). Lower Miocene: reef hole (60).

Species No.—S(33), R(24).

Discussion.—Closely related to *Pokornyella calix* (lower Chattian, Switzerland) described by Oertli (1956) and *P. japonica* (Holocene, Japan) of Ishizaki (1968) in shape and ornamentation. All three species have the enlarged anteromarginal reticulations. *Pokornyella pseudojaponica* differs primarily from the Oligocene species by having a ventral and posterodorsal ridge and from *P. japonica* by lacking the horizontal lateral ridges. *Aurila* sp. aff. *A. cicatricosa* of Bold (1966b) (Pliocene, Venezuela) is also a similar species but appears to lack the *Pokornyella*-type caudal process.

Pokornyella pseudojaponica inflata Holden, n. sp., n. subsp.

Plate 11, figures 10, 11

Diagnosis.—Like *P. pseudojaponica* s.s., but greatly inflated and lacking the ventral and posterodorsal ridges and almost all the caudal process.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184409.	Adult carapace	-----S-138.23	784	528	496
Paratype					
USNM 184410.	Adult carapace	-----S-138.23	750	510	483
Paratype					
UCB 40538.	Adult carapace	-----S-140.21	702	466	458

Distribution.—Upper Miocene: Sand Island hole (16).

Species No.—S(34).

Discussion.—Toward the end of its range at Midway Island, *Pokornyella pseudojaponica* rapidly becomes highly inflated. This change begins at S-140.21 m and continues at S-138.23 m. At S-135.94 and S-135.65 only the inflated subspecies is found.

Genus *RADIMELLA* Pokorny, 1968*Radimella convoluta* (Brady)

Plate 2, figure 1; plate 11, figures 14, 15

Cythere convoluta Brady, 1868, Ann. and Mag. Nat. History, ser. 4, v. 2, no. 9, p. 182, pl. 12, figs. 3, 4.

Brady, 1880, Rept. * * * Voyage * * * *Challenger*, Zoology, v. 1, p. 92, pl. 22, figs. 3a-d.
Mutilus? aff. *M.?* *oahuensis* Holden. Resig, 1969, Univ. Hawaii Inst. Geophys., HIG-69-2, pl. 9, fig. 7.

Diagnosis.—Dorsolateral ridge continuous with ventrolateral ridge around posterior forming right angle in posterodorsum; four other parallel lateral ridges trend toward anterior in ventral half.

Description.—Lateral view: carapace subquadrate; greatest height at anterocardinal angle; ventral margin straight; dorsal margin straight to slightly arched; posterior margin subtruncate with low brief caudal process. Ornamentation of unbroken anteriorly sloping dorsolateral ridge bending through 90° at the posterodorsum to form a vertical posterior ridge which continues with a long curved ventral ridge; four subparallel centrolateral ridges sloping to ventral half of anterior. Light reticula between ridges. Dorsal view: anterior and posterior blunt; carapace evenly inflated; greatest width central.

Hinge apparently holamphidont; median bar of left valve smooth. Nonvestibulate duplicature traversed by many radial pore canals (75–100± in anterior), most with midswellings. Four adductor muscle scars in vertical row with the middle two divided; three small frontal scars.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184411.	Adult carapace	S-73.46	710	438	338
Paratype					
USNM 184412.	Adult carapace	S-73.46	670	420	322
Paratype					
USNM 184413.	Adult broken LV	S-73.46	---	425	175

Distribution.—Pleistocene(?): Sand Island hole (13); reef hole (4).

Discussion.—The species was also found by J. E. Hazel (in Resig, 1969) in the Pleistocene from the subsurface at Hawaii at -660.3 feet (-198 m).

Radimella convoluta occurs intermittently in the Pleistocene(?) of the Sand Island borehole from S-45.11 m to S-78.63 m and in the reef borehole only at R-89.46 m. It is probably derived from *Radimella polycosta*, which is last found in the upper Miocene in both boreholes at S-138.23 m and R-158.34 m. *Radimella convoluta* differs from *R. polycosta* by lacking two of the concentric anterolateral ridges and by having an entire dorsolateral ridge; otherwise the two species appear similar.

Radimella polycosta Holden, n. sp., sensu stricto

Plate 1, figures 8, 9; plate 2, figure 2; plate 11, figure 13

Diagnosis.—Lateral surface ornamented by eight horizontal ridges: top ridge short, second ridge down sinuous, third ridge down short and located in an-

terior half of valve, ridges seven and eight down in the ventrolateral area continue into anterolateral area and parallel the anterior margin.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype					
USNM 184414.	Adult carapace	R-308.46	617	392	303
Paratype					
USNM 184415.	Adult carapace	R-308.76	672	403	343
Holotype					
USNM 184416.	Adult LV	S-140.21	618	367	160
Paratype					
USNM 184417.	Adult LV	S-140.21	594	361	148

Distribution.—Upper Miocene: Sand Island hole (3); reef hole (26). Lower Miocene: reef hole (11).

Species No.—S(39), R(26).

Description.—Lateral view: subquadrate; straight dorsum almost parallel to straight venter; caudal process stubby; anterior slightly obliquely rounded; 7–11 horizontal lateral ridges of which the dorsal three always short; two anterior concentric lateral ridges; two anterior marginal ridges; small reticula between ridges; eye tubercles prominent. Dorsal view: lenticular; ends bluntly pointed; sides flattened; posterior depression between elevated dorsal ridges.

Hinge holamphidont; median left valve bar smooth. Duplicature of moderate width, nonvestibulate; many radial pore canals with small midswellings, tendency to be paired; normal pores very small. Four entire adductor scars in vertical row; two circular frontal scars.

Discussion.—See *Radimella resigi*.

Radimella polycosta rugosa Holden, n. sp., n. subsp.

Plate 2, figures 6, 7; plate 11, figure 16

Diagnosis.—Like *Radimella polycosta* s.s. but having much heavier lateral ridges and more inflated carapace.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184418.	Adult ♀ LV	R-173.28	621	375	207
Paratype					
USNM 184419.	Adult ♀ RV	R-173.28	590	344	167
Paratype					
USNM 184420.	Adult ♂ RV	R-173.28	639	360	160

Distribution.—Lower Miocene: reef hole (23).

Species No.—R(36).

Genus AURILA Pokorny, 1955

Aurila sp. aff. *A. lincolniensis* (LeRoy)

Plate 2, figure 8; plate 11, figure 12; plate 16, figure 22

Types and dimensions.—

		Depth (m)	L	H	W
Specimen					
USNM 184421.	Adult LV	R-321.87	499	311	135
Specimen					
USNM 184422.	Adult carapace	R-320.65	495	321	235
Specimen					
USNM 184423.	Adult carapace	S-152.25	557	350	232

Distribution.—Upper Miocene: Sand Island hole (9). Lower Miocene: reef hole (20).

Species No.—S(63), R(65).

Discussion.—The species is very similar to *Aurila laevicula* (Edwards, 1944) from the Miocene of the United States East coast and Caribbean (Bold, 1963a) and to *A. lincolnensis* from Pliocene to Holocene of California and Baja California (Benson, 1959). Subtle differences in shape and ornamentation separate these two from the Midway species.

The one specimen from which good musculature was preserved shows three frontal scars and two of the adductors divided. This pattern is typical for *Aurila*.

Aurila sp.

Plate 11, figures 17, 18

Type and dimensions.—Specimen USNM 184426. Adult RV. R=73.46 m. L=534, H=317, W=109.

Distribution.—Pleistocene(?): Sand Island hole (1).

Species No.—S(24).

Genus *PROCYTHEREIS* Skogsberg, 1928

"*Procythereis*" *northpacifica* Holden, n. sp.

Plate 2, figures 19–21

Diagnosis.—Strongly alate; sides flattened; ornamentation lacking to deeply but sparsely pitted; few random tubercles.

Description.—Lateral view: subquadrate; venter straight; dorsum straight to slightly rounded; posterior truncate; anterior slightly rounded; surfaces with shallow to deep sparse large round pits, some specimens apparently smooth; alae along ventral midhalf of valve smooth; eye tubercles distinct. Dorsal view: arrowhead shaped; greatest width in posterior three-quarters; posterior and anterior lateral areas compressed; dorsum and anterior heavily rimmed.

Hinge holamphidont; posterior tooth of right valve reniform; median bar of left valve smooth. Normal pores abundant, deep; duplicature moderate width. Four undivided adductor scars; two frontal scars.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype					
USNM 184429.	Adult LV	S-147.37	718	423	233
Paratype					
USNM 184430.	Adult RV	S-147.37	714	409	228
Holotype					
USNM 184431.	Adult carapace	S-152.40	662	415	432

Distribution.—Upper Miocene: reef hole (26); Sand Island hole (32).

Species No.—S(44), R(21).

Discussion.—The species has a strong resemblance to members of the genus *Nephokirkos* (Howe, 1951) except that it lacks a distinct caudal process.

Together with *Nephokirkos*? sp. of Hazel and Holden (1971) from the Eocene of Tonga, it probably represents a distinct genus. Another closely related species from Bass Strait, Australia, has been seen by the writer.

Subfamily COQUIMBINAE Ohmert, 1968

Genus MUELLERINA Bassiouni, 1965

Muellerina? sp.

Plate 5, figures 17, 18

Types and dimensions.—

		Depth (m)	L	H	W
Specimen					
USNM 184427.	Adult carapace	R-311.35	613	326	242
Specimen					
USNM 184428.	Adult carapace	R-311.81	600	319	251

Distribution.—Lower Miocene: reef hole (4).

Species No.—R(66).

Subfamily THAEROCYTHERINAE Hazel, 1967

Genus QUADRACYTHERE Hornibrook, 1953

Quadracythere trijugis Holden, n. sp.

Plate 3, figures 14, 15; plate 5, figure 24; plate 12, figure 9

Diagnosis.—Slightly concave venter and parallel dorsum; caudal process concave above and below, at midheight; several discontinuous lateral ridges and small to large reticula.

Description.—Lateral view: subquadrate; venter slightly concave, parallel to slightly arched dorsum, anterior bluntly rounded; pointed caudal process, at midheight, concave above and below; several semi-horizontal discontinuous lateral ridges; long curved alar ridge divided; posterodorsal ridge complex, prominent; various-sized reticula between ridges. Dorsal view: anterior blunt; anterior and posterior lateral surfaces compressed; equally wide along midhalf with median sulcus at midlength.

Hinge holamphidont; median bar of left valve lightly crenulate; posterior tooth of right valve reniform. Duplicature nonvestibulate, of moderate width; many simple straight radial pore canals with small midswellings. Four adductor scars; two small circular frontal scars.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184432.	Adult carapace	S-140.21	783	466	583
Paratype					
USNM 184433.	Adult carapace	R-326.14	710	433	386
Paratype					
USNM 184434.	Adult LV	S-140.21	734	436	192
Paratype					
USNM 184435.	Young RV	S-140.21	586	323	148

Distribution.—Upper Miocene: Sand Island hole (3). Lower Miocene: reef hole (1).

Species No.—S(45), R(59).

Discussion.—The late Miocene specimens have two well-developed ridges on the subcentral swelling reminiscent of many species of *Jugosocythereis*. These are barely discernible on the single early Mio-

cene specimen from the reef hole, which is also more evenly reticulate like *Q. aequabilis* from which this species probably originated. The immature individuals from the upper Miocene (pl. 5, fig. 24) closely resemble adults of *Q. spica* from the lower Miocene (pl. 5, figs. 22, 25).

Name.—*tri* = three, *jugis* = linked in a team, referring to the three closely related, and probably consecutively derived, species of *Quadracythere* at Midway.

Quadracythere aequabilis Holden, n. sp.

Plate 17, figures 11–14

Diagnosis.—Like *Q. trijugis*, but devoid of lateral ridges; reticula heavily and evenly distributed, fanning out from subcentral swelling in anterolateral area; alar ridge poorly developed or absent; posterodorsal tubercle brief to large and bulbous.

Description.—Lateral view: venter concave at in-turned area, broadly convex in posterior part with well-developed flangelike ridge; dorsum straight to gently rounded, subparallel with venter; brief caudal process at midheight; surface evenly and deeply reticulate, fanning out from subcentral swelling toward anterior margin; ventral alae absent to poorly developed, small posteroventral tubercle always present; small posterodorsal tubercle sometimes greatly enlarged into bulbous structure. Dorsal view: sublenticular; ends blunt; anterolateral and posterior surfaces compressed; greatest width in posterior third.

Hinge holamphidont, median bar faintly crenulate. Duplicature rather narrow, nonvestibulate; radial pore canals abundant, about 35 in anterior, each with small midswelling. Abundant normal pores forming distinct internal pits. Four adductor scars; two small round frontal scars.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype					
USNM	184436.	Adult ♂ carapace	-----R-320.35	739	448 385
Paratype					
USNM	184437.	Adult ♂ LV	-----R-320.35	738	456 194
Paratype					
USNM	184438.	Adult ♀ carapace	-----R-320.35	699	434 400
Holotype					
USNM	184439.	Adult ♀ carapace	-----R-336.58	708	433 370
Paratype					
UCB	40540.	Adult ♂ carapace	-----R-338.12	820	476 376

Distribution.—Lower Miocene: reef hole (49).

Species No.—R(85).

Discussion.—In the younger part of its range most of the specimens have greatly inflated posterodorsal and posteroventral tubercles. These features may represent responses to local environmental changes, as other specimens of the same species in the same sample are quite lenticular.

The pattern of ornamentation of *Q. aequabilis*, especially with the fanning out of reticula on the anterior surface, indicates close affinities and probably direct ancestry to *Q. trijugis* higher in the section and descent from *Q. spica* lower in the section.

Name.—*aequabilis* = uniform, equitable, referring to the even reticulate pattern, which is the dominant ornamentation.

Quadracythere spica Holden, n. sp.

Plate 5, figures 22, 25

Diagnosis.—*Loxoconcha*-form; evenly reticulate, without lateral ridges; posterodorsal and posteroventral spikelike tubercles.

Description.—Lateral view: dorsum straight; venter sinuous; well-developed caudal process in lower half, concave above; ventral alae absent; posterodorsal and posteroventral tubercles spikelike, large; surface evenly reticulate, fanning out in all directions from subcentral tubercle; eye tubercle prominent. Dorsal view: terminally blunt; anterolateral and posterolateral areas compressed; greatest width at posteroventral tubercle.

Types and dimensions.—

			<i>Depth (m)</i>	<i>L</i>	<i>H</i>	<i>W</i>
Paratype						
USNM	184440.	Adult LV	-----R-343.05	673	384	182
Holotype						
USNM	184441.	Adult carapace	-----R-343.30	618	358	316
Paratype						
UCB	40541.	Adult carapace	-----R-343.30	612	338	290

Distribution.—Lower Miocene: reef hole (3).

Species No.—R(99).

Genus *JUGOSOCYTHEREIS* Puri, 1957

Jugosocythereis canaliculata Holden, n. sp. sensu stricto

Plate 4, figure 22, 23; plate 12, figure 8; plate 14, figure 16

Diagnosis.—Covered with narrow furrows or coalesced reticula; elongate alae prominent; subcentral and posterodorsal tubercles poorly developed.

Description.—Lateral view: dorsum and venter slightly rounded; ventral caudal process straight to somewhat concave above; anterior faintly flattened in dorsal part; surface covered with narrow grooves aligned vertically in posterior, sloping posteriorly on alae, sloping anteriorly elsewhere; large alae slightly curved; eye tubercles prominent. Dorsal view: arrow shaped; anterior blunt; posterior compressed, pointed.

Hinge amphidont; left valve median bar smooth; right valve terminal tooth reniform. Nonvestibulate; radial pore canals abundant, unbranched, with median swellings. Four adductor scars, the middle two divided; two circular frontal scars.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184442.	Adult LV	S-45.11	586	325	183
Paratype					
USNM 184443.	Adult carapace	S-45.11	632	327	365
Paratype					
USNM 184444.	Adult carapace	R-22.25	622	353	374
Paratype					
UCB 40542.	Adult LV	R-138.32	616	360	200

Distribution.—Pleistocene(?): Sand Island hole (20); reef hole (1). Post-Miocene: reef hole (1).

Species No.—S(11), R(3).

Discussion.—Internal features and distinctive ornamentation indicate a close relationship to the late Cenozoic *J. venulosus* from the Hawaiian Islands (Holden, 1967). That species, however, is trituberculate, whereas *J. canaliculata* has only the alae well developed.

Name.—*canaliculata* (L.) = grooved.

Jugosocythereis canaliculata reticulata Holden, n. sp., n. subsp.

Plate 4, figures 1–5; plate 12, figure 20

Diagnosis.—Like *J. canaliculata* s.s., but grooves broken up into elongate reticulæ; alae much less developed.

Types and dimensions.—

		Depth (m)	L	H	W
Holotype					
USNM 184445.	Adult LV	S-86.87	631	364	176
Paratype					
USNM 184446.	Adult RV	S-86.87	634	346	170
Paratype					
USNM 184447.	Adult carapace	S-97.84	582	334	288
Paratype					
USNM 184448.	Adult carapace	S-90.37	659	399	340
Paratype					
USNM 184449.	Adult carapace	S-90.37	611	336	324
Paratype					
USNM 184450.	Adult LV	S-91.14	600	342	181

Distribution.—Pleistocene(?): Sand Island hole (850); reef hole (27).

Species No.—S(32), R(18).

Discussion.—Extremely abundant in the Sand Island hole between S-85 m and S-98 m in fauna S., often accounting for as much as 90 percent of the fauna.

Jugosocythereis lactea (Brady)

Plate 3, figures 22, 23; plate 12, figures 15–17

Cythere lactea Brady, 1866, Zool. Soc. [London] Trans., v. 5, p. 377, pl. 60, figs. 3a–c.

Brady, 1880, Rept. *** Voyage *** Challenger, Zoology, v. 1, p. 91, pl. 22, figs. 1a–d.

Chapman, 1914, Royal Soc. Victoria Proc., new ser., v. 27, p. 36, pl. 6, fig. 15.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184451.	Adult RV	S-73.46	540	303	173
Hypotype					
USNM 184452.	Adult carapace	S-74.22	582	326	314
Hypotype					
USNM 184453.	Adult carapace	R-31.55	562	339	188
Hypotype					
USNM 184454.	Adult LV	S-73.46	584	355	170

Distribution.—Pleistocene(?): Sand Island hole (8); reef hole (2).

Species No.—S(1), R(9).

Discussion.—This species was originally reported by Brady (1866) off Australia at 17 fm and again (1880) at lat 40°S. in the mid-Pacific at 420 fm. Specimens from the mid-Pacific location are probably in redeposited material. Surprisingly, I have found the species abundant at the Line Islands, Fiji, New Caledonia, and Australia. A small species, it was probably overlooked by Brady in prolific samples or else considered a young of *Jugosocythereis deltoides*, which almost always is associated with it.

Chapman (1914) reported the species at 310–320 and 562–564 feet in the Funafuti drill holes. The age of the Funafuti section is Pleistocene to Holocene (Ladd and others, 1970) and not Miocene, as originally believed.

Jugosocythereis pannosa (Brady)

Plate 3, figures 17–21; plate 12, figure 14

Cythere pannosa Brady, 1869, Fonds de la mer, v. 1, p. 154, pl. 19, figs. 1, 2.

Cythereis vicksburgensis Howe and Law, 1936, Louisiana Geol. Survey Geol. Bull. 7, p. 34, pl. 4, fig. 4, pl. 5, figs. 1, 2. Bold, 1946, Amsterdam, p. 89, pl. 10, fig. 5.

Cythereis bicarinata Swain, 1946, Jour. Paleontology, v. 20, no. 4, p. 376, pl. 54, figs. 7a–d; pl. 55, figs. 1a–e.

Hermanites? pannosa (Brady). Bold, 1957, Micropaleontology, v. 3, no. 3, p. 240, pl. 2, fig. 2.

Jugosocythereis bicarinata (Swain). Puri, 1957, Florida Geol. Survey Bull. 38, p. 200, pl. 12, figs. 11–20.

Jugosocythereis vicksburgensis (Howe and Law). Bold, 1963a, Micropaleontology, v. 9, no. 4, p. 388, 389, pl. 7, fig. 6.

Jugosocythereis pannosa (Brady). Bold, 1966a, Caribbean Jour. Sci., v. 6, no. 1–2, p. 47, pl. 1, fig. 11.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM 184471.	Adult carapace	R-355.09	648	383	380
Hypotype					
USNM 184472.	Adult carapace	R-355.09	671	386	397
Hypotype					
USNM 184473.	Adult carapace	R-355.09	653	400	364
Hypotype					
USNM 184474.	Adult carapace	R-343.30	658	410	393
Hypotype					
USNM 184475.	Adult carapace	S-149.05	668	410	400
Hypotype					
USNM 184476.	Adult LV	S-152.40	653	394	202

Distribution.—Upper Miocene: Sand Island hole (4). Lower Miocene: reef hole (19).

Species No.—S(58), R(87).

Discussion.—This species is known from the Oligocene to Holocene in the Caribbean-gulf coast region of North America. At Midway, the late Miocene specimens have fewer reticulations than the early Miocene specimens and the bladeliike lateral ridges are more subdued.

Genus *TENEDOCYHERE* Sissingh, 1972

Tenedocythere turda Holden, n. sp.

Plate 1, figure 11; plate 12, figures 6, 7

Diagnosis.—Large; highly inflated; large equal

reticula; faint lateral ridges on subcentral tubercle; long thin dorsolateral ridge.

Description.—Highly inflated; covered with large shallow reticula. Lateral view: subquadrate; straight dorsum almost parallel with straight venter; anterior finely denticulate, slightly flattened in upper part; posterior blunt with five short spines in ventral half, concave in upper half. Entirely covered with large equal shallow reticulations. Ventrolateral and posterolateral ridges thin, long; faint ridges in subcentral area; small posterolateral ridge. Dorsal view: length about 1.75 times width; equally wide along midhalf; terminally blunt.

Hinge amphidont, median bar smooth. Nonvestibulate; radial pore canals straight, unpaired, some with median swellings, about 20–25 anteriorly. Normal pores moderately abundant, forming internal pits; four adductors; two frontal scars.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype USNM	184455.	Young RV -----	R-338.94	749	456 263
Holotype USNM	184456.	Adult carapace -----	R-317.37	940	575 542
Paratype USNM	184457.	Adult LV -----	R-317.37	880	500 250
Paratype USNM	184458.	Adult carapace -----	R-296.66	828	467 463
Paratype UCB	40543.	Adult carapace -----	R-296.66	842	483 484

Distribution.—Lower Miocene: reef hole (25).

Species No.—R(61).

Discussion.—This species is related to "*Cythere prava*" of Brady (1880) from the Admiralty Islands (= *Bradleya* sp. a of Apostolescu (1967) from New Caledonia). The stratigraphically higher specimens at R-296.66 m are more like the Holocene "*Cythere prava*" than those at R-317.37 m. Instead of prominent midlateral ridges, however, they have three (one weak), not two, subcentral ridges and an unbroken midlateral ridge. Seen dorsally, the modern species appears sulcate because of its broken ridge.

Name.—*turda* (L.) = plump, stout.

Tenedocythere quadranodosa Holden, n. sp.

Plate 5, figures 19–21; plate 12, figures 10–12

Diagnosis.—Straight venter and dorsum converging posteriorly; four large nodes; subcentral, posterodorsal, posteroventral, and posterolateral, equally developed; outer anteromarginal ridge set back on lateral surface.

Description.—Lateral view: subquadrate wedge-shaped; dorsum and ventrum straight, converging posteriorly; anterior finely denticulate, broadly rounded, slightly flattened dorsally; posterior truncate; surface reticulate; four equally large tubercles at subcentral area, ventral and dorsal posteriors and in posterolateral area; subcentral node surmounted by three faint ridges; two anterior ridges with large reticula between, outermost ridge set back on lateral

surface. Dorsal view: greatest width at subcentral tubercle; bluntly pointed at ends.

Hinge holamphidont, median bar smooth. Nonvestibulate; radial pore canals simple, straight, without midswellings, about 25 anteriorly; four adductor scars; two frontal scars.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype USNM	184459.	Adult LV -----	S-141.73	748	467 226
Holotype USNM	184460.	Adult RV -----	S-141.73	774	450 209
Paratype USNM	184461.	Adult LV -----	S-140.21	752	473 228
Paratype USNM	184462.	Adult LV -----	S-140.21	734	467 217
Paratype UCB	40544.	Adult LV -----	S-140.21	770	447 216

Distribution.—Upper Miocene: Sand Island hole (27).

Species No.—S(46).

Discussion.—Similar in basic morphology to *Tenedocythere turda* and "*Cythere prava*" of Brady (1880) except not as inflated, and the various lateral ridges are locally coalesced into four distinct tubercles.

Tenedocythere setigera Holden, n. sp.

Plate 2, figure 5; plate 3, figures 8–13; plate 5, figure 23; plate 12, figure 13

Diagnosis.—Short low incomplete ridges variably developed over lightly reticulate surface; some pustules. Anteromarginal rim and subcentral tubercle weakly developed.

Description.—Carapace subquadrate, dorsal margin and ventral margins slightly converging posteriorly. Posterior subtruncate; caudal process near venter, with three terminal spines and four larger spines along posteroventer. Surface shallow to deeply reticulate with about six pustules, sometimes having weak, discontinuous anteroventrally trending ridges, especially on subcentral tubercle. Alae well developed, thin.

Hinge holamphidont, terminal teeth of right valve smooth; median bar of left valve smooth. Radial pore canals simple, about 20 anteriorly, 20 posteriorly, forming fan-shaped spray in caudal area. Four adductor scars on side of subcentral depression; two frontal scars. Prominent boss above frontal scars.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype USNM	184463.	Adult LV -----	R-343.30	683	420 200
Paratype USNM	184464.	Adult carapace -----	R-343.30	733	422 386
Holotype USNM	184465.	Adult LV -----	R-338.94	672	408 192
Paratype USNM	184466.	Adult? RV -----	R-309.46	619	365 206
Paratype USNM	184467.	Adult carapace -----	R-311.37	678	415 368
Paratype USNM	184468.	Adult carapace -----	R-296.66	670	408 400
Paratype USNM	184469.	Adult carapace -----	R-320.65	636	391 366
Paratype USNM	184470.	Adult carapace -----	R-320.65	608	374 349
Paratype UCB	40545.	Adult carapace -----	R-338.94	610	387 350

Distribution.—Lower Miocene: reef hole (136).

Species No.—R (62).

Discussion.—*Tenedocythere setigera* is highly variable in the reef hole section between 325 and 345 m; one variant resembles "*Procythereis*" *north-pacifica* in some respects. (See pl. 3, figs. 12, 13.) Two forms within the same sample often show a gradation, which indicates that they are all the same species.

Genus HERMANITES Puri, 1955

Hermanites hawaiiensis Holden, n. sp.

Plate 5, figure 13

Hermanites sp. Holden, 1967, Pacific Sci., v. 21, no. 1, p. 42, 43, text-figs. 32a-c.

Diagnosis.—Dorsal margin straight; well-developed ridge from posterodorsal tubercle to ventral ridge; ornamentation of well-defined, evenly spaced reticulations radiating out in all directions from prominent isolated subcentral tubercle. In dorsal view, three knobs stand out: subcentral tubercle, posterodorsal tubercle, and terminal ala.

Description.—The description for *Hermanites* sp. by Holden (1967) applies here.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype USNM	184477.	Adult carapace -----R-300.59	568	323	273
Paratype USNM	184478.	Adult carapace -----S-91.14	580	337	297
Holotype USNM	184479.	Adult LV -----S-91.14	584	335	169
Paratype UCB	40546.	Adult carapace -----R-306.32	500	298	243

Distribution.—Pleistocene(?): Sand Island hole (3). Lower Miocene: reef hole (5).

Species No.—S (25), R (42).

Discussion.—This species was originally described from drowned terraces of late Cenozoic age around the Hawaiian Islands (Holden, 1967).

The species is derived from *Hermanites prae-hawaiiensis* in the lower Miocene. Specimens of both species occur in R-306.32 m, but are poor examples, as they show transitional characters. Closely related to *H. hornibrooki* (Puri), late Miocene to Holocene, in the Caribbean (see Bold, 1968), but has a blunter posterior, more evenly developed alae, and an irregular dorsolateral riblet. The Midway and Hawaiian species is also larger.

Hermanites prae-hawaiiensis Holden, n. sp.

Plate 5, figures 10-12, 14-16

Diagnosis.—Dorsal margin slightly rounded; alae poorly developed, nonextended; surfaces randomly and sparsely pitted; posterodorsal to ala ridge absent; otherwise like *H. hawaiiensis*.

Description.—In lateral view: carapace subquad-

rate; anterior slightly obliquely rounded with many small denticles near valve edge; posterior subtruncate; dorsum gently rounded; venter straight; subcentral and posterodorsal tubercles prominent; alae weak; surfaces having large random sparse pits; oblique dorsolateral riblet extending to dorsum. In dorsal view: anterior and posterior blunt; greatest width at subcentral tubercles; posterodorsal tubercles also extended; alae barely visible or imperceptible. Internal features not observed.

Types and dimensions.—

		Depth (m)	L	H	W
Paratype USNM	184480.	Adult carapace -----R-343.30	584	318	277
Paratype USNM	184481.	Adult carapace -----R-343.30	582	333	257
Paratype USNM	184482.	Adult carapace -----R-343.30	601	356	283
Holotype USNM	184483.	Adult carapace -----R-321.87	600	350	283
Paratype USNM	184484.	Adult carapace -----R-336.27	632	352	274
Paratype USNM	184485.	Adult carapace -----R-311.35	572	322	267
Paratype UCB	40547.	Adult carapace -----R-320.35	498	290	225

Distribution.—Lower Miocene: reef hole (105).

Species No.—R (67).

Discussion.—This species is closely related to *Hermanites tosaensis* (Ishizaki, 1968, 1969), living species in southern Japan. The two species are similar in side view except that *H. prae-hawaiiensis* lacks the stout vertical subocular ridge and the connecting ridge between the posterocardinal angle and posterior part of the ventral ridge. Dorsal comparisons could not be made.

Hermanites prae-hawaiiensis lived early at Midway, being first found at R-336.96 m, but quickly evolved into *H. hawaiiensis* which is first recognized at R-306.32 m, also in the lower Miocene, and was still present in the post-Miocene (Pleistocene) at S-73.46 m. Presumably *H. prae-hawaiiensis* came from the Asian coast where the closely related *H. tosaensis* still lives.

Hermanites tschoppi (Bold)

Plate 4, figures 6-9, 15; plate 12, figure 5; plate 13, figures 3, 4

Cythereis tschoppi Bold, 1946, Amsterdam, p. 93 (part), pl. 10, figs. 14a, b.

Hermania reticulata Puri, 1954, Florida Geol. Survey Bull. 36, p. 267, pl. 11, figs. 8, 9, text-figs. g, h.

Hermanites haidingeri (Reuss). Bold, 1957, Micropaleontology, v. 3, no. 3, p. 239, pl. 2, figs. 1a, b (not *Cypridina haidingeri* Reuss, 1850).

Hermanites sp. aff. *H. paijenborchiana* Keij. Bold, 1960, Micropaleontology, v. 6, no. 2, p. 170, pl. 8, fig. 10.

Hermanites fungosa Butler, 1963, Louisiana Geol. Survey Geol. Bull. 39, p. 63, pl. 4, figs. 4-6.

Hermanites tschoppi (Bold). Bold, 1965, Micropaleontology, v. 4, no. 1, p. 398, pl. 6, figs. 2a, b.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM 184486.	Adult ♂	LV	-----S-141.73	711	369	183
Hypotype						
USNM 184487.	Adult ♀	carapace	-----S-147.37	685	390	360
Hypotype						
USNM 184488.	Adult ♀	LV	-----R-344.37	374	362	146
Hypotype						
USNM 184489.	Adult ♂	RV	-----R-296.66	779	367	165
Hypotype						
USNM 184490.	Adult ♀	LV	-----R-296.66	742	403	233
Hypotype						
USNM 184491.	Adult ♀	RV	-----R-173.28	725	417	235

Distribution.—Upper Miocene: Sand Island hole (103); reef hole (7). Lower Miocene: reef hole (75).

Species No.—S(54), R(28).

Discussion.—A very wide ranging species known from the middle Tertiary of the Florida gulf coast, and throughout the Caribbean. Quite possibly the Eocene *Hermanites paijenborchiana* of Belgium is conspecific.

In some specimens the ventral ala of the right valve is incompletely formed, and the posterior part of it is left stranded as a vertically oriented flange-like tubercle. (See for instance pl. 4, fig. 9.) These individuals usually occur with the normal types, and thus this feature must be considered intra-specific variation. The weak submedian ridge occurring in the type specimen mentioned by Bold (1965) is poorly developed in the late Miocene Midway individuals.

Hermanites sp. aff. *H. barri* (Bold, 1960)

Plate 4, figure 24; plate 12, figure 21

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM 184493.	Adult	RV	-----S-148.74	962	558	275
Specimen						
UCB 40549.	Adult	RV	-----R-338.94	998	610	280

Distribution.—Upper Miocene: Sand Island hole (1). Lower Miocene: reef hole (1).

Species No.—S(59), R(96).

Discussion.—Only one poorly preserved right valve found. Though it has the same basic morphology as Bold's late Eocene Caribbean *Costa barri* (Bold, 1960), no definite taxonomic assignment can be given the specimen.

Genus *CLETOCYTHEREIS* Swain, 1963

Cletocythereis bradyi Holden, 1967

Plate 4, figure 13

Cythere rastromarginata Brady, 1880, Rept. * * * Voyage * * * Challenger, Zoology, v. 1, p. 83, pl. 16, figs. 2a-d; not fig. 1a-c.

Cletocythereis bradyi Holden, 1967, Pacific Sci., v. 21, no. 1, p. 40, text-figs. 31a-c.

Ishizaki, 1968, Tohoku Univ. Sci. Repts., ser. 2 (Geology), v. 40, no. 1, p. 40, pl. 8, fig. 9.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM 184492.	Adult ♀	carapace	-----S-44.20	667	325	340
Hypotype						
UCB 40548.	Adult ♂	LV	-----S-91.14	672	335	199

Distribution.—Pleistocene(?): Sand Island hole (20).

Species No.—S(12).

Discussion.—This species differs from *Hermanites tschoppi* by having a perfect dorsal ridge running from the posterodorsum to the eye tubercle instead of one that dips down toward the midlateral region, and by having a wider anteromarginal rim. Very probably *Cletocythereis bradyi* evolved from *Hermanites tschoppi* in the early post-Miocene.

Genus *HAMMATOCYHERE* Keen, 1972

Hammatocythere? sebastianensis (Bold)

Plate 3, figures 1-4, 16; plate 12, figures 1-4

"*Cythereis*" *sebastianensis* Bold, 1965, Micropaleontology, v. 11, no. 4, p. 399, pl. 6, figs. 3a, b; pl. 7, figs. 6a, b.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM 184503.	Adult	RV	-----R-296.66	667	365	137
Hypotype						
USNM 184504.	Adult	LV	-----R-318.67	689	393	170
Hypotype						
USNM 184505.	Adult	RV	-----R-318.67	674	374	163
Hypotype						
USNM 184506.	Adult	carapace	-----R-318.67	697	400	350
Hypotype						
USNM 184507.	Adult	carapace	-----R-296.66	616	366	275
Hypotype						
USNM 184508.	Adult	LV	-----R-318.67	650	370	162

Distribution.—Lower Miocene: reef hole (about 390).

Species No.—R(48).

Discussion.—The species is extremely abundant in the interval between R-317.37 m and 318.82 m in fauna R, accounting for as much as 75 percent of the ostracode fauna.

In the original description (Bold, 1965), muscle scars were not reported. On the Midway specimens they are well preserved, the adductors consisting of a row of four narrow elongate scars on the side of a deep subcentral depression with two frontal scars within the depression (pl. 12, fig. 3). Radial pore canals are moderately abundant, unbranched, sinuous, and have median enlargements.

The species is questionably assigned to *Hammatocythere* because of atypical radial pore canals and the unusually thin shell of most specimens. However, general shape, ornamentation, and other internal features are typical of the genus. *Hammatocythere* was originally described from the lower and middle Oligocene of Europe (Keen, 1972).

Family *TRACHYLEBERIDAE* Sylvester-Bradley

Subfamily *TRACHYLEBERIDINAE* Sylvester-Bradley

Genus *NEOCAUDITES* Puri, 1960

Neocaudites sp.

Plate 12, figures 18, 19

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM 184501.	Adult	carapace	-----R-307.39	586	240	242
Specimen						
USNM 184502.	Adult	carapace	-----R-307.39	569	317	234
Specimen						
UCB 40553.	Adult	carapace	-----R-307.39	525	283	200

Distribution.—Lower Miocene: reef hole (4).

Species No.—R (68).

Discussion.—This form is similar to *Rectotrachyleberis edwardsii* (Miocene, Europe) in that both have a long midlateral ridge that goes beyond the subcentral area almost to the anterior margin. Also, both species are smooth between the prominent ridges.

Neocauides terryi Holden

Neocauides terryi Holden, 1967, Pacific Sci., v. 21, no. 1, p. 43, 44, text-figs. 33a-d.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM	184494.	Adult ♂	carapace	S-140.67	461	225 134
Hypotype						
UCB	40550.	Adult ♀	LV	S-140.21	448	237 83

Distribution.—Upper Miocene: Sand Island hole (2).

Species No.—S (47).

Discussion.—The specimens are smaller but otherwise identical with the fossil specimens of Holden (1967) from Hawaii.

Genus OCCULTOCYHEREIS Howe, 1951

Occultocythereis sp.

Plate 12, figures 22, 23

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184495.	Adult	carapace	R-283.46	495	248 180
Specimen						
USNM	184496.	Adult	carapace	R-295.81	510	267 205
Specimen						
UCB	40551.	Adult	carapace	R-283.46	501	248 205

Distribution.—Lower Miocene: reef hole (8).

Species No.—R (49).

Discussion.—This species differs from most other species of *Occultocythereis* by having a pointed caudal process with ventral spines close to the terminal part. The marginal rims are narrow, and the carapace is moderately inflated in the alar region.

Genus PLATYCOSTA Holden, 1964

Platycosta amicus Holden, n. sp.

Plate 4, figures 16, 17; plate 13, figures 1, 2

Diagnosis.—Small fine reticulations, faint midlateral ridge from posterodorsum to subcentral tubercle; posterior right-valve tooth entire.

Description.—Small, surfaces finely reticulate; males longer than females. Lateral view: dorsum and venter straight, slightly converging posteriorly; anterior broadly and evenly rounded; posterior bluntly pointed at midheight, concave in dorsal half; small smooth subcentral tubercle, faint smooth ridge between it and posterodorsal tubercle; brief swelling along midventrolateral area; prominent continuous rim along anterior, ventral, and posterior margins,

sometimes broken by large flangelike spines in posteroventer; about eight large spines along anterior edge, some of which coalesce to outer marginal ridge. Dorsal view: compressed; greatest width behind middle at ventral midlateral swelling; terminal-ly blunt, anteroventrum often massive and wide.

Hinge holamphidont. Nonvestibulate duplicature wide; radial pore canals large, often bifurcating, some with midswellings; normal pores small. Four adductor scars; U-shaped frontal scar.

Types and dimensions.—

				Depth (m)	L	H	W
Paratype							
USNM	184497.	Adult ♂	carapace	R-336.27	500	269	166
Holotype							
USNM	184498.	Adult ♀	carapace	R-366.27	504	272	175
Paratype							
USNM	184499.	Adult ♂	carapace	R-320.35	453	223	168
Paratype							
USNM	184500.	Adult ♂	RV	S-45.11	483	232	102
Paratype							
UCB	40552.	Adult ♂	carapace	R-320.35	421	226	166

Distribution.—Pleistocene(?): Sand Island hole (1). Lower Miocene: reef hole (47).

Species No.—S (20), R (55).

Discussion.—This is the second known species of the genus *Platycosta*. The type species occurs in the Upper Cretaceous of southern California and Baja California (Holden, 1964, 1970).

Name.—*amicus* (L.) = friend.

Family CYTHERIDEIDAE Sars, 1925

Subfamily CYTHERIDEINAE Sars, 1925

Genus CYPRIDEIS Jones, 1857

Cyprideis beaconensis (LeRoy)

Plate 6, figures 21-23; plate 13, figures 5-7

Cytheridea beaconensis LeRoy, 1943, Jour. Paleontology v. 17, no. 4, p. 359, pl. 58, figs. 21-25, text-fig. 2c.

Cyprideis (Goerlichia) *stewarti* Benson, 1959, Kansas, Univ. Paleont. Contr., Arthropoda, Art. 1, p. 45, pl. 2, figs. 2a, b; pl. 9, figs. 17.

Cyprideis (Goerlichia) *miguelensis* Benson, 1959, Kansas Univ. Paleont. Contr., Arthropoda, Art. 1, p. 45, 46, pl. 2, figs. 3a, b; l. 9, fig. 16.

Cyprideis (Goerlichia) sp. Benson, 1959, Kansas Univ. Paleont. Contr., Arthropoda, Art. 1, p. 46, 47, pl. 2, figs. 5a, b; pl. 9, figs. 13, 15.

Cyprideis lengae Hartmann, 1961, Zeitschr. Wiss. Zoologie, v. 165, p. 428-452, figs. 3-24.

Hartmann, 1962, Hamburg. Zool. Mus. Inst., Mitt., v. 60, p. 36, 194.

Cyprideis beaconensis LeRoy. Sandberg, 1964, Stockholm Contr. Geology, v. 12, p. 95-100, pl. 4, figs. 11-13; pl. 5, figs. 1-12; pl. 17, figs. 2a, b; pl. 19, figs. 7, 8; pl. 20, figs. 3, 4; pl. 21, figs. 1a-c; pl. 22, figs. 7a, b.

Resig, 1969, Hawaii Inst. Geophysics, HIG-69-2, p. 24, pl. 9, figs. 13-19.

Types and dimensions.—

				Depth (m)	L	H	W
Hypotype							
USNM	184509.	Adult ♀	RV	S-78.49	936	520	249
Hypotype							
USNM	184510.	Adult ♂	RV	S-74.22	950	484	203
Hypotype							
USNM	184511.	Adult ♀	LV	S-78.49	899	520	235
Hypotype							
UCB	40554.	Adult ♂	RV	S-73.91	922	484	194
Hypotype							
UCB	40555.	Adult ♀	LV	S-73.91	903	517	273

Distribution.—Pleistocene(?): Sand Island hole (110).

Species No.—S(13).

Discussion.—This brackish-water species occurs in great abundance in fauna S₃ together with an otherwise normal marine assemblage. The lack of tubercles on any of the specimens is an additional indication that salinity was not much below normal. As pointed out by Resig (1969) for the Pleistocene occurrence of the species on Oahu, Hawaii, the environment was probably an open lagoon locally freshened by stream runoff rather than a closed lagoon that became fresh.

The species is known only from the Pleistocene and Holocene.

Family CYTHERURIDAE Müller, 1894
Subfamily CYTHERURINAE Müller, 1894
Genus SEMICYTHERURA Wager, 1957

Semicytherura sp.

Plate 13, figures 8, 9

Types and dimensions.—

		Depth (m)	L	H	W
Specimen					
USNM	184512. Adult carapace	R-320.95	342	190	189
Specimen					
UCB	40556. Adult carapace	R-321.72	342	183	208

Distribution.—Upper Miocene: Sand Island hole (1). Lower Miocene: reef hole (2).

Species No.—S(35), R(77).

Genus HEMICYTHERURA Eloffson, 1941

Hemicytherura pentagona Hornibrook

Plate 13, figures 13, 14

Hemicytherura pentagona Hornibrook, 1952, New Zealand Geol. Survey Palaeont. Bull. 18, p. 59, pl. 13, figs. 202–205, 211.

Hemicytherura cuneata Hanai, 1957, Tokyo Univ. Fac. Sci. Jour., sec. 2, v. 11, pt. 1, p. 24, 25, pl. 2, figs. 2a, b; text-figs. 1a, b.

Ishizaki, 1966, Tohoku Univ. Sci. Repts. ser. 2 (Geology), v. 37, no. 2, p. 140, pl. 18, figs. 22, 23.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype					
USNM	184513. Adult carapace	S-140.21	325	200	166
Hypotype					
USNM	184514. Adult carapace	S-140.67	302	142	150
Hypotype					
UCB	40557. Adult carapace	S-135.64	315	193	163

Distribution.—Upper Miocene: Sand Island hole (3).

Species No.—S(36), R(38).

Discussion.—Hanai stated that his Japanese species shows only minor ornamental differences when compared with *H. pentagona* and that therefore the two are closely related. Minor differences occur between the Midway specimens and those from Japan and New Zealand, not the least of which is the Midway specimen's lack of faint reticulations between

the major ridges (poor preservation?). Regardless, they appear to be assignable to the same species. Hanai (1957) and Hornibrook (1952) reported it as Holocene. The species is also known from the lower Miocene of Japan (Ishizaki, 1966).

Family BYTHOCYTHERIDAE Sars, 1926
Genus BYTHOCERATINA Hornibrook, 1953

Bythoceratina sp.

Plate 13, figures 10–12

Type and dimensions.—Specimen USNM 184515. Adult RV. S-45.11 m. L=380+ (broken), H=192, W=182.

Distribution.—Pleistocene(?): Sand Island hole (1).

Species No.—S(23).

Family PARACYTHERIDEIDAE Puri, 1957
Subfamily PARACYTHERIDEINAE Puri, 1957
Genus PARACYTHERIDEA Müller, 1894

Paracytheridea sp.

Plate 13, figures 18, 19

Types and dimensions.—

		Depth (m)	L	H	W
Specimen					
USNM	184516. Adult LV	R-320.50	502	243	203
Specimen					
USNM	184517. Adult LV	R-320.35	483	250	216
Specimen					
UCB	40558. Adult LV	R-320.04	508	249	202
Specimen					
UCB	40559. Adult RV	R-320.95	502	207	215

Distribution.—Lower Miocene: reef hole (8).

Species No.—R(78).

Discussion.—The species has some resemblance to the Holocene *Paracytheridea tschoppi* (Bold, 1946) but is relatively unornamented on the anterior swelling. It is also very similar to *P. sp.* of Hazel and Holden (1971) from the Eocene of Tonga but has less of an alar spine and better developed ridges in the posterodorsum.

Family KRITHIDAE Sars, 1925
Subfamily KRITHINAE Mandelstam, 1958
Genus PARAKRITHELLA Hanai, 1961

Parakrithella robusta Holden, n. sp.

Plate 6, figures 14–17; plate 13, figures 15–17

Diagnosis.—Highest in posterior half; dorsum almost straight, sloping down to evenly rounded anterior margin; broad anterior vestibule, venter straight.

Description.—Dimorphism present with inferred ♂ being longer and posteriorly inflated; carapace heavy, semitransparent. Lateral view: dorsum highly arched in posterior half, flattened in anterior half; anterior evenly rounded; venter straight; posterior broadly rounded to dorsal high point; surfaces smooth. Dorsal view: greatest width in posterior third (♂) to about at midlength (♀); ends bluntly pointed.

Right-valve dorsal margin fits into groove of left valve; groove faintly crenulate toward posterior part with corresponding crenulations in left-valve dorsum. Large anterior vestibule; radial pore canals sparse, about 11 anteriorly, large, tending to branch near margins; normal pores sparse, forming deep pits internally. Four adductor scars; one frontal scar, always with large normal pore just above and below.

Types and dimensions.—

			Depth (m)	L	H	W
Paratype						
USNM	184518.	Adult♂ LV	-----S-141.73	682	370	170
Paratype						
USNM	184519.	Adult♀ RV	-----S-141.73	683	333	138
Holotype						
USNM	184520.	Adult♀ carapace	-----S-140.67	701	366	300
Paratype						
USNM	184521.	Adult♂ carapace	-----S-140.67	708	367	306
Paratype						
USNM	184522.	Adult♂ LV	-----S-140.21	692	355	173
Paratype						
UCB	40560.	Adult♂ LV	-----S-140.21	680	370	175

Distribution.—Upper Miocene: Sand Island hole (825); reef hole (73).

Species No.—S (48), R (22).

Discussion.—The genus is known only from Japan (Hanai, 1959, 1961; Ishizaki, 1968, 1971) and from the Pliocene-Pleistocene(?) of Okinawa (Hanai, 1959) with the single species *Parakrithella pseudodonta*. It is noteworthy that the Japanese species is found only in shallow water. The fauna accompanying *P. robusta* also indicates a shallow-water preference.

Parakrithella eopacifica Holden, n. sp.

Plate 17, figures 15–19

Diagnosis.—Carapace small, suboblong, thin shelled; dimorphic with posteriorly arched inferred males; inturned area concave; posterior bluntly pointed.

Description.—Lateral view: inferred males posteriorly arched; females more evenly arched or dorsally flat; ventral margin sinuous, broadly rounded in posterior half, concave at inturned area; posterior bluntly pointed in ventral half; left valve overlapping right valve along all margins. Dorsal view: greatest width at midlength and midheight; anterior sharply pointed; posterior rounded.

Right-valve dorsum fitting into groove of left valve; short section faintly crenulate in posterior half of right-valve dorsum with corresponding crenulations in left valve. Anterior duplicature wide with deep vestibule branching about five times into large radial pore canals. Radial pore canals large, often branching twice or thrice near margins. Normal pores large, sparse, apparently sieve type. Four elongate large adductor scars.

Types and dimensions.—

			Depth (m)	L	H	W
Holotype						
USNM	184523.	Adult♂ RV	-----R-319.21	450	218	102
Paratype						
USNM	184524.	Adult♀ carapace	-----R-320.95	452	210	172
Paratype						
USNM	184525.	Adult♂ carapace	-----R-320.95	483	233	186
Paratype						
USNM	184526.	Adult♀ carapace	-----R-288.65	560	557	207
Paratype						
UCB	40561.	Adult♂ carapace	-----R-283.46	503	233	200

Distribution.—Lower Miocene: reef hole (290).

Species No.—R (40).

Discussion.—The major differences between this species and *Parakrithella robusta* are size and heaviness of shell. *Parakrithella robusta* is 680 to 710 μ long and thick shelled, whereas *P. eopacifica* is typically 450 to 480 μ long and fragile. In the upper part of its range, *P. eopacifica* gradually increases in size and at about 280 m in the reef hole is 500 to 560 μ long. Most probably this species gives rise to *P. robusta*, but the section containing the transitional forms is missing.

Family LEPTOCYTHERIDAE Hanai, 1961

Genus CALLISTOCYHERE Ruggieri, 1953

Callistocythere crenata (Brady)

Plate 14, figures 1, 2

Cythere crispata Brady. Brady, 1880, Rept. * * * Voyage * * *

Challenger, Zoology, v. 1, p. 72, 73, pl. 14, figs. 8a–d.

Cythere crenata Brady, 1890, Royal Soc. Edinburgh Trans., v. 35, p. 497, 498, pl. 2, figs. 35, 36.

Callistocythere aff. *crispata* (Brady). Apostolescu, 1967, Paris, Editions Fond. Singer-Polignac, pl. 2, figs. 50–52.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM	184527.	Adult LV	-----S-44.20	365	210	98
Hypotype						
USNM	184528.	Adult RV	-----S-44.20	350	201	83
Hypotype						
UCB	40562.	Adult LV	-----S-78.88	433	245	92

Distribution.—Pleistocene(?): Sand Island hole (3). Lower Miocene: reef hole (3).

Species No.—S (14), R (79).

Discussion.—These specimens are identical with Holocene specimens from New Hebrides and Fiji. The species is also known from Hong Kong, Booby Island (near Torres Straits), and Port Jackson, Australia (Brady, 1880), and New Caledonia (Apostolescu, 1967). The Midway specimens are somewhat variable in ornamentation. In some specimens, certain lateral ridges are accentuated. (See pl. 14, fig. 2.)

Callistocythere sp. 1

Plate 13, figures 20, 21

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184529.	Adult LV	-----S-147.37	450	222	118
Specimen						
USNM	184530.	Adult RV	-----S-147.37	448	225	98

Distribution.—Upper Miocene: Sand Island hole (2).

Species No.—S (60).

Callistocythere sp. 2

Plate 14, figures 7, 8

Type and dimensions.—Specimen USNM 184531. Adult carapace. R=320.95 m. L=400, H=201, W=133.

Distribution.—Lower Miocene: reef hole (1).

Species No.—R (80).

Family LOXOCONCHIDAE Sars, 1925

Genus LOXOCONCHA Sars, 1865

Loxoconcha longispina Key

Plate 4, figure 14; plate 5, figures 3–6; plate 14, figures 12–15

Loxoconcha alata Brady, 1880, Rept. *** Voyage *** Challenger, Zoology, v. 1, pt. 3, p. 122, pl. 27, figs. 6a–j (not Brady, 1868).

Loxoconcha alata Brady var. *longispina* Key, 1953, Kon. Nederlandse Akad. Wetensch., ser. B, v. 56, pt. 2, p. 160, pl. 1, figs. 10a, b.

Loxoconcha longispina Key. Holden, 1967, Pacific Sci., v. 21, no. 1, p. 32–24, figs. 23a–d.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM	184532.	Adult♂ LV	S-78.88	584	316	192
Hypotype						
USNM	184533.	Adult♂ RV	S-78.88	579	332	154
Hypotype						
USNM	184534.	Young LV	S-78.88	416	234	140
Hypotype						
USNM	184535.	Adult♀ RV	S-79.19	521	440	166
Hypotype						
USNM	184536.	Adult♀ carapace	S-79.19	536	317	317
Hypotype						
USNM	184537.	Adult♂ LV	S-147.37	486	249	170
Hypotype						
USNM	184538.	Adult♂ carapace	S-147.37	490	230	294
Hypotype						
UCB	40563.	Adult♂ carapace	S-79.19	584	334	314
Hypotype						
UCB	40564.	Adult♀ LV	S-147.37	450	252	167

Distribution.—Pleistocene(?): Sand Island hole (135); reef hole (55). Upper Miocene: Sand Island hole (5). Lower Miocene: reef hole (17). Post-Miocene: reef hole (2).

Species No.—S (2), R (4).

Discussion.—The Pleistocene(?) specimens are not as strongly alate as others reported from the tropical Pacific, but the early and late Miocene specimens are.

The species is variable; two forms are represented. The majority are the larger but relatively shorter forms represented on plate 5, figures 3–6, and plate 14, figures 12–14. The smaller and relatively longer form occurs near the bottom of both holes but is not found mixed with the larger form.

Loxoconcha antillea Bold sensu stricto

Plate 4, figures 10, 11; plate 5, figures 1, 2; plate 14, figures 4–6, 17

Loxoconcha antillea Bold, 1946, Amsterdam, p. 110, pl. 15, figs. 3a–c.

Bold, 1965, Micropaleontology, v. 11, no. 4, p. 402, pl. 4, figs. 3a–c.

Loxoconcha fischeri (Brady). Bold, 1957, Micropaleontology, v. 3, no. 3, p. 244, pl. 2, fig. 7 (not *L. fischeri* (Brady)).

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM	184539.	Adult♂ LV	R-161.39	546	296	136
Hypotype						
USNM	184540.	Adult♀ LV	S-141.73	464	271	140
Hypotype						
USNM	184541.	Adult♀ carapace	R-283.46	518	285	278
Hypotype						
USNM	184542.	Adult♀ LV	S-140.21	518	301	165
Hypotype						
USNM	184543.	Adult♂ LV	S-141.73	526	276	131
Hypotype						
USNM	184544.	Adult♀ carapace	S-140.21	493	280	329
Hypotype						
USNM	184545.	Adult♂ carapace	S-140.21	552	287	240

Distribution.—Upper Miocene: Sand Island hole (65); reef hole (20). Lower Miocene: reef hole (46).

Species No.—S (37), R (29).

Discussion.—The species is widespread in the Caribbean Miocene. At Midway it is very abundant in the upper and lower Miocene samples.

In two upper Miocene samples (S-140.21 m and S-141.73 m) it shows variation, most of the individuals being inflated and having a smooth knob-like ala (♀). In the lower Miocene (greater than 300-m depth), a new subspecies is found that lacks the horizontally aligned reticulations and antero-lateral ridges. This new subspecies, *L. antillea diffusia*, and *L. antillea* s.s. are mutually exclusive.

Loxoconcha antillea Bold *diffusia* Holden, n. subsp.

Plate 4, figures 18–21; plate 14, figure 3

Diagnosis.—Like *L. antillea* s.s., but lacking double horizontal anterolateral ridge, and having evenly developed reticulations and weak tubercles.

Types and dimensions.—

			Depth (m)	L	H	W
Holotype						
USNM	184546.	Adult♀ carapace	R-318.52	471	256	233
Paratype						
USNM	184547.	Adult♂ carapace	R-343.30	567	303	226
Paratype						
USNM	184548.	Adult♀ carapace	R-343.30	483	269	232
Paratype						
USNM	184549.	Adult♂ carapace	R-343.30	616	292	230
Paratype						
USNM	184550.	Adult♂ LV	R-318.52	527	252	117

Distribution.—Lower Miocene: reef hole (31).

Species No.—R (70).

Discussion.—See *Loxoconcha antillea* s.s. for a discussion of the subspecies. Named for its diffused and random pattern of reticulations.

Loxoconcha uranouchiensis Ishizaki

Plate 4, figure 12; plate 14, figures 9–11

Loxoconcha uranouchiensis Ishizaki, 1968, Tohoku Univ. Sci. Repts. ser. 2 (Geology), v. 40, no. 1, p. 32, pl. 7, figs. 2, 3.

Ishizaki, 1971, Tohoku Univ. Sci. Repts., ser. 2 (Geology), v. 43, no. 1, p. 87, pl. 3, fig. 17.

Loxoconcha sp. 2. Resig, 1969, Hawaii Inst. Geophys., HIG-69-2, pl. 9, fig. 5.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM	184551.	Adult ♀ LV	-----S-45.11	470	243	134
Hypotype						
USNM	184552.	Adult ♀ LV	-----S-44.20	458	273	166
Hypotype						
USNM	184553.	Adult ♂ carapace	-----S-73.47	532	267	277
Hypotype						
USNM	184554.	Adult ♀ RV	-----S-78.88	482	283	133
Hypotype						
UCB	40565.	Adult ♂ carapace	-----S-85.19	524	282	249

Distribution.—Pleistocene(?): Sand Island hole (73); reef hole (9).

Species No.—S(15), R(19).

Discussion.—The known geographic range of living members of the species is from northern to southern Honshu, Japan. The fossil specimens, including those of Resig from the Pleistocene of Hawaii (Resig, 1969), differ from the living Japanese specimens, as illustrated by Ishizaki (1968, 1971), by having interruptions on the lateral ridges that define the reticula. On some specimens this gives the surface a random texture of pillars, incomplete ridges, and some reticulations. On others, however, reticulations dominate.

Loxoconcha sp. 1
Plate 14, figures 18–20

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184555.	Adult ♀ LV	-----S-44.20	389	225	116
Specimen						
USNM	184556.	Adult ♂ RV	-----S-73.46	426	233	103

Distribution.—Pleistocene(?): Sand Island hole (3).

Species No.—S(16).

Discussion.—Possibly a descendant of *L. antillea*, which is last found at a depth of S-135.94 m. *Loxoconcha sp. 1* differs from *L. antillea* in two ways: (1) The two horizontal anterolateral ridges of *L. antillea*, divided by one or two reticula, are divided by three to four in *L. sp. 1*; (2) the posterior tubercle, situated between the ala and posterodorsal tubercles in *L. antillea*, is fused to the posterodorsal tubercle in *L. sp. 1*.

Loxoconcha sp. 2
Plate 5, figures 7–9

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184557.	Adult carapace	-----R-355.09	450	263	250
Specimen						
USNM	184558.	Adult carapace	-----R-355.09	435	253	266
Specimen						
USNM	184559.	Adult carapace	-----R-355.09	473	273	257

Distribution.—Lower Miocene: reef hole (4).

Species No.—R(98).

Genus *LOXOCONCHELLA* Triebel, 1954
Loxoconchella honoluluensis (Brady)
Plate 6, figures 18–20

Loxoconcha honoluluensis Brady, 1880, Rept. *** Voyage ***
Challenger, Zoology, v. 1, pt. 3, p. 118, pl. 28, figs. 6a–f.

Loxoconchella honoluluensis (Brady). Triebel, 1954, Senckenbergiana Lethaea, v. 85, p. 19, pl. 1, figs. 1–6.
Holden, 1967, Pacific Sci., v. 21, no. 1, p. 34, figs. 24a–b.
Apostolescu, 1967, Paris, Editions Fond. Singer-Polignac, pl. 2, figs. 29–31.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM	184560.	Adult RV	-----S-147.37	614	400	169
Hypotype						
USNM	184561.	Adult RV	-----R-173.29	567	375	181
Hypotype						
USNM	184562.	Adult carapace	-----S-149.66	653	446	316
Hypotype						
UCB	40566.	Adult LV	-----R-283.46	650	433	160

Distribution.—Upper Miocene: Sand Island hole (30); reef hole (8). Lower Miocene: reef hole (26).

Species No.—S(49), R(23).

Discussion.—No differences can be observed between the early Miocene, late Miocene, and Holocene specimens from elsewhere in the Pacific.

Loxoconchella anomala (Brady)

Plate 6, figure 13

Loxoconcha anomala Brady, 1880, Rept. *** Voyage ***
Challenger, Zoology, v. 1, p. 123, pl. 28, figs. 5a–d.
Loxoconchella anomala (Brady). Holden, 1967, Pacific Sci.,
21, no. 1, p. 34–36. 25a–f.

Types and dimensions.—

			Depth (m)	L	H	W
Hypotype						
USNM	184563.	Adult carapace	-----MR-21.34	584	418	373
Hypotype						
USNM	184564.	Adult LV	-----R-31.55	624	451	258
Hypotype						
UCB	40567.	Adult LV	-----S-44.20	568	406	177

Distribution.—Pleistocene(?): Sand Island hole (2); reef hole (1). Living in Midway lagoon (1).

Species No.—S(17), R(10).

Loxoconchella sp.
Plate 15, figures 1, 2

Type and dimensions.—Specimen USNM 184565.
Adult RV. S-140.21 m. L=468+ (broken), H=320,
W=156.

Distribution.—Upper Miocene: Sand Island hole (1).

Species No.—S(50).

Discussion.—The species differs from *L. anomala* by being smooth and having a more dorsally situated tubercle, and from *L. honoluluensis* by having a tubercle. It may represent an ancestral form of *L. anomala*, which at Midway occurs considerably higher in the section.

Family PARADOXOSTOMATIDAE Brady and Norman, 1889
Subfamily PARADOXOSTOMATINAE Brady and Norman 1889
Genus PARADOXOSTOMA Fischer, 1855

Paradoxostoma romei McKenzie

Plate 15, figures 5, 6

Paradoxostoma romei McKenzie, 1967b, Royal Soc. Victoria
Proc., v. 80, pt. 1, no. 89, 90, figs. 4e, 8i–r.

Type and dimensions.—Hypotype USNM 184566. Adult LV. R=31.55 m. L=534, H=242, W=83.

Distribution.—Pleistocene(?) : reef hole (1).

Species No.—R(12).

Discussion.—The duplicatures and vestibule are identical to those of *P. romei* from southern Australia (McKenzie, 1967b).

Paradoxostoma sp. 1

Plate 15, figures 3, 4

Types and dimensions.—

Specimen		Depth (m)	L	H	W
USNM 184567.	Adult carapace	S-79.19	428	185	118
UCB 40568.	Adult carapace	S-79.19	409	178	107

Distribution.—Pleistocene(?) : Sand Island hole (4).

Species No.—S(28).

Paradoxostoma sp. 2

Plate 15, figures 13, 14

Type and dimensions.—Specimen USNM 184568. Adult LV. R=320.34 m. L=635, H=240, W=90.

Distribution.—Lower Miocene: reef hole (2).

Species No.—R(81).

Subfamily CYTHEROMATINAE Eloffson, 1939
Genus PELLUCISTOMA Coryell and Fields, 1937

Pellucistoma sp.

Plate 15, figures 7, 8

Type and dimensions.—Specimen USNM 184569. Adult LV. R=163.6 m. L=542, H=277, W=132

Distribution.—Upper Miocene: reef hole (1).

Species No.—R(35).

Family PECTOCYTHERIDAE Hanai, 1957

Genus MUNSEYELLA Bold, 1957

Munseyella inconspicua (Brady)

Plate 1, figures 14–16; plate 11, figures 3–5

Cythere inconspicua Brady, 1880, Rept. *** Voyage *** Challenger, Zoology, v. 1, p. 70, 71, pl. 13, figs. 1a–d.

Cythere cuneolus Brady, 1890, Royal Soc. Edinburgh Trans., v. 35, p. 500, pl. 2, figs. 6, 7.

Leptocythere demissa (Brady). Key, 1954, Kon. Nederlandse Akad. Wetensch., ser. B, v. 57, pt. 2, p. 354, pl. 1, figs. 3a, b.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype USNM 184570.	Adult carapace	R-313.64	385	213	203
Hypotype USNM 184571.	Adult carapace	R-313.64	390	210	200
Hypotype USNM 184572.	Adult carapace	R-313.64	369	210	197
Hypotype USNM 184573.	Adult LV and RV	S-78.88	417	230	118
Hypotype USNM 184574.	Adult LV	S-78.88	417	222	117
Hypotype UCB 40569.	Adult carapace	R-306.32	401	209	188

Distribution.—Pleistocene(?) : Sand Island hole

(4). Upper Miocene: Sand Island hole (4); reef hole (1). Lower Miocene: reef hole (13).

Species No.—S(21), R(20).

Discussion.—This species was originally described from Torres Straits, Australia (Brady, 1880), and is widespread in the Pacific and Caribbean regions. Teeter (1966) notes the species occurs in the Great Barrier Reef, the Philippines, Hawaii, Qatar, the Bahamas, and Florida. This writer has found the species in Fiji, the New Hebrides, and Barbados.

The early Miocene specimens are slightly smaller, more wedge shaped when seen laterally, and slightly more compressed than geologically younger specimens.

Family XESTOLEBERIDAE Sars, 1928

Genus XESTOLEBERIS Sars, 1865

Xestoleberis tumefacta Brady

Plate 16, figures 4–7

Xestoleberis tumefacta Brady, 1880 Rept. *** Voyage *** Challenger, Zoology, v. 1, p. 128, 129, pl. 31, figs. 4a–d.

Brady, 1890, Royal Soc. Edinburgh Trans., v. 35, p. 508, pl. 3, figs. 7, 8.

Apostolescu, 1967, Paris, Editions Fond. Singer-Polignac, pl. 2, figs. 23–25.

Types and dimensions.—

		Depth (m)	L	H	W
Hypotype USNM 184580.	Adult RV	S-45.11	518	336	183
Hypotype USNM 184581.	Adult LV	S-44.20	461	315	205
Hypotype USNM 184582.	Adult RV	S-44.20	470	308	150
Hypotype USNM 184583.	Adult carapace	S-44.20	487	331	333
Hypotype UCB 40571.	Adult LV	R-283.46	560	373	224
Hypotype UCB 40572.	Adult carapace	R-283.46	568	375	386

Distribution.—Pleistocene(?) : Sand Island hole (58); reef hole (1). Lower Miocene: reef hole (9).

Species No.—S(6), R(14).

Discussion.—The early Miocene specimens differ morphologically from those of the post-Miocene by being more pointed anteriorly as seen from above and by being considerably larger. Living individuals from the southwest Pacific (Brady, 1880, 1890), however, are large like the early Miocene specimens at Midway.

Xestoleberis sp. cf. X. granulosa Brady

Plate 15, figures 9–12

Types and dimensions.—

		Depth (m)	L	H	W
Specimen USNM 184584.	Adult carapace	S-78.88	468	235	229
Specimen USNM 184585.	Adult LV	S-78.88	440	233	117
Specimen USNM 184586.	Adult RV	R-31.55	456	240	131
Specimen UCB 40573.	Adult RV	R-31.55	448	223	127

Distribution.—Pleistocene(?): Sand Island hole (7); reef hole (7). Lower Miocene: reef hole (14).

Species No.—S(29), R(5).

Discussion.—The living *Xestoleberis granulosa* is very similar to the early Miocene Midway species. Possibly they are conspecific. Brady's species lives in Bass Strait and Port Jackson (near Sydney), Australia (Brady, 1880), in temperate waters. *Xestoleberis* sp. B of Bold (1966a) from Panama is similar but has a more rounded dorsum and more pointed anterior.

Xestoleberis sp. cf. *X. briggsi* McKenzie

Plate 16, figures 1–3

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184587.	Adult ♀ carapace	-----R-320.95	388	183	227
Specimen						
USNM	184588.	Adult ♀ carapace	-----R-320.95	382	200	242
Specimen						
USNM	184589.	Adult ♀ carapace	-----R-320.95	373	186	226
Specimen						
UCB	40574.	Adult ♀ carapace	-----R-320.95	371	192	223

Distribution.—Lower Miocene: reef hole (11).

Species No.—R(82).

Discussion.—*Xestoleberis briggsi*, from Port Phillip Bay, Victoria, Australia (McKenzie, 1967b), closely resembles this species, differing primarily by lacking the anteroventral notch (pl. 16, fig. 2) and by having a more evenly rounded dorsum. Dorsal and anterior comparisons could not be made.

Xestoleberis sp. cf. *X. curta* (Brady)

Plate 15, figures 23–25; plate 17, figure 1

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184590.	Adult ♀ LV	-----S-73.46	566	336	199
Specimen						
USNM	184591.	Adult ♀ RV	-----S-73.46	524	300	156
Specimen						
USNM	184592.	Adult ♀ carapace	-----S-73.46	566	343	297
Specimen						
UCB	40575.	Adult ♀ carapace	-----S-97.84	582	335	308
Specimen						
UCB	40576.	Adult ♂ carapace	-----S-73.45	506	291	271

Distribution.—Pleistocene(?): Sand Island hole (184); reef hole (38). Upper Miocene: Sand Island hole (3); reef hole (4). Lower Miocene: reef hole (160).

Species No.—S(3), R(11).

Discussion.—It is uncertain whether these specimens can be referred to *Xestoleberis curta*. *X. curta* is living on Fanning Island, Line Group, and, though morphologically similar, the Holocene specimens are smaller ($380\mu = \delta$, $430\mu = \text{♀}$. Personal observation). It apparently occurs throughout the sequence at Midway.

Xestoleberis datelinensis n. sp.

Plate 17, figures 2–6

Diagnosis.—Venter straight (side view) and flat-

ly rounded (anterior view); dorsum unevenly rounded, anteriorly flattened; radial pore canals, many branched in ventral half, simple in dorsal half.

Description.—Fairly large, heavy; dimorphism pronounced with smaller, dorsally lenticular males, posteriorly inflated females. Lateral view female: venter straight, long; dorsum unevenly rounded with two faintly flattened parts posteriorly, one anteriorly; highest point at midlength. Dorsal view female: greatest width in posterior third; sides along midlength flattened, anteriorly converging; anterior pointed.

Hinge typical of genus, posterior element of right valve projecting, with about seven toothlets; anterior elementation elongate crenulate ridge. Anterior duplicature wide, posterior narrow and non-vestibulate; anterior vestibule deep; dorsal radial pore canals simple, some false; ventral ones many branched from deep vestibular pockets. Normal pores small, sparse. Muscle scars not preserved.

Types and dimensions.—

			Depth (m)	L	H	W
Paratype						
USNM	184593.	Adult ♀ carapace	-----R-317.37	532	295	301
Holotype						
USNM	184594.	Adult ♂ carapace	-----R-317.37	481	246	242
Paratype						
USNM	184595.	Adult ♀ LV	-----R-318.36	514	283	149
Paratype						
UCB	40577.	Adult ♀ carapace	-----R-335.74	572	324	331
Paratype						
UCB	40578.	Adult ♂ carapace	-----R-335.74	548	282	285

Distribution.—Lower Miocene: reef hole (230).

Species No.—R(53).

Discussion.—Very abundant from bottom of reef hole to R-284 m. Size gradually decreases from $L = 550\mu$ at R-355 m to 530μ at 317 m to 480μ at 284 m.

The species is considered to be the direct ancestor of *Xestoleberis* sp. cf. *X. curta*, on the basis of similarities of morphology, dimorphism, and duplicature. The males of the two species are similar in shape, but the females have flattened sides and flattened venter in *X. datelinensis* and both are rounded in the other. The distinctive anteroventral radial pore canals persist in *X. sp.* of *X. curta*, but the vestibular pockets are reduced in size.

Xestoleberis sp. 1

Plate 15, figures 19–22

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184596.	Adult ♀ LV	-----S-147.37	572	293	172
Specimen						
USNM	184597.	Adult ♂ LV	-----S-147.37	526	288	169
Specimen						
USNM	184598.	Adult ♀ LV	-----S-147.37	533	283	179
Specimen						
USNM	184599.	Adult ♂ RV	-----S-147.37	526	293	150

Distribution.—Upper Miocene: Sand Island hole (40); reef hole (5).

Species No.—S(61), R(25).

Discussion.—The specimens are oblong in side view, with an evenly rounded posterior and equally rounded anterior. This species appears to precede *Xestoleberis* sp. 2 in the Sand Island hole and occurs with it at the reef hole. They are not closely related.

Xestoleberis sp. 2

Plate 15, figures 15–18

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184600.	Adult LV	-----S-140.21	433	259	172
Specimen						
USNM	184601.	Adult RV	-----S-140.21	425	---	141
Specimen						
UCB	40579.	Adult LV	-----S-140.67	433	282	150
Specimen						
UCB	40580.	Adult carapace	-----R-321.86	402	244	243

Distribution.—Upper Miocene: Sand Island hole (19); reef hole (12)

Species No.—S(38), R(17).

Discussion.—A highly arched species with a somewhat pointed anterior and little or no sexual dimorphism.

Family and genus uncertain

"*Cythere*" sp. aff. "*C.*" caudata Brady

Plate 16, figures 8, 9

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184575.	Adult carapace	-----R-320.34	428	200	142
Specimen						
USNM	185576.	Adult carapace	-----R-320.34	407	183	145
Specimen						
UCB	40570.	Adult carapace	-----R-336.27	422	203	149

Distribution.—Lower Miocene: reef hole (4)

Species No.—R(83)

Discussion.—The species belongs to an undescribed genus. Other closely related species include *Cythere caudata* originally described living at Fiji (Brady, 1890), also living and fossil specimens from the Hawaiian Islands (Holden, 1967) and living specimens in Manila Bay (Key, 1954); "*Cythere*" sp. cf. "*C.*" caudata living at Clipperton Island (Allison and Holden, 1971). The Midway specimens, unlike all the others so far described, are smooth. Preservation is poor, and internal features were not observed.

Ostracode sp.

Plate 16, figures 14, 15

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184577.	Adult carapace	-----R-317.91	700	383	227
Specimen						
USNM	184578.	Penultimate RV	-----R-317.91	605	352	134
Specimen						
USNM	184579.	3rd from last instar LV	-----R-317.91	533	333	117

Distribution.—Lower Miocene: reef hole R-317.91 m (3).

Species No.—R(76).

Discussion.—The species appears to be a *Candona*,

but its identification cannot be positively determined.

Suborder PLATYCOPINA Sars, 1866

Family CYTHERELLIDAE Sars, 1866

Genus CYTHERELLA Jones, 1849

Cytherella textum Holden, n. sp.

Plate 17, figures 7–10

Diagnosis.—Much elongated; posterior bluntly rounded; posterodorsal margin flattened, sloping; surfaces ornamented with fine striae.

Description.—Lateral view: elongate, twice as long as high; venter faintly concave; anterior evenly rounded; dorsum fairly straight, flattened, and sloping in posterodorsal area; ornamentation of extremely fine parallel ridges generally in a concentric pattern everywhere except in posterior; extreme posterior usually has coarse pits; right valve overlap slight. Dorsal view: lanceolate; anterior bluntly pointed; greatest width in posterior third; posterior truncate (♀) to compressed behind inflation (♂).

Central muscle-scar pattern typical of genus, in dorsal half just posterior to midlength.

Types and dimensions.—

			Depth (m)	L	H	W
Paratype						
USNM	184602.	Adult♂ LV	-----R-335.74	700	348	141
Paratype						
USNM	184603.	Adult♂ RV	-----R-335.74	701	350	149
Holotype						
USNM	184604.	Adult♀ carapace	-----R-284.00	810	391	327
Paratype						
USNM	184605.	Adult♂ carapace	-----R-284.00	750	373	292
Paratype						
UCB	40581.	Adult♂ carapace	-----R-244.12	766	393	305

Distribution.—Lower Miocene: reef hole (90).

Species No.—R(51).

Discussion.—This species is similar to *Cytherella vanveeni* from the Miocene of Guatemala, Puerto Rico, and Cuba (Bold, 1946, 1965), especially in lateral view, though that species has a heavier anterior rim and coarser ornamentation. *Cytherella foveata* from the Upper Cretaceous of south Limburg (Veen, 1932) also has the same general shape, but its sexual dimorphism is expressed differently, and it lacks the fine ornamental striations.

Name.—*textum* (L.) = that which is woven; a web, referring to its fine ornamentation.

Cytherella sp. 1

Plate 16, figures 23, 24

Type and dimensions.—Specimen USNM 184606. Adult ♀ RV. R-288.65 m. L=766, H=412, W=149.

Distribution.—Lower Miocene: reef hole (1).

Species No.—R(56).

Discussion.—The specimens are much larger than those of *Cytherella* sp. 2 and have a more rounded posterior and straighter dorsum. It is possibly allied to *C.* sp. a of Apostolescu (1967) from New Caledonia, but lacks the beveled posterodorsum.

Cytherella sp. 2

Plate 16, figures 10-13

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184607.	Adult ♀ carapace	-----S-151.79	657	385	288
Specimen						
USNM	184608.	Adult ♀ RV	-----S-152.25	631	366	150
Specimen						
USNM	184609.	Adult ♀ LV	-----S-152.25	616	352	150
Specimen						
UCB	40582.	Adult ♂ RV	-----S-152.25	575	318	118

Distribution.—Upper Miocene: Sand Island hole (105). Lower Miocene: reef hole (3).

Species No.—S(51), R(50).

Discussion.—A very common and sometimes abundant species from S-149 to S-152 m.

Genus CYTHERELLOIDEA Alexander, 1929

Cytherelloidea sp. cf. *C. umbonata* Edwards

Plate 6, figures 5-8, 10

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184610.	Adult ♀ carapace	-----S-149.66	601	338	223
Specimen						
USNM	184611.	Adult ♀ carapace	-----R-343.30	666	372	267
Specimen						
USNM	184612.	Adult ♂ carapace	-----R-343.30	559	313	295
Specimen						
USNM	184613.	Adult ♂ LV	-----R-343.30	584	310	102
Specimen						
USNM	184614.	Adult ♀ RV	-----S-141.73	662	384	135

Distribution.—Upper Miocene: Sand Island hole (88). Lower Miocene: reef hole (180).

Species No.—S(52), R(58).

Discussion.—It is rather remarkable that the species is common and sometimes very abundant in the upper Miocene Sand Island hole but is completely lacking in the corresponding part of the reef hole. *Cytherelloidea* prefers shallow water and is rarely found deeper than 90 m (Sohn, 1962). In the upper Miocene the reef hole is considered to represent water about 40 m (Todd and Low, 1970) to 15 m (this report) deeper than that represented in the Sand Island hole. This difference in depth may explain the absence of any late Miocene *Cytherelloidea* in the reef hole.

Similar to *Cytherelloidea umbonata* from the upper Miocene of North Carolina (Edwards, 1944) in shape and ornamentation except smaller, having a more truncate posterior, and lacking a ridge anterior to the subcentral pit. In the Midway specimens the ornament varies from fine pitting to none at all. (See pl. 6, figs. 8, 9.)

The species has the type of hingement described by Bold (1963) for *Cytherelloidea praecipua*, *C. semipunctata*, and *C. sp. 2*. (See pl. 16, figs. 10, 12, 13.)

Cytherelloidea sp. cf. *C. umbonata* Edwards variation

Plate 6, figure 9; plate 16, figures 17, 21

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM	184615.	Adult ♀ carapace	-----R-173.28	652	385	248
Specimen						
USNM	184616.	Adult ♀ LV	-----R-338.94	626	303	149
Specimen						
UCB	40583.	Adult ♀ RV	-----R-173.28	622	355	150

Distribution.—Upper Miocene: Sand Island hole (14). Lower Miocene: reef hole (4).

Species No.—S(53), R(37).

Discussion.—Similar to *Cytherelloidea* sp. cf. *C. umbonata*, except that the surfaces are completely smooth. Usually the variants are associated.

Cytherelloidea semipunctata Holden, n. sp.

Plate 6, figures 1, 2; plate 16, figure 16

Diagnosis.—Two sinuous lateral ridges, of which the top one is poorly developed; dorsal ridge paralleling lateral ridges; surfaces smooth on ridges and in anterolateral area, deep puncta elsewhere.

Description.—Lateral view: dorsum sinuous, sloping in posterior part; venter straight; anterior broadly rounded with low denticles; posterior flat-tended (♀) to rounded (♂); large rounded anterior rim; two sinuous lateral ridges, top ridge poorly developed; sinuous dorsal ridge paralleling lateral ridges, connects with anteromarginal rim; lateral ridges connect with posterior margin via two circular posterior swellings (♀) or terminate before reaching posterior margin (♂); anterolateral-midlateral region and ridges smooth, deep circular pits elsewhere. Dorsal view: lanceolate, greatest width in extreme posterior; anterior bluntly pointed.

Hinge well developed: larger right valve strongly overlapping left valve just anterior to midlength with broad projecting flange; left valve with narrower tooth, just posterior to right-valve flange, fitting into distinct socket of right valve. Muscle scars poorly defined, on raised boss in upper half at mid-length.

Types and dimensions.—

			Depth (m)	L	H	W
Holotype						
USNM	184617.	Adult ♀ RV	-----R-308.45	674	367	147
Paratype						
USNM	184618.	Adult ♀ LV	-----R-308.45	669	376	123
Paratype						
USNM	184619.	Adult ♀ carapace	-----R-284.74	684	392	259
Paratype						
USNM	184620.	Adult ♀ LV	-----R-308.45	684	367	117
Paratype						
USNM	184621.	Adult ♀ RV	-----R-308.45	701	400	150

Distribution.—Lower Miocene: reef hole R-284 to 313 m (60).

Species No.—R(52).

Discussion.—This species is considered to be a precursor to *Cytherelloidea praecipua* from the Holocene of the Caribbean (Bold, 1963b) and Pacific (Allison and Holden, 1971). *Cytherelloidea keiji* (McKenzie, 1967b) from southern Australia is closely related and may be conspecific with *C. praecipua*.

Both *C. praecipua* and *C. keiji* have the same shape, ridge structure, and hingement as the Midway species, but have more densely pitted surfaces.

This species is much like *Cytherelloidea* sp. 2, but has lateral ridges and very deep simple punctae.

Cytherelloidea? japonica Ishizaki

Plate 6, figure 12; plate 16, figure 20

Ambocythere japonica Ishizaki, 1968, Tohoku Univ. Sci. Repts., ser. 2 (Geology), v. 40, no. 1, p. 39, pl. 2, fig. 9; pl. 8, figs. 15-17.

Type and dimensions.—Hypotype USNM 184628. Adult RV. S=44.20 m. L=506, H=300, W=133.

Distribution.—Pleistocene(?): Sand Island hole (1).

Species No.—S(19).

Discussion.—Though it has the same dimensions as the type figured by Ishizaki (1968), the single Midway specimen has no duplicature and appears to be immature. Also, the dorsum is broken and the hinge is obscure. The distinctive surface ornamentation is identical with that of the Japanese specimens.

Cytherelloidea sp. 1

Plate 6, figure 11

Type and dimensions.—Specimen USNM 184622. Adult ♂ RV. S=44.20 m. L=664, H=339, W=134. The single adult specimen is probably a male.

Distribution.—Pleistocene(?): Sand Island hole (3).

Species No.—S(18).

Discussion.—The complete lack of longitudinal lateral ridges suggests *Cytherella* rather than *Cytherelloidea*. However, the deep though small pits and faint anterior marginal ridge is indicative of the genus *Cytherelloidea*. The single adult specimen is probably a male.

Cytherelloidea sp. 2

Plate 6, figures 3, 4; plate 16, figures 18, 19

Types and dimensions.—

			Depth (m)	L	H	W
Specimen						
USNM 184623.	Adult ♂	RV	R-318.52	650	433	195
Specimen						
USNM 184624.	Adult ♀	RV	R-318.52	668	361	170
Specimen						
USNM 184625.	Adult ♀	carapace	R-318.36	686	384	260
Specimen						
USNM 184626.	Adult ♂	carapace	R-318.36	648	367	223

Distribution.—Lower Miocene: reef hole R-318.21 to R-318.66 m (30).

Species No.—R(71).

Discussion.—This species is closely related to *Cytherelloidea* sp. cf. *C. umbonata* and possibly is a phenotypic variant of it. Its range is brief and coincides well with that of *Patagonacythere? sebastianensis*, which usually occurs in great abundance. The species is distinctive, having no well-defined

lateral ridges and having rare pits of a type atypical of *C. sp. cf. C. umbonata*. A well-developed hinge like that of *C. sp. cf. C. umbonata* and other allied Midway species is present.

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<i>turda</i>	25, 26; pls. 1, 12

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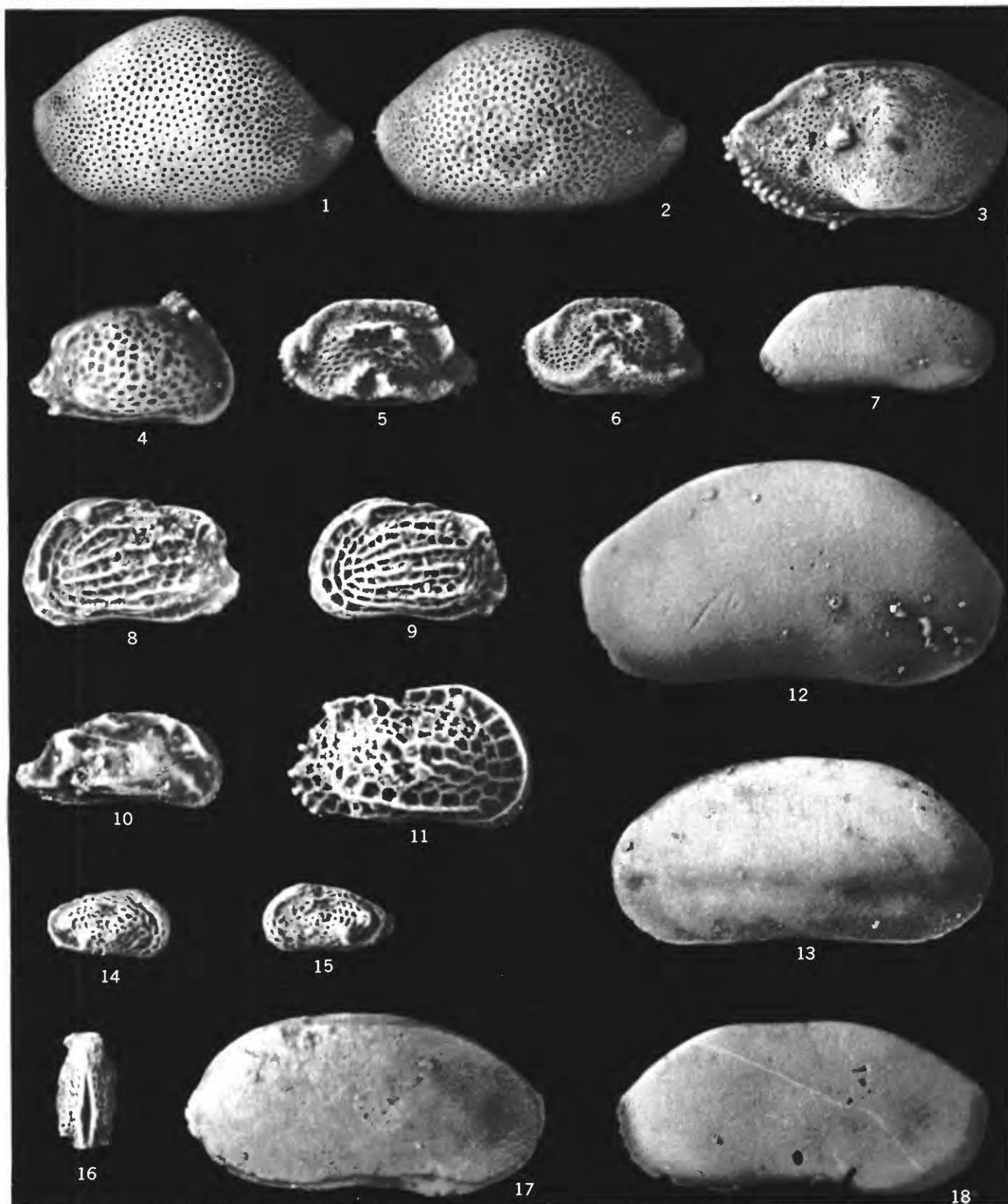
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sp. 2 -----	36; pl. 15

PLATES 1-17

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PLATE 1

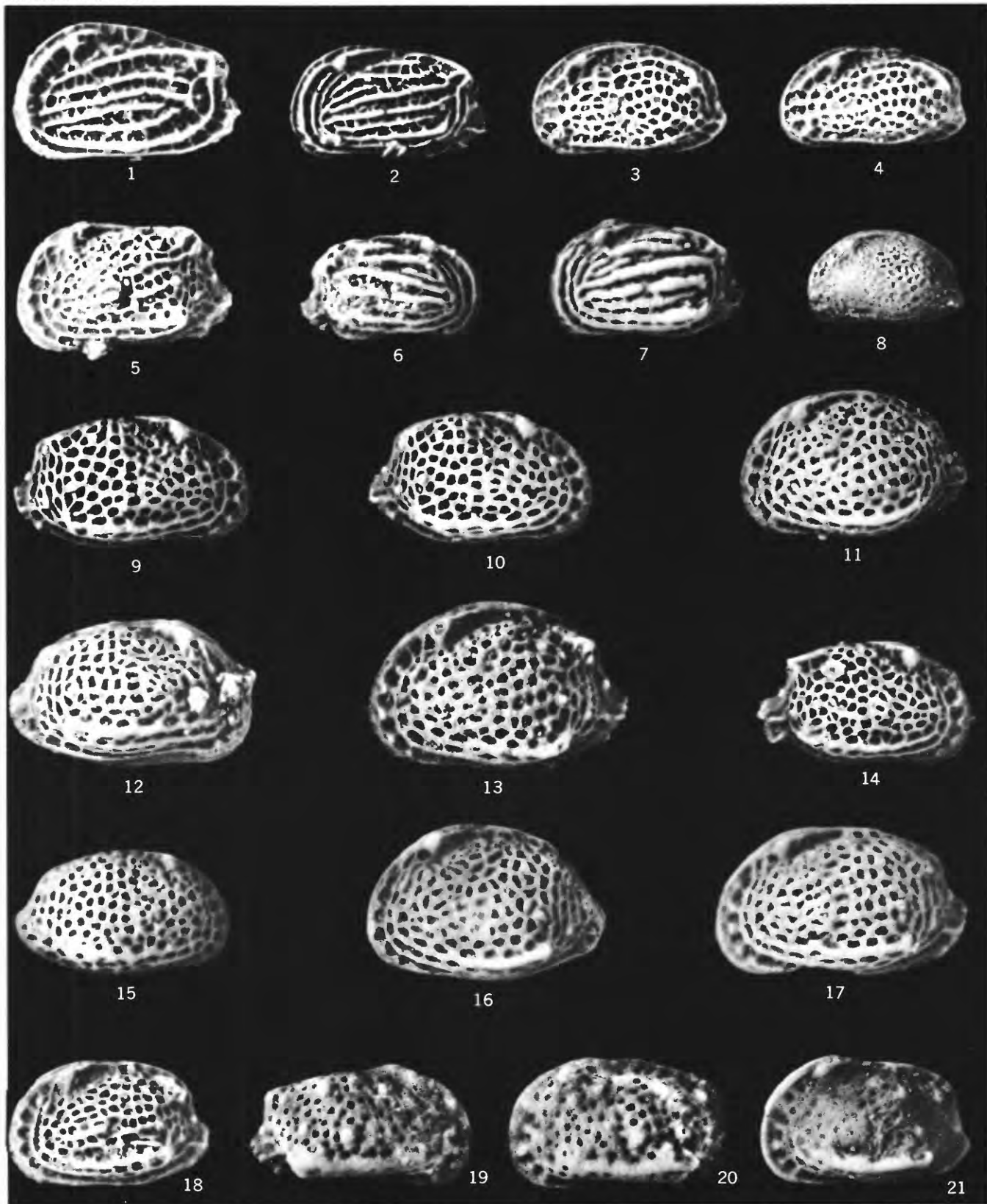
- FIGURES
- 1, 2. *Bairdoppilata* sp. aff. *B. bradyi* (Bold) (p. F17).
 1. Lateral view adult male left valve. KR-12.19 m. Specimen USNM 184356. × 52.
(See pl. 9, fig. 21 for internal view.)
 2. Lateral view adult female left valve. S-44.20 m. Specimen USNM 184355. × 49.
 3. *Havanardia?* *cuneolus* Holden, n. sp. (p. F14).
 - Right valve lateral view adult carapace. R-342.90 m. Holotype USNM 184321. × 52.
 4. *Pokornyella deformis* (Reuss)? (p. F21).
 - Right valve lateral view adult carapace. R-317.60 m. Hypotype USNM 184397. × 55.
 - 5, 6. *Triebelina crumena* (Stephenson) (p. F15).
 5. Left valve lateral view adult carapace. R-326.55 m. Hypotype USNM 184328.
× 56.
 6. Left valve lateral view adult carapace. R-321.87 m. Hypotype USNM 184327.
× 48.
 - 7, 12, 13, 17, 18. *Bythocypris reniformis* Brady (p. F18).
 7. Lateral view young right valve. S-147.83 m. Hypotype USNM 184373. × 50.
 12. Left valve lateral view adult carapace. R-172.21 m. Hypotype USNM 184376.
× 51.
 13. Left valve lateral view adult carapace. R-321.86 m. Hypotype USNM 184374.
× 51.
 17. Right valve lateral view adult carapace. R-317.60 m. Hypotype USNM 184375.
× 50.
 18. Lateral view adult right valve. S-147.83 m. Hypotype USNM 184372. × 50.
 - 8, 9. *Radimella polycosta* Holden, n. sp. sensu stricto (p. F22).
 8. Left valve lateral view adult carapace. R-308.76 m. Paratype USNM 184415.
× 52.
 9. Left valve lateral view adult carapace. R-308.46 m. Paratype USNM 184414.
× 53.
 10. *Caudites* sp. (p. F20).
 - Lateral view adult right valve. S-140.21 m. Specimen USNM 184389. × 52.
 11. *Tenedocythere turda* Holden, n. sp. (p. F25).
 - Lateral view young right valve. R-338.94 m. Paratype USNM 184455. × 53.
 - 14-16. *Munseyella inconspicua* (Brady) (p. F34).
 - From R-313.64 m.
 14. Right valve lateral view adult carapace. Hypotype USNM 184570. × 52.
 15. Left valve lateral view adult carapace. Hypotype USNM 184571. × 54.
 16. Dorsal view adult carapace. Hypotype USNM 184572. × 52.



BAIRDOPPILATA, HAVANARDIA?, POKORNYELLA, TRIEBELINA, BYTHOCYPRIS, RADIMELLA, CAUDITES, TENEDOCYTHERE, AND MUNSEYELLA

PLATE 2

- FIGURE
1. *Radimella convoluta* (Brady) (p. F21).
Left valve lateral view adult carapace. S-73.46 m. Holotype USNM 184411. \times 53.
 2. *Radimella polycosta* Holden, n. sp. sensu stricto (p. F22).
Lateral view adult left valve. S-140.21 m. Holotype USNM 184416. \times 52.
 - 3, 4. "*Hemicythere*" *gordoni* Bold (p. F20).
From R-308.46 m.
3. Left valve lateral view adult carapace. Hypotype USNM 184424. \times 48.
4. Lateral view adult left valve. Hypotype USNM 184425. \times 50.
 5. *Tenedocythere setigera* Holden, n. sp. (p. F26).
Left valve lateral view adult carapace. R-311.35 m. Paratype USNM 184467. \times 52.
 - 6, 7. *Radimella polycosta rugosa* Holden, n. sp., n. subsp. (p. F22).
From R-173.28 m.
6. Lateral view adult right valve. Paratype USNM 184419. \times 51.
7. Lateral view adult left valve. Holotype USNM 184418. \times 51.
 8. *Aurila* sp. aff. *A. lincolniensis* (LeRoy) (p. F22).
Lateral view adult left valve. R-321.87 to 323.39 m. Specimen USNM 184421. \times 52.
 - 9-18. *Pokornyyella pseudojaponica* Holden, n. sp. sensu stricto (p. F21).
9. Lateral view adult right valve. S-147.37 m. Paratype USNM 184402. \times 53.
10. Lateral view adult right valve. S-147.37 m. Paratype USNM 184403. \times 52.
11. Lateral view adult left valve. S-140.21 m. Paratype USNM 184404. \times 52.
12. Right valve lateral view adult carapace. R-172.21 m. Paratype USNM 184400.
 \times 52.
13. Lateral view adult left valve. S-149.66 m. Paratype USNM 184405. \times 51.
14. Lateral view adult right valve. S-140.21 m. Paratype USNM 184407. \times 51.
15. Lateral view adult right valve. S-171.91 m. Paratype USNM 184401. \times 51.
16. Left valve lateral view adult carapace. R-172.21 m. Paratype USNM 184399.
 \times 52.
17. Left valve lateral view adult carapace. R-160.63 m. Paratype USNM 184406.
 \times 52.
18. Left valve lateral view adult carapace. R-161.24 m. Paratype USNM 184408.
 \times 52.
 - 19-21. "*Procythereis*" *northpacific*a Holden, n. sp. (p. F23).
19. Lateral view adult right valve. R-147.37 m. Paratype USNM 184430. \times 52.
20. Lateral view adult left valve. R-152.40 m. Holotype USNM 184431. \times 53.
21. Left valve lateral view adult carapace. R-147.37. Paratype USNM 184429. \times 47.



RADIMELLA, "*HEMICYTHERE*," *TENEDOCYTHERE*, *AURILA*, *POKORNYELLA*, AND "*PROCYTHEREIS*"

PLATE 3

FIGURES 1-4, 16. *Hammatocythere? sebastianensis* (Bold) (p. F28).

1. Lateral view adult right valve. R-296.66 m. Hypotype USNM 184503. \times 52.
2. Lateral view adult left valve. R-318.67 m. Hypotype USNM 184504. \times 53. (See pl. 12, figs. 1, 4, for dorsal and internal views.)
3. Lateral view adult right valve. R-318.67 m. Hypotype USNM 184505. \times 52. (See pl. 12, fig. 2, for dorsal view.)
4. Dorsal view adult carapace. R-318.67 m. Hypotype USNM 184506. \times 52.
16. Left valve adult carapace. R-296.66 m. Hypotype USNM 184507. \times 52.

5-7. *Orionina flabellacosta* Holden, n. sp. (p. F20).

5. Lateral view adult female left valve. R-343.30 m. Paratype USNM 184391. \times 52.
6. Lateral view adult female left valve. R-355.09 m. Paratype USNM 184392. \times 50.
7. Right valve lateral view adult male carapace. R-344.12 m. Holotype USNM 184390. \times 50.

8-13. *Tenedocythere setigera* Holden, n. sp. (p. F26).

8. Lateral view adult left valve. R-343.30 m. Paratype USNM 184463. \times 51.
9. Dorsal view adult carapace. R-343.30 m. Paratype USNM 184464. \times 50.
10. Lateral view adult left valve. R-338.94 m. Holotype USNM 184465. \times 51. (See pl. 12, fig. 13, for internal view.)
11. Lateral view adult (?) right valve. R-308.46 m. Paratype USNM 184466. \times 52.
12. Left valve view adult carapace. R-320.65 m. Paratype USNM 184469. \times 52.
13. Right valve view adult carapace. R-320.65 m. Paratype USNM 184470. \times 51.

14, 15. *Quadracythere trijugis* Holden, n. sp. (p. F23).

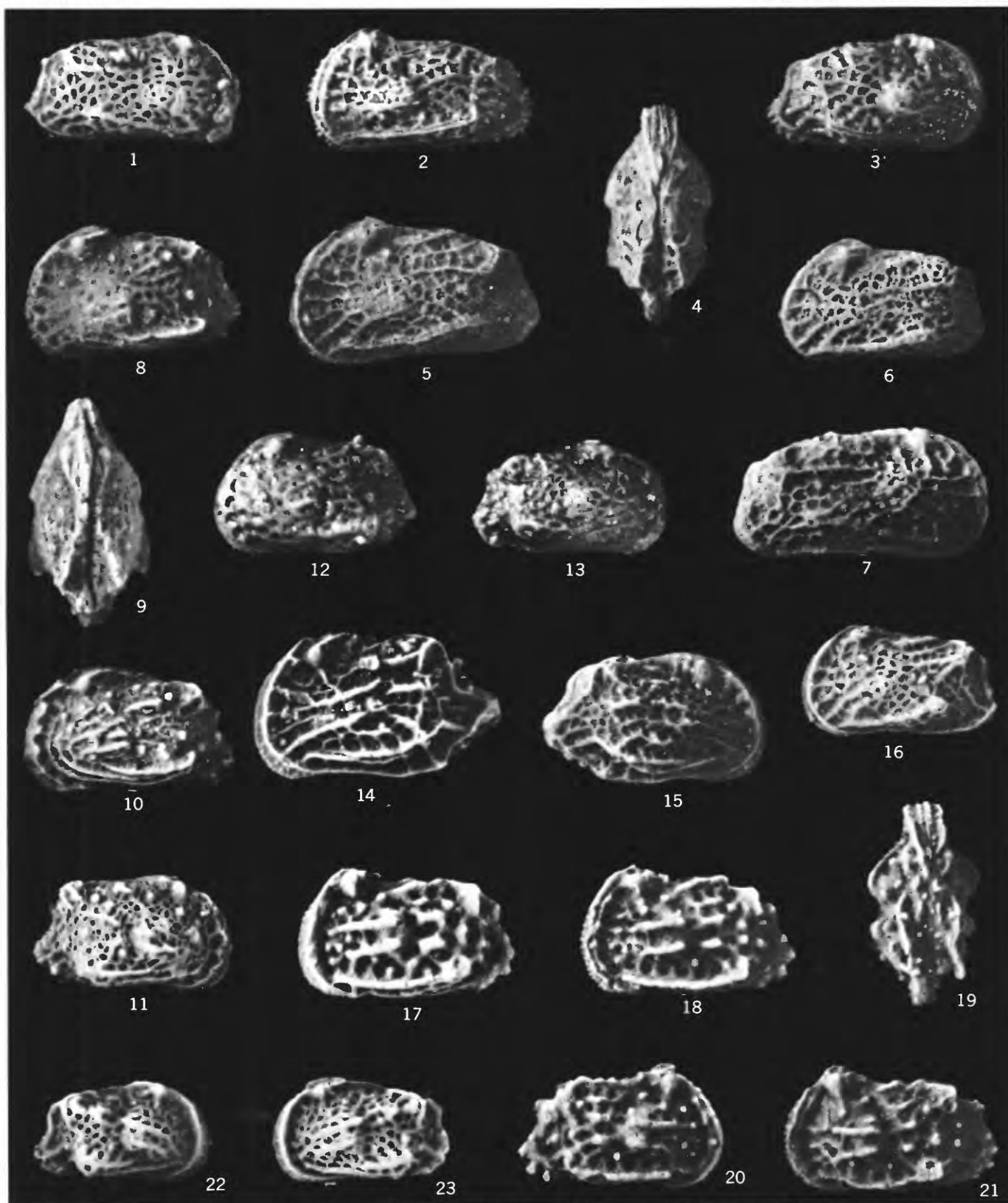
14. Left valve view adult carapace (large form). S-140.21 m. Holotype USNM 184432. \times 51.
15. Right valve view adult carapace (small form). R-326.14 m. Paratype USNM 184433. \times 51.

17-21. *Jugosocythereis pannosa* (Brady) (p. F25).

17. Left valve view adult carapace. S-149.05 m. Hypotype USNM 184475. \times 52.
18. Left valve view adult carapace. R-355.09 m. Hypotype USNM 184472. \times 51.
19. Dorsal view adult carapace. R-355.09 m. Hypotype USNM 184473. \times 50.
20. Right valve view adult carapace. R-355.09 m. Hypotype USNM 184471. \times 51.
21. Left valve view adult carapace. R-343.30 m. Hypotype USNM 184474. \times 52.

22, 23. *Jugosocythereis lactea* (Brady) (p. F25).

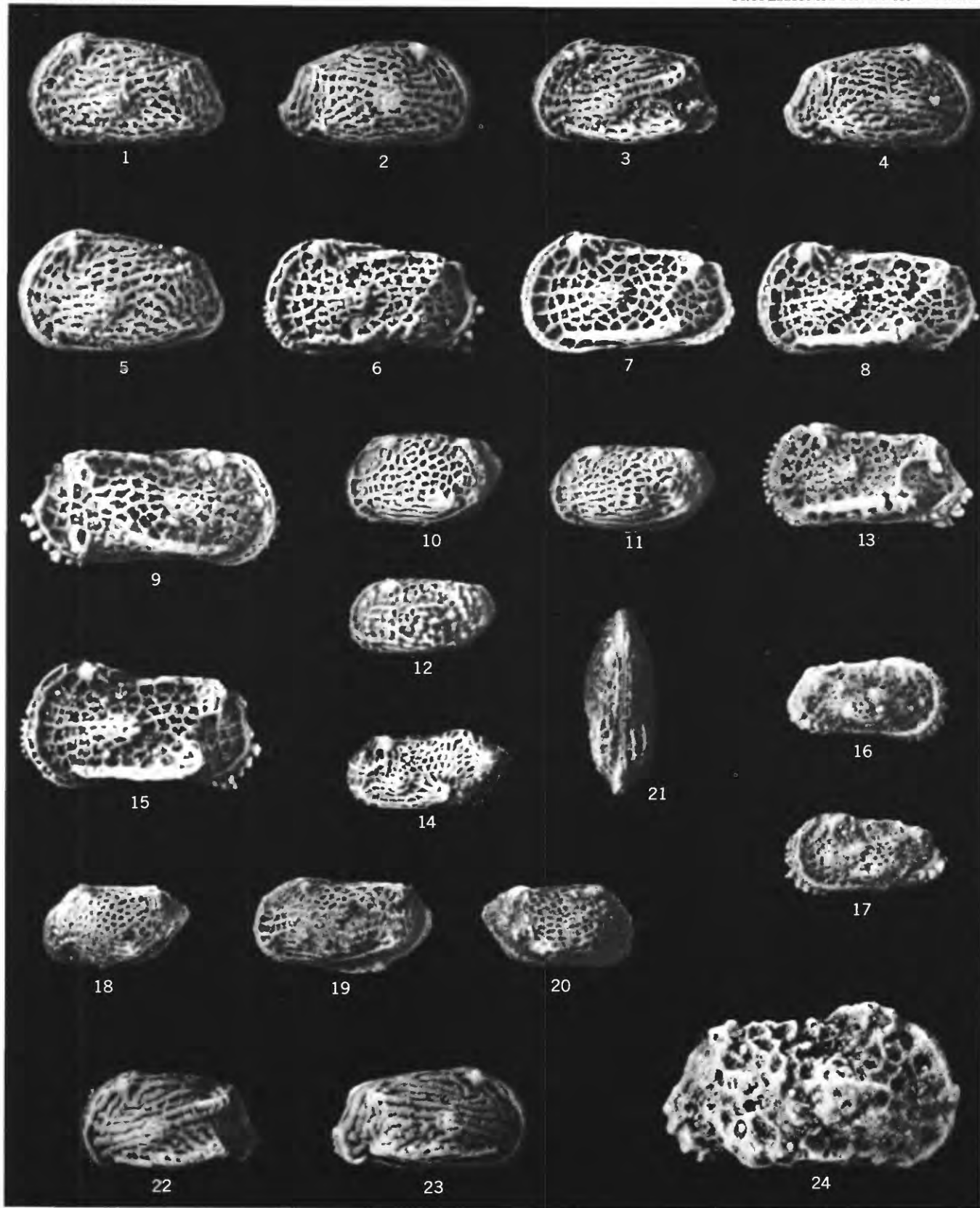
22. Lateral view adult right valve. S-73.46 m. Hypotype USNM 184451. \times 53.
23. Left valve view adult carapace. S-74.22 m. Hypotype USNM 184452. \times 50.



HAMMATOCYTHERE?, *ORIONINA*, *TENEDOCYTHERE*, *QUADRACYTHERE*, AND *JUGOSOCYTHEREIS*.

PLATE 4

- FIGURES 1-5. *Jugosocythereis canaliculata reticulata* Holden, n. sp., n. subsp. (p. F25).
1. Lateral view adult left valve. S-86.87 m. Holotype USNM 184445. $\times 52$.
 2. Lateral view adult right valve. S-86.87 m. Paratype USNM 184446. $\times 50$.
 3. Lateral view adult left valve. S-91.14 m. Paratype USNM 184450. $\times 51$.
 4. Right valve lateral view adult carapace. S-90.37 m. Paratype USNM 184449. $\times 51$.
 5. Left valve lateral view adult carapace. S-90.37 m. Paratype USNM 184448. $\times 52$.
- 6-9, 15. *Hermanites tschoppi* (Bold) (p. F27).
6. Lateral view adult female left valve. R-344.27 m. Hypotype USNM 184488. $\times 52$.
 7. Left valve lateral view adult female carapace. S-141.37 m. Hypotype USNM 184487. $\times 51$. (See pl. 13, fig. 3, for dorsal view.)
 8. Lateral view adult male left valve. S-141.73 m. Hypotype USNM 184486. $\times 51$. (See pl. 13, fig. 4, for internal view.)
 9. Lateral view adult male right valve. R-296.66 m. Hypotype USNM 184489. $\times 55$.
 15. Lateral view adult female left valve. R-296.66 m. Hypotype USNM 184490. $\times 54$.
- 10, 11. *Loxoconcha antillea* Bold sensu stricto (p. F32).
10. Lateral view adult female left valve. S-140.21 m. Hypotype USNM 184542. $\times 50$. (See pl. 14, fig. 6, for internal view.)
 11. Lateral view adult male left valve. S-141.73 m. Hypotype USNM 184543. $\times 51$.
12. *Loxoconcha uranouchiensis* Ishizaki (p. F32).
- Lateral view adult female left valve. S-45.11 m. Hypotype USNM 184551. $\times 51$.
13. *Cletocythereis bradyi* Holden (p. F28).
- Left valve lateral view adult female carapace. S-44.20. Hypotype USNM 184492. $\times 52$.
14. *Loxoconcha longispina* Key (p. F32).
- Lateral view adult male left valve. S-147.37 m. Hypotype USNM 184537. $\times 55$.
- 16, 17. *Platycosta amicus* Holden, n. sp. (p. F29).
- From R-336.27 m.
 16. Right valve lateral view adult male carapace. Paratype USNM 184497. $\times 52$.
 17. Left valve lateral view adult female carapace. Holotype USNM 184498. $\times 52$.
- 18-21. *Loxoconcha antillea* Bold *diffusa* Holden, n. subsp. (p. F32).
18. Left valve lateral view adult female carapace. R-318.52 m. Holotype USNM 184546. $\times 51$.
 19. Left valve lateral view adult male carapace. R-343.30 m. Paratype USNM 184547. $\times 51$.
 20. Right valve lateral view adult female carapace. R-343.30 m. Paratype USNM 184548. $\times 52$.
 21. Dorsal view adult male carapace. R-343.30 m. Paratype USNM 184549. $\times 50$.
- 22, 23. *Jugosocythereis canaliculata* Holden, n. sp., sensu stricto (p. F24).
- From S-45.11 m.
 22. Lateral view adult left valve. Holotype USNM 184442. $\times 51$. (See pl. 14, fig. 16, for internal view.)
 23. Right valve lateral view adult carapace. Paratype USNM 184443. $\times 51$.
24. *Hermanites* sp. aff. *H. barri* (Bold, 1960) (p. F28).
- Lateral view adult right valve. S-148.74 m. Specimen USNM 184493. $\times 49$. (See pl. 12, fig. 21, for dorsal view.)

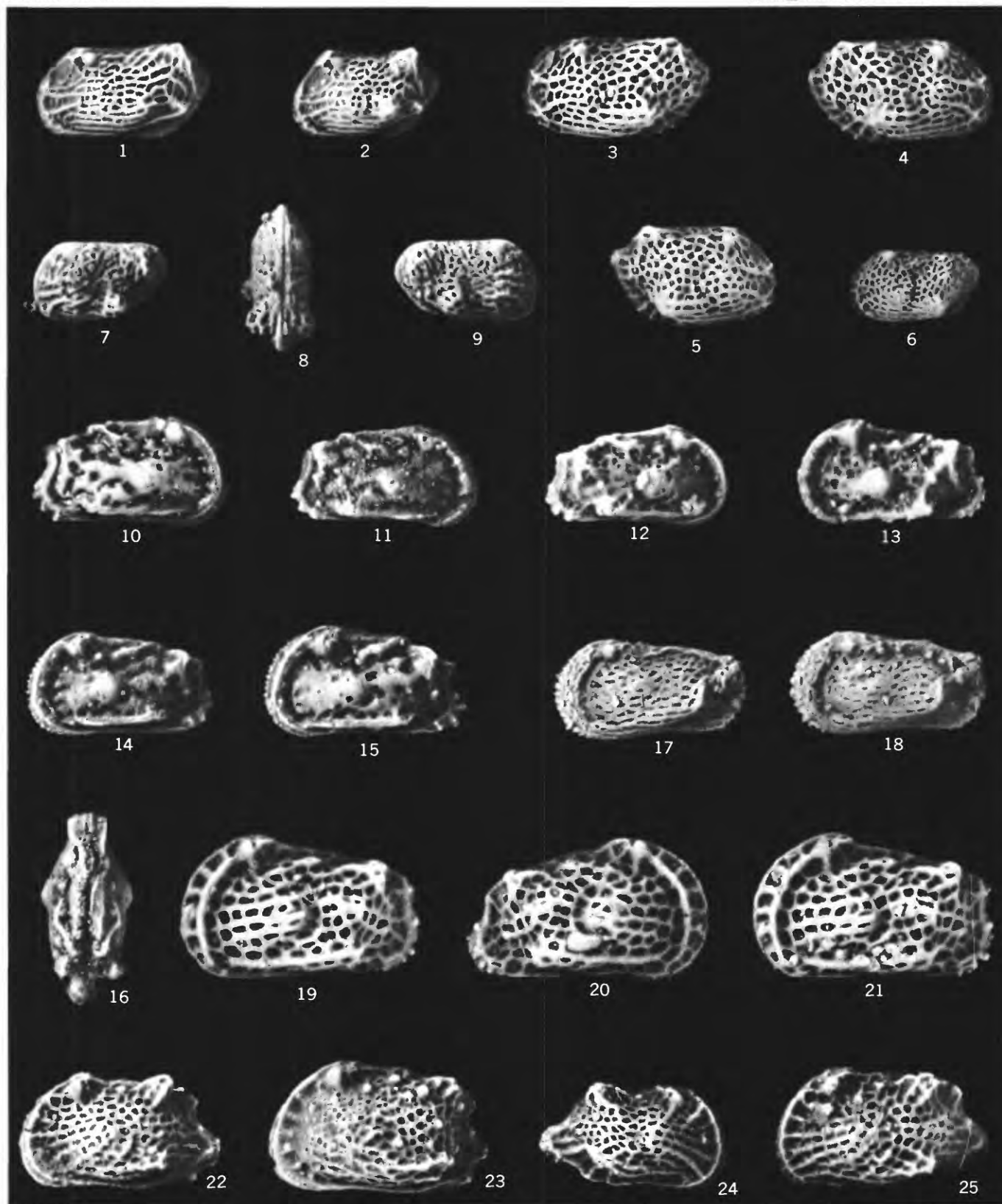


JUGOSOCYTHEREIS, HERMANITES, LOXOCONCHA, CLETOCYTHEREIS, AND PLATYCOSTA

PLATE 5

FIGURES

- 1, 2. *Loxoconcha antillea* Bold sensu stricto (p. F32).
 1. Lateral view adult male left valve. R-161.39 m. Hypotype USNM 184539. $\times 51$.
 2. Lateral view adult female left valve. S-141.73 m. Hypotype USNM 184540. $\times 51$.
- 3-6. *Loxoconcha longispina* Key (p. F32).
 3. Lateral view adult male left valve. S-78.88 m. Hypotype USNM 184532. $\times 51$.
(See pl. 14, fig. 13, for internal view.)
 4. Lateral view adult male right valve. S-78.88 m. Hypotype USNM 184533. $\times 51$.
 5. Lateral view adult female right valve. S-79.19 m. Hypotype USNM 184535. $\times 52$.
 6. Lateral view young left valve. S-78.88 m. Hypotype USNM 184534. $\times 50$.
- 7-9. *Loxoconcha* sp. 2 (p. F33).
From R-355.09 m.
 7. Left valve lateral view adult carapace. Specimen USNM 184558. $\times 51$.
 8. Dorsal view adult carapace Specimen USNM 184559. $\times 51$.
 9. Right valve lateral view adult carapace. Specimen USNM 184557. $\times 52$.
- 10-12, 14-16. *Hermanites praehawaiianensis* Holden, n. sp. (p. F27).
 10. Right valve lateral view adult carapace. R-321.87 m. Holotype USNM 184483. $\times 53$.
 11. Right valve lateral view adult carapace. R-343.30 m. Paratype USNM 184480. $\times 51$.
 12. Left valve lateral view adult carapace. R-311.35 m. Paratype USNM 184485. $\times 51$.
 14. Left valve lateral view adult carapace. R-343.30 m. Paratype USNM 184481. $\times 52$.
 15. Left valve lateral view adult carapace. R-336.27 m. Paratype USNM 184484. $\times 52$.
 16. Dorsal view adult carapace. R-343.30 m. Paratype USNM 184482. $\times 53$.
13. *Hermanites hawaiianensis* Holden, n. sp. (p. F27).
Lateral view adult left valve. S-91.14 m. Holotype USNM 184479. $\times 53$.
- 17, 18. *Muellerina?* sp. (p. F23).
 17. Left valve lateral view adult carapace. R-311.81 m. Specimen USNM 184428. $\times 51$.
 18. Left valve lateral view adult carapace. R-311.35 m. Specimen USNM 184427. $\times 51$.
- 19-21. *Tenedocythere quadranodosa* Holden, n. sp. (p. F26).
 19. Lateral view adult left valve. S-141.73 m. Paratype USNM 184459. $\times 51$. (See pl. 12, fig. 11, for dorsal view.)
 20. Lateral view adult right valve. S-141.73 m. Holotype USNM 184460. $\times 50$. (See pl. 12, fig. 12, for dorsal view.)
 21. Lateral view adult left valve. S-140.21 m. Paratype USNM 184461. $\times 51$.
- 22, 25. *Quadracythere spica* Holden, n. sp. (p. F24).
 22. Left valve lateral view adult carapace. R-343.30 m. Hypotype USNM 184441. $\times 53$.
 25. Lateral view adult left valve. R-343.05 m. Paratype USNM 184440. $\times 51$.
23. *Tenedocythere setigera* Holden, n. sp. (p. F26).
Left valve lateral view adult carapace. R-296.66 m. Paratype USNM 184468. $\times 52$.
24. *Quadracythere trijugis* Holden, n. sp. (p. F23).
Lateral view young right valve. S-140.21 m. Paratype USNM 184435. $\times 51$.



LOXOCONCHA, HERMANITES, MUELLERINA?, TENEDOCYTHERE, AND QUADRACYTHERE

PLATE 6

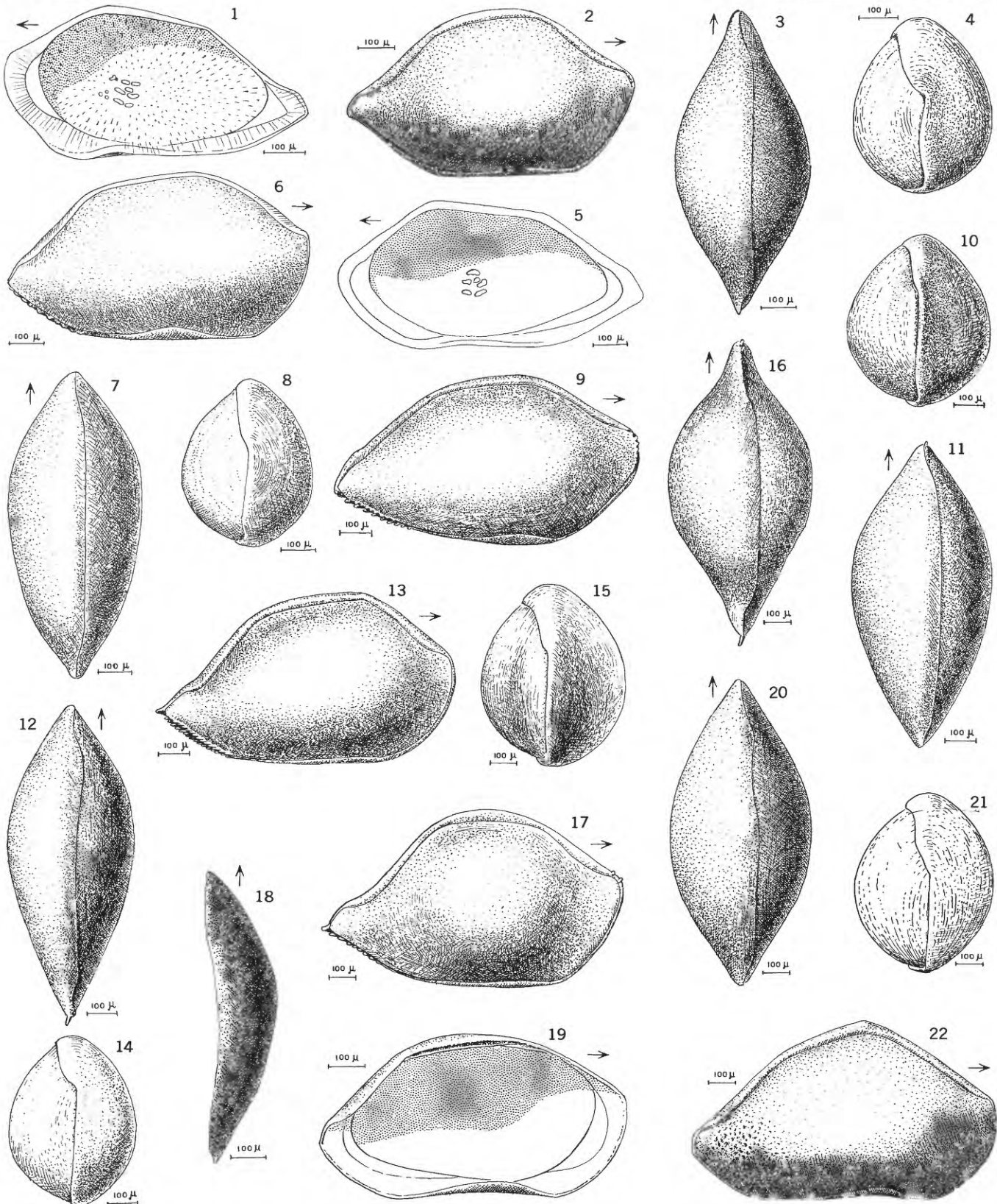
- FIGURES
- 1, 2. *Cytherelloidea semipunctata* Holden, n. sp. (p. F37).
From R-308.45 m.
1. Lateral view adult female right valve. Holotype USNM 184617. $\times 50$.
2. Lateral view adult female left valve. Paratype USNM 184618. $\times 52$.
 - 3, 4. *Cytherelloidea* sp. 2 (p. F38).
From R-318.52 m.
3. Lateral view adult male right valve. Specimen USNM 184623. $\times 52$.
4. Lateral view adult female right valve. Specimen USNM 184624. $\times 50$.
 - 5-8, 10. *Cytherelloidea* sp. cf. *C. umbonata* Edwards (p. F37).
5. Left valve lateral view adult female carapace. S-149.66 m. Specimen USNM 184610. $\times 51$.
6. Left valve lateral view adult female carapace. R-343.30 m. Specimen USNM 184611. $\times 51$.
7. Left valve lateral view adult male carapace. R-343.30 m. Specimen USNM 184612. $\times 52$.
8. Lateral view adult male left valve. R-343.30 m. Specimen USNM 184613. $\times 52$.
10. Lateral view adult female right valve. S-141.73 m. Specimen USNM 184614. $\times 51$.
 9. *Cytherelloidea* sp. cf. *C. umbonata* Edwards variation (p. F37).
Lateral view adult female left valve. R-338.94 m. Specimen USNM 184616. $\times 50$.
(See pl. 16, fig. 21, for dorsal view.)
 11. *Cytherelloidea* sp. 1 (p. F38).
Lateral view adult male right valve. S-44.20 m. Specimen USNM 184622. $\times 50$.
 12. *Cytherelloidea?* *japonica* Ishizaki (p. F38).
Lateral view adult female right valve. S-44.20 m. Hypotype USNM 184628. $\times 51$.
(See pl. 16, fig. 20, for dorsal view.)
 13. *Loxoconchella anomala* (Brady) (p. F33).
Left valve lateral view adult carapace. MR-21.34 m. Hypotype USNM 184563. $\times 51$.
 - 14-17. *Parakrithella robusta* Holden, n. sp. (p. F30).
14. Left valve lateral view adult male carapace. S-140.67 m. Paratype USNM 184521. $\times 52$.
15. Lateral view adult female right valve. S-141.73 m. Paratype USNM 184519. $\times 50$.
(See pl. 13, fig. 16, for dorsal view.)
16. Right valve lateral view adult female carapace. S-140.67 m. Holotype USNM 184520. $\times 51$.
17. Lateral view adult male left valve. S-141.73 m. Paratype USNM 184518. $\times 51$.
 - 18-20. *Loxoconchella honoluliensis* (Brady) (p. F33).
18. Lateral view adult right valve. S-147.37 m. Hypotype USNM 184560. $\times 50$.
19. Right valve lateral view adult carapace. S-149.66 to 151.18 m. Hypotype USNM 184562. $\times 51$.
20. Lateral view adult right valve. R-173.29 m. Hypotype USNM 184561. $\times 51$.
 - 21-23. *Cyprideis beaconensis* (LeRoy) (p. F29).
21. Lateral view adult male right valve. S-74.22 m. Hypotype USNM 184510. $\times 51$.
(See pl. 13, figs. 5, 7, for internal and dorsal views.)
22. Lateral view adult female right valve. S-78.49 m. Hypotype USNM 184509. $\times 50$.
(See pl. 13, fig. 6, for dorsal view.)
23. Lateral view adult female left valve. S-78.49 m. Hypotype USNM 184511. $\times 51$.



CYTHERELLOIDEA, LOXOCONCHELLA, PARAKRITHELLA, AND CYPRIDEIS

PLATE 7

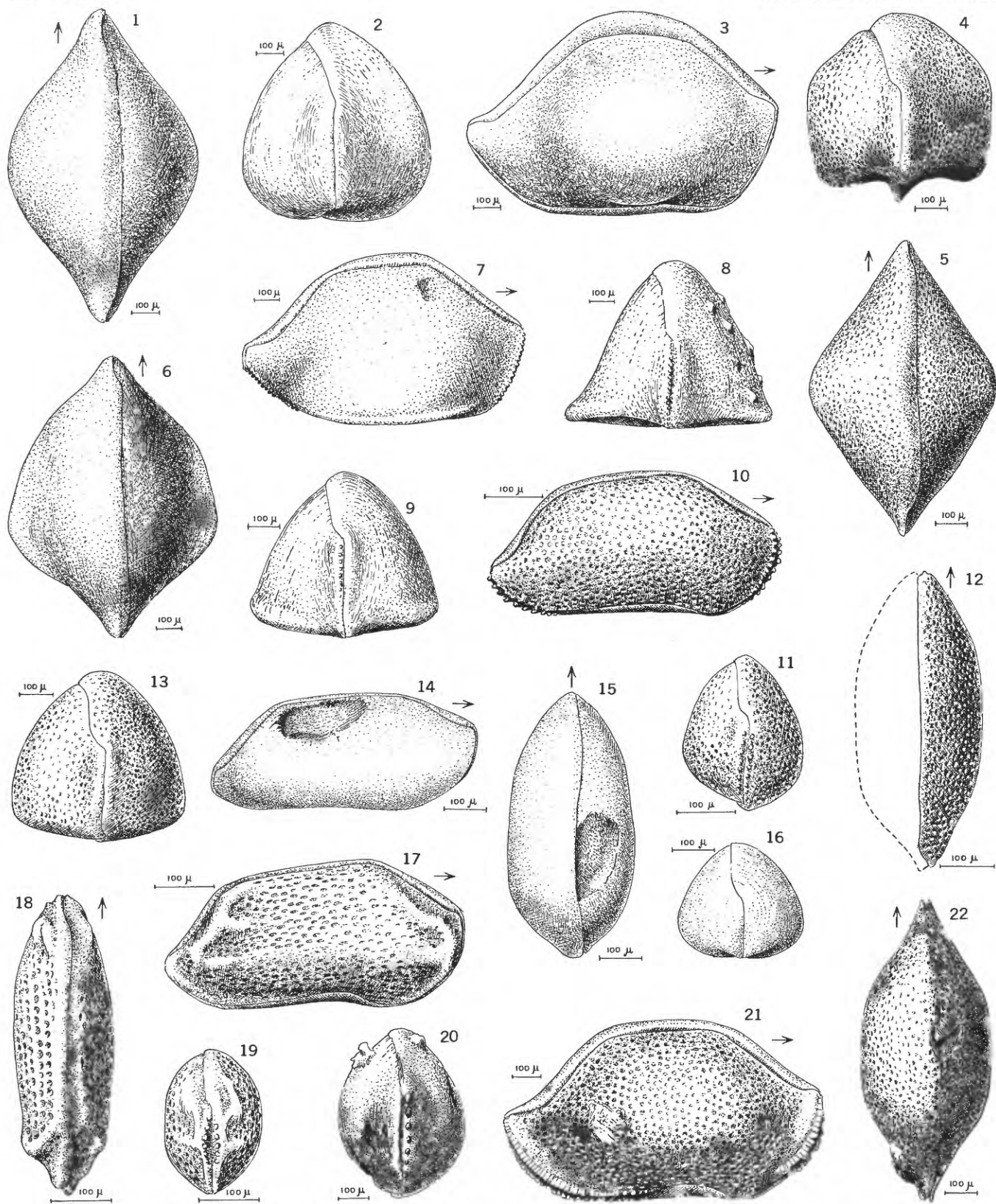
- FIGURE 1. *Neonesidea gierloffii* (Hartmann) (p. F11).
 Internal view adult right valve. S-44.21 m. Hypotype USNM 184298.
- 2-4. *Neonesidea* sp. aff. *N. cassida* (Bold) (p. F11).
 2. Right valve lateral view adult carapace. R-320.95 m. Specimen USNM 184299.
 3. Dorsal view adult carapace. R-321.72 m. Specimen USNM 184301.
 4. Anterior view adult carapace. R-321.72 m. Specimen USNM 184300.
- 5-8. *Neonesidea* sp. cf. *N. sinuvillosa* (Swain) (p. F12).
 From S-147.37 m.
 5. Internal view adult female right valve. Specimen USNM 184303.
 6-8. Lateral right valve, dorsal, and anterior views of adult male carapace. Specimen USNM 184302.
- 9-11. *Neonesidea schulzi* (Hartmann) (p. F12).
 Right valve lateral, anterior, and dorsal views of adult carapace. R-295.05 m. Hypotype USNM 184305.
- 12-14. *Neonesidea spica* Holden, n. sp. (p. F12).
 Dorsal, right valve lateral, and anterior views of adult carapace. R-320.95 m. Holotype USNM 184311.
- 15-17. *Neonesidea* sp. 1 (p. F14).
 Anterior, dorsal, and right valve lateral views of adult carapace. R-337.34 m. Specimen USNM 184316.
- 18, 19. *Neonesidea* sp. 3 (p. F14).
 18. Dorsal view adult right valve. R-321.41 m. Specimen USNM 184319.
 19. Internal view adult left valve. R-320.34 m. Specimen USNM 184320.
- 20-22. *Neonesidea* sp. 2 (p. F14).
 Dorsal, anterior and right valve lateral views of adult carapace. R-336.56 m. Specimen USNM 184318.



NEONESIDEA

PLATE 8

- FIGURES 1-3. *Neonesidea? reefholensis* Holden, n. sp. (p. F13).
Dorsal, anterior, and right valve lateral views of adult carapace. R-343.30 m. Holotype USNM 184314.
- 4, 5. *Havanardia? cuneolus* Holden, n. sp. (p. F14).
Anterior and dorsal views of adult carapace. R-343.21 m. Paratype USNM 184322.
- 6-8. *Havanardia* sp. 1 (p. F14).
Dorsal, right valve lateral, and anterior views of adult carapace. R-343.30 m. Specimen USNM 184323.
9. *Havanardia* sp. 2 (p. F15).
Anterior view adult carapace. R-284.00 m. Specimen USNM 184325.
- 10-12. *Triebelina reticulopuncta* Benson (p. F15).
From R-295.50 m.
10, 11. Right valve lateral and anterior views of adult carapace. Hypotype USNM 184331.
12. Dorsal view adult right valve. Hypotype USNM 184330.
13. *Havanardia* sp. 3 (p. F15).
Anterior view adult carapace. R-231.65 m. Specimen USNM 184326.
- 14-16. *Triebelina* sp. 1 (p. F16).
Right valve lateral, dorsal, and anterior views of adult carapace. R-172.21 m. Specimen USNM 184335.
- 17-19. *Triebelina* sp. 2 (p. F16).
Right valve lateral, dorsal, and anterior views of adult carapace. R-161.24 m. Specimen USNM 184337.
- 20-22. *Paranesidea handeli* Holden, n. sp. (p. F16).
20. Anterior view adult carapace. R-342.90 m. Paratype USNM 184345.
21. Right valve lateral view adult carapace. R-337.72 m. Paratype USNM 184347.
22. Dorsal view adult carapace. R-343.30 m. Holotype USNM 184344.



NEONESIDEA?, *HAVANARDIA?*, *HAVANARDIA*, *TRIEBELINA*, AND *PARANESIDEA*

PLATE 9

FIGURES 1-4, 6. *Paranesidea* sp. 2 (p. F17).

- 1, 3. Right valve lateral and anterior views of adult female carapace. R-311.35 m. Specimen USNM 184352.
2. Dorsal view adult left valve. R-311.35 m. Specimen USNM 184353.
4. Right valve lateral view adult male carapace. R-313.64 m. Specimen USNM 184354.
6. Right valve lateral view adult carapace, color pattern in stipple. R-285.90 m. Specimen USNM 184350.

5. *Paranesidea* sp. 1 (p. F17).

Right valve lateral view adult carapace. R-341.38 m. Specimen USNM 184349.

7-9. *Paranesidea victrix* (Brady) (p. F16).

7. Internal view adult left valve. R-343.21 m. Hypotype USNM 184341.
8. Dorsal view adult carapace. R-338.94 m. Hypotype USNM 184338.
9. Anterior view adult carapace. R-338.94 m. Hypotype USNM 184340.

10-12. *Bairdoppilata planolata* Holden, n. sp. sensu stricto (p. F17).

10. Right valve lateral view adult carapace. R-284.00 m. Paratype USNM 184358.
- 11, 12. Dorsal and anterior views of adult carapace. R-343.05 m. Holotype USNM 184359.

13-16. *Bairdoppilata planolata ventrocaudata* Holden, n. sp., n. subsp. (p. F18).

From R-311.35 m.

- 13, 14, 16. Dorsal, anterior, and lateral views of adult left valve. Holotype USNM 184360.

15. Internal view adult right valve. Paratype USNM 184361.

17-19. *Bairdoppilata planolata magnumcaudata* Holden, n. sp., n. subsp. (p. F18).

Dorsal, right valve lateral, and anterior views of adult carapace. R-311.81 m. Holotype USNM 184362.

20, 21. *Bairdoppilata* sp. aff. *B. bradyi* (Bold) (p. F17).

20. Dorsal view adult carapace. R-31.55 m. Specimen USNM 184357.
21. Internal view adult left valve. KR-12.19 m. Specimen USNM 184356. (See pl. 1, fig. 1, for lateral view.)

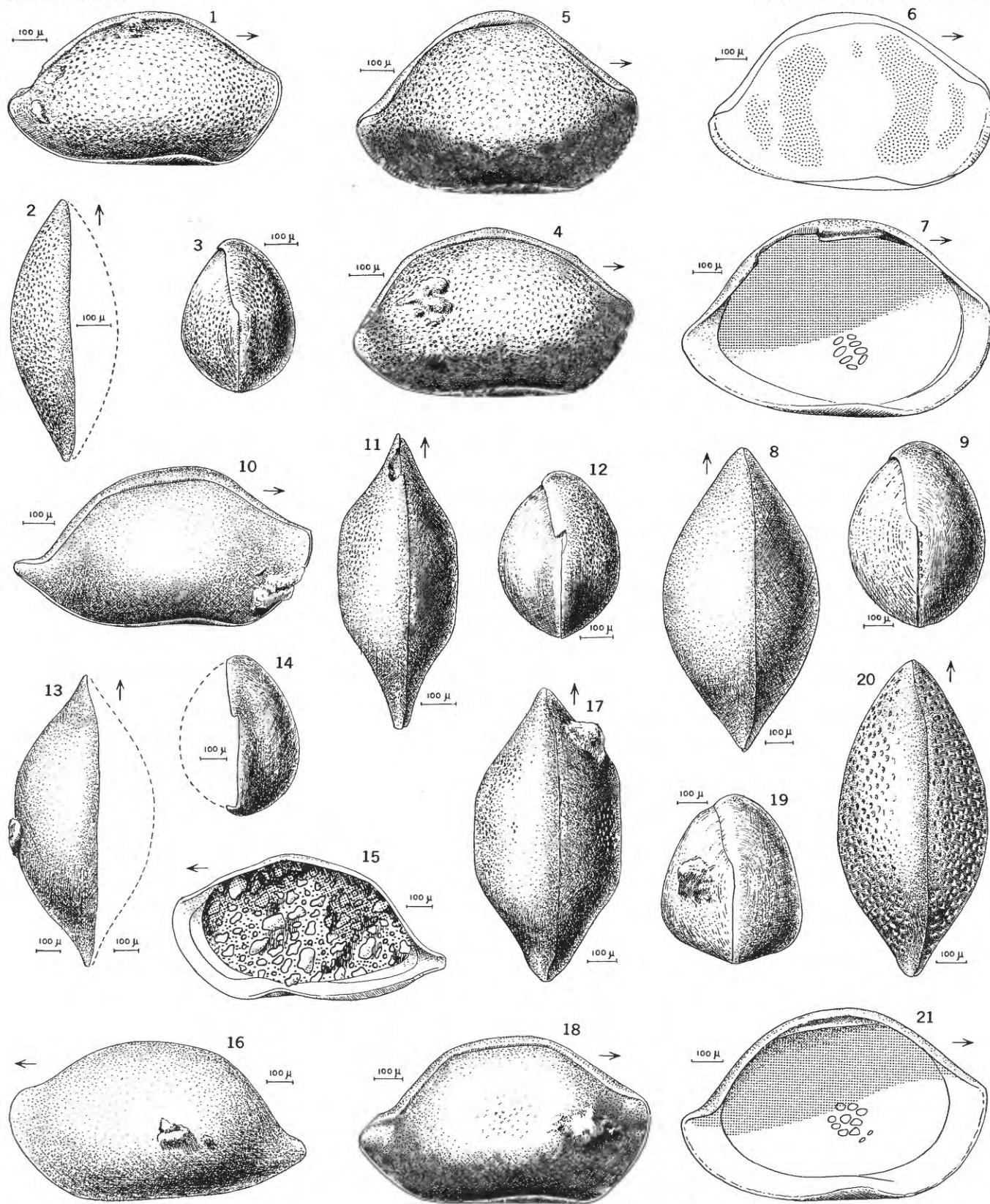
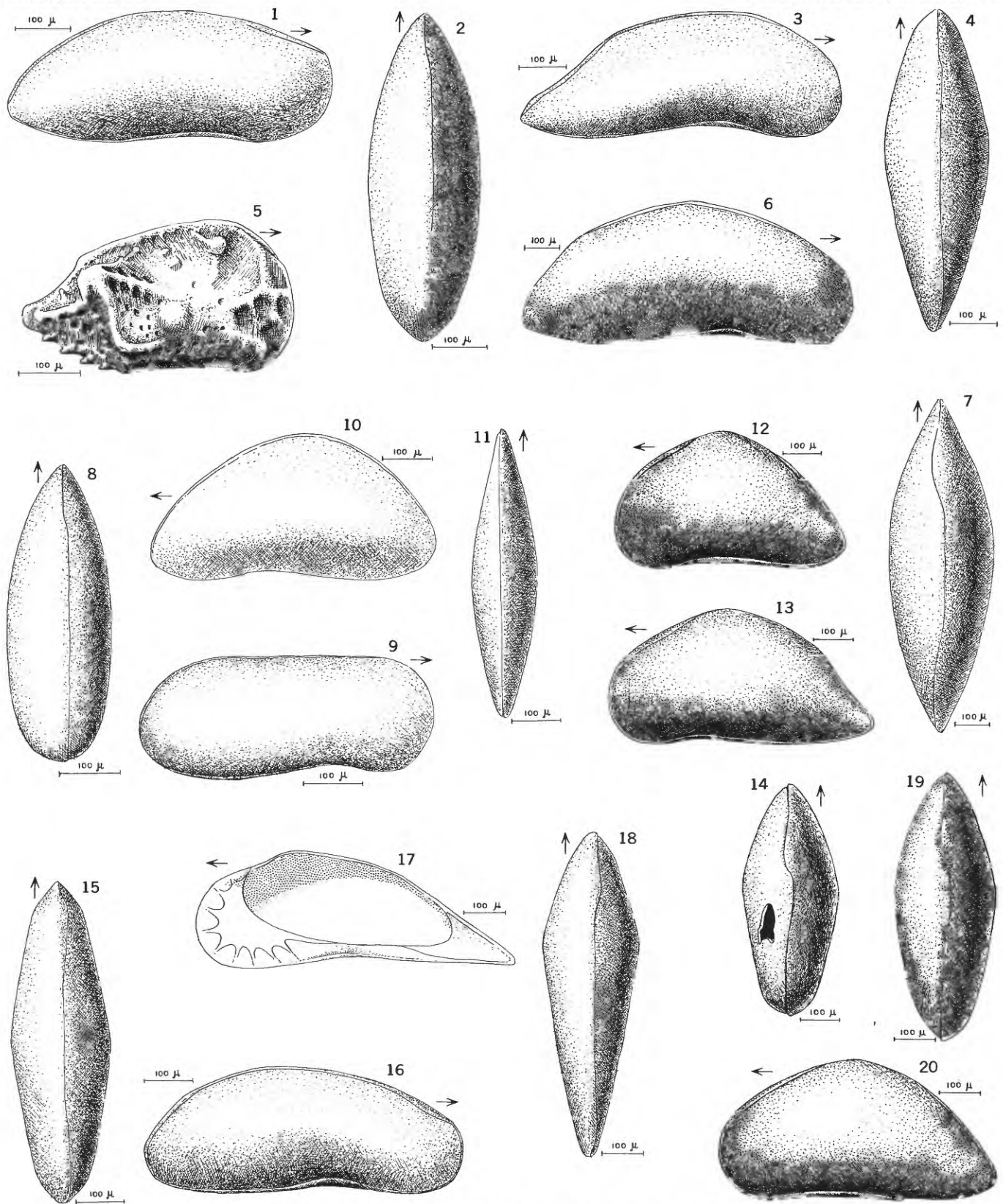
*PARANESIDEA AND BAIRDOPPILATA*

PLATE 10

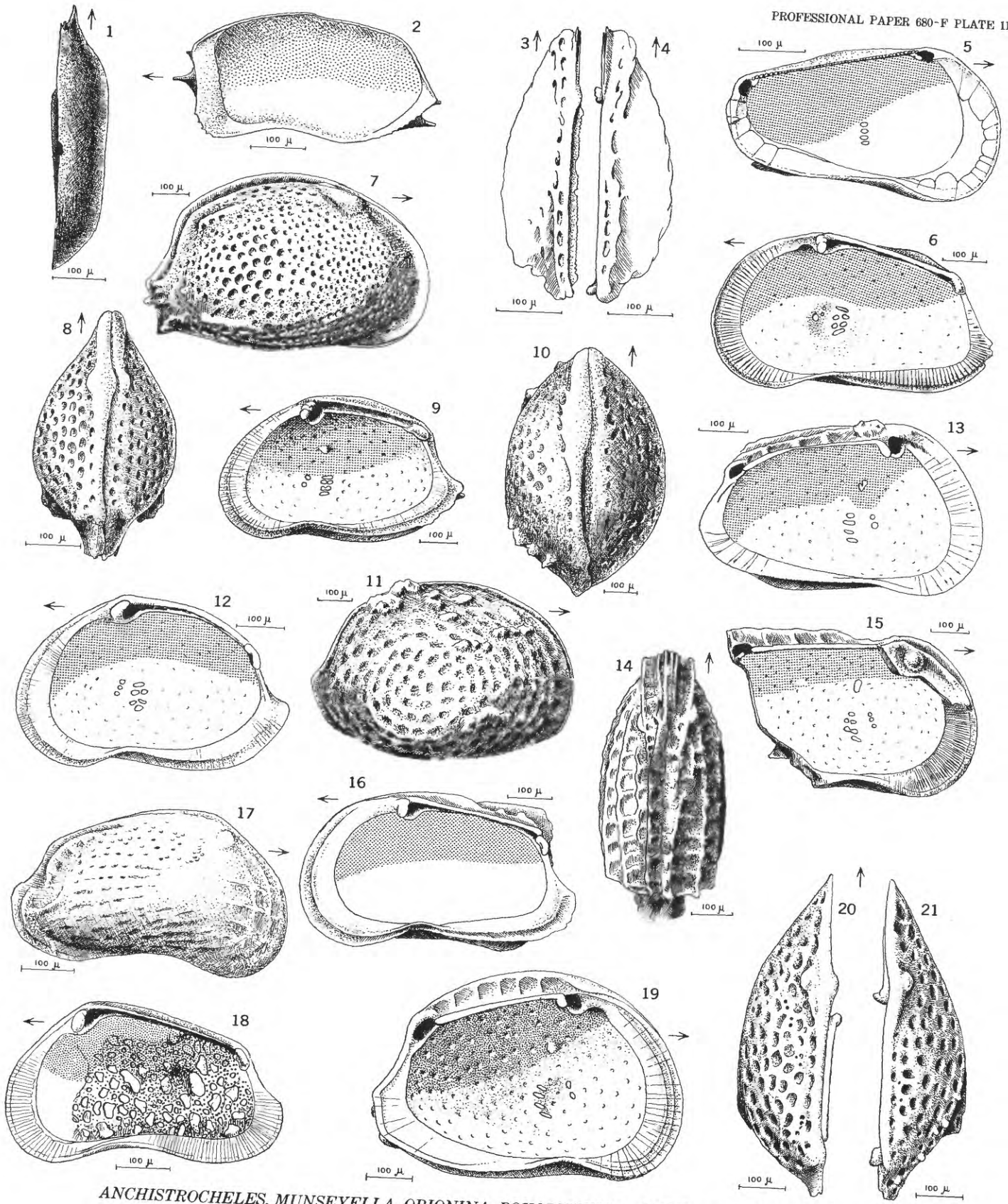
- FIGURES 1, 2. *Pontocyprilla?* sp. 1 (p. F20).
Right valve lateral and dorsal views of adult carapace. R-287.43 m. Specimen USNM 184384.
- 3, 4. *Paracypris* sp. cf. *P. rosefieldensis* Howe and Law (p. F19).
Right valve lateral and dorsal views of adult carapace. R-320.50 m. Specimen USNM 184378.
5. *Caudites* sp. (p. F20).
Lateral view penultimate right valve. R-31.55 m. Specimen USNM 184388.
- 6, 7. *Macrocyprina gracilis* (Brady) (p. F19).
Right valve lateral and dorsal views of adult carapace. R-317.90 m. Hypotype USNM 184368.
- 8, 9. *Pontocyprilla?* sp. 2 (p. F20).
Dorsal and right valve lateral views of adult carapace. R-320.96 m. Specimen USNM 184386.
- 10, 11. *Potamocypris?* sp. (p. F19).
Left valve lateral and dorsal views of adult carapace. S-73.46 m. Specimen USNM 184377.
- 12-14, 19, 20. *Macrocypris?* sp. aff. *M.?* *dimorpha* Hazel and Holden (p. F18).
12. Left valve lateral view adult female carapace. R-320.95 m. Hypotype USNM 184363.
13. Left valve lateral view adult male carapace. R-343.05 m. Hypotype USNM 184364.
14. Dorsal view adult female carapace. R-320.95 m. Hypotype USNM 184367.
19. Dorsal view adult male carapace. S-44.20 m. Hypotype USNM 184365.
20. Left valve lateral view adult male carapace. R-162.76 m. Hypotype USNM 184366.
- 15, 16. *Aglaiocypris* sp. (p. F19).
Dorsal and right valve lateral views of adult carapace. R-317.90 m. Specimen USNM 184382.
- 17, 18. *Paracypris franquesi* Howe and Chambers (p. F19).
17. Internal view adult right valve. R-320.95 m. Hypotype USNM 184381.
18. Dorsal view adult carapace. R-320.35 m. Hypotype USNM 184380.



*PONTOCYPRELLA? PARACYPRIS, CAUDITES, MACROCYPRINA, POTAMOCYPRIS?,
MACROCYPRIS?, AND AGLAIOCYPRIS*

PLATE 11

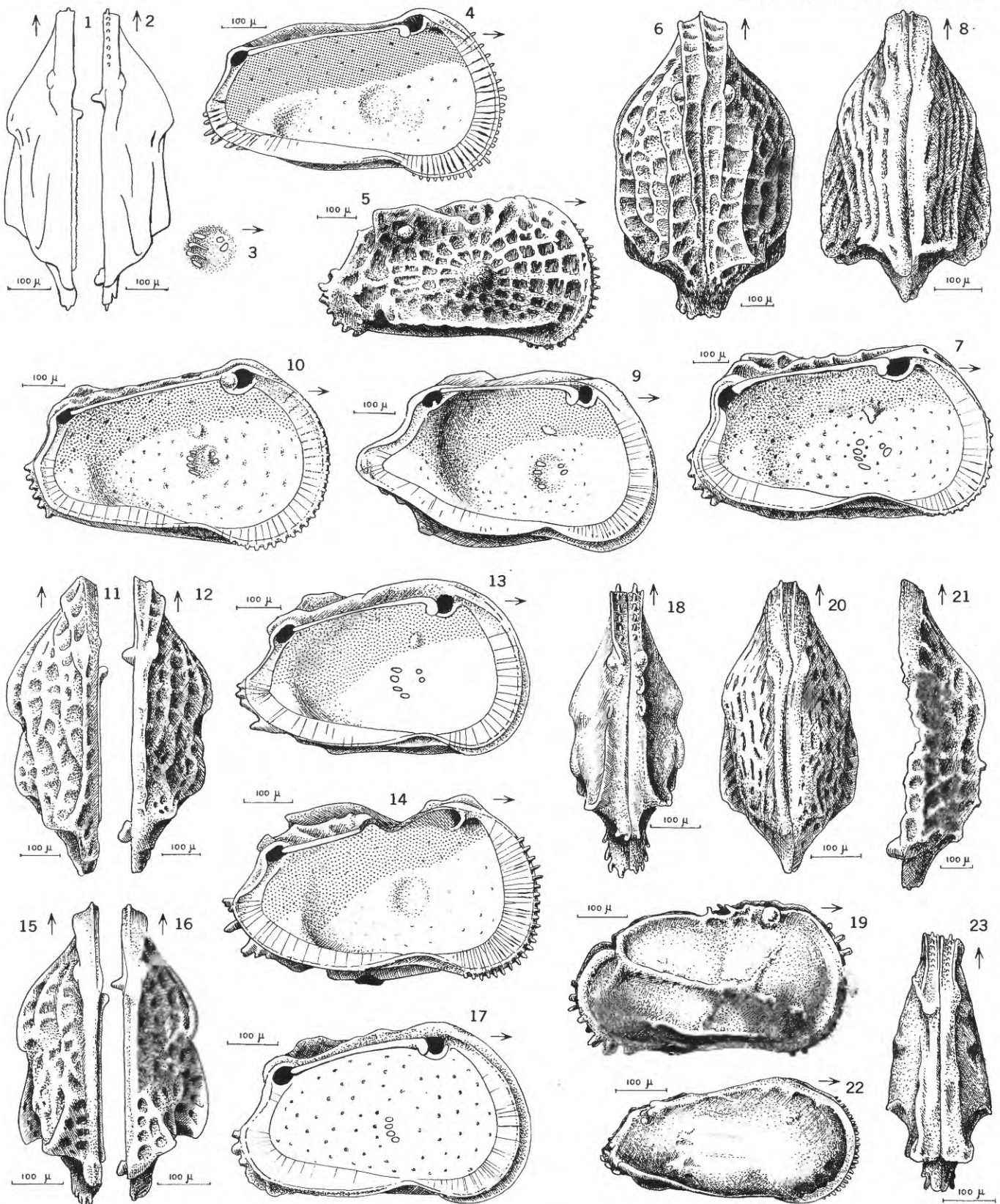
- FIGURES 1, 2. *Anchistrocheles* sp. (p. F18).
Dorsal and internal views of adult right valve. S-79.19 m. Specimen USNM 184627.
- 3-5. *Munseyella inconspicua* (Brady) (p. F34).
From S-78.88 m.
3, 4. Dorsal line drawings adult left and right valves. Hypotype USNM 184573.
5. Internal view adult left valve. Hypotype USNM 184574.
6. *Orionina flabellacosta* Holden, n. sp. (p. F20).
Internal view adult female right valve. R-344.12 m. Paratype USNM 184393.
- 7-9. *Pokorniyella deformis* (Reuss)? (p. F21).
From R-300.59 m.
7. Right valve lateral view adult male carapace. Hypotype USNM 184394.
8. Dorsal view adult female carapace. Hypotype USNM 184395.
9. Internal view adult female right valve. Hypotype USNM 184396.
- 10, 11. *Pokorniyella pseudojaponica inflata* Holden, n. sp., n. subsp. (p. F21).
From S-138.23 m.
10. Dorsal view adult carapace. Paratype USNM 184410.
11. Right valve lateral view adult carapace. Holotype USNM 184409.
12. *Aurila* sp. aff. *A. lincolnensis* (LeRoy) (p. F22).
Internal view adult right valve. S-152.25 m. Specimen USNM 184423. (See pl. 16, fig. 23, for dorsal view.)
13. *Radimella polycosta* Holden, n. sp. sensu stricto (p. F22).
Internal view adult left valve. S-140.21 m. Paratype USNM 184417.
- 14, 15. *Radimella convoluta* (Brady) (p. F21).
From S-73.46 m.
14. Dorsal view adult carapace. Paratype USNM 184412.
15. Internal view adult broken left valve. Paratype USNM 184413.
16. *Radimella polycosta rugosa* Holden, n. sp., n. subsp. (p. F22).
Internal view adult male right valve. R-173.28 m. Paratype USNM 184420.
- 17, 18. *Aurila* sp. (p. F23).
External and internal views of adult right valve. R-73.46 m. Specimen USNM 184426.
- 19-21. *Pokorniyella pseudojaponica* Holden, n. sp. sensu stricto (p. F21).
Internal and dorsal views of adult left valve and dorsal view adult right valve. S-147.37 m. Holotype USNM 184398.



ANCHISTROCHELES, MUNSEYELLA, ORIONINA, POKORNYELLA, AURILA, AND RADIMELLA

PLATE 12

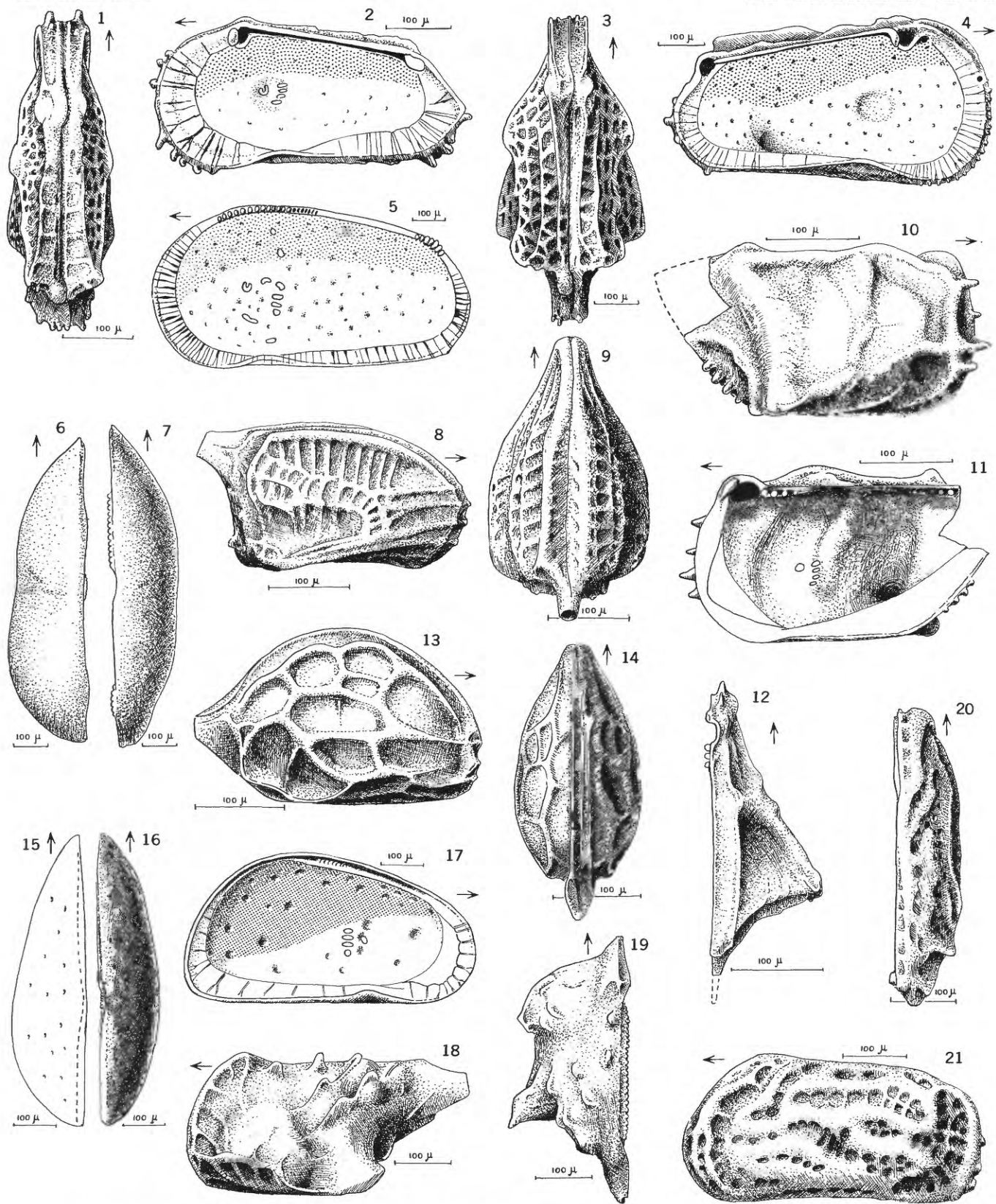
- FIGURES 1-4. *Hammatocythere? sebastianensis* (Bold) (p. F28).
 From R-318.67 m.
 1, 4. Dorsal line drawing and internal view adult left valve. Hypotype USNM 184504. (See pl. 3, fig. 2, for lateral view.)
 2. Dorsal line drawing adult right valve. Hypotype USNM 184505. (See pl. 3, fig. 3, for lateral view.)
 3. Central muscle-scar pattern adult left valve. Hypotype USNM 184508.
5. *Hermanites tschoppi* (Bold) (p. F27).
 Lateral view adult female right valve. R-173.28 m. Hypotype USNM 184491.
- 6, 7. *Tenedocythere turda* Holden, n. sp. (p. F25).
 From R-317.37 m.
 6. Dorsal view adult carapace. Holotype USNM 184456.
 7. Internal view adult left valve. Paratype USNM 184457.
8. *Jugosocythereis canaliculata* Holden, n. sp. sensu stricto (p. F24).
 Dorsal view adult carapace. R-22.25 m. Paratype USNM 184444.
9. *Quadracythere trijugis* Holden, n. sp. (p. F23).
 Internal view adult left valve. S-140.21 m. Paratype USNM 184434.
- 10-12. *Tenedocythere quadranodosa* Holden, n. sp. (p. F26).
 10. Internal view adult left valve. S-140.21 m. Paratype USNM 184462.
 11. Dorsal view adult left valve. S-141.73 m. Paratype USNM 184459. (See pl. 5, fig. 19, for lateral view.)
 12. Dorsal view adult right valve. S-141.73 m. Holotype USNM 184460. (See pl. 5, fig. 20, for lateral view.)
13. *Tenedocythere setigera* Holden, n. sp. (p. F26).
 Internal view adult left valve. R-338.94 m. Holotype USNM 184465. (See pl. 3, fig. 10, for lateral view.)
14. *Jugosocythereis pannosa* (Brady) (p. F25).
 Internal view dorsally broken adult left valve. S-152.40 m. Hypotype USNM 184476.
- 15-17. *Jugosocythereis lactea* (Brady) (p. F25).
 15, 16. Dorsal view adult left and right valves. R-31.55 m. Hypotype USNM 184453.
 17. Internal view adult left valve. S-73.46 m. Hypotype USNM 184454.
- 18, 19. *Neocaudites* sp. (p. F28).
 From R-307.39 m.
 18. Dorsal view adult carapace. Specimen USNM 184501.
 19. Right valve lateral view adult carapace. Specimen USNM 184502.
20. *Jugosocythereis canaliculata reticulata* Holden, n. sp., n. subsp. (p. F25).
 Dorsal view adult carapace. S-97.84 m. Paratype USNM 184447.
21. *Hermanites* sp. aff. *H. barri* (Bold, 1960) (p. F28).
 Dorsal view dorsally broken adult right valve. S-148.74 m. Specimen USNM 184493.
 (See pl. 4, fig. 24, for lateral view.)
- 22, 23. *Occultocythereis* sp. (p. F29).
 22. Right valve lateral view adult carapace. R-283.46 m. Specimen USNM 184495.
 23. Dorsal view adult carapace. R-295.81 m. Specimen USNM 184496.



HAMMATOCYTHERE?, *HERMANITES*, *TENEDOCYTHERE*, *JUGOSOCYTHEREIS*, *QUADRACYTHERE*, *NEOCAUDITES*,
AND *OCCULTOCYTHEREIS*

PLATE 13

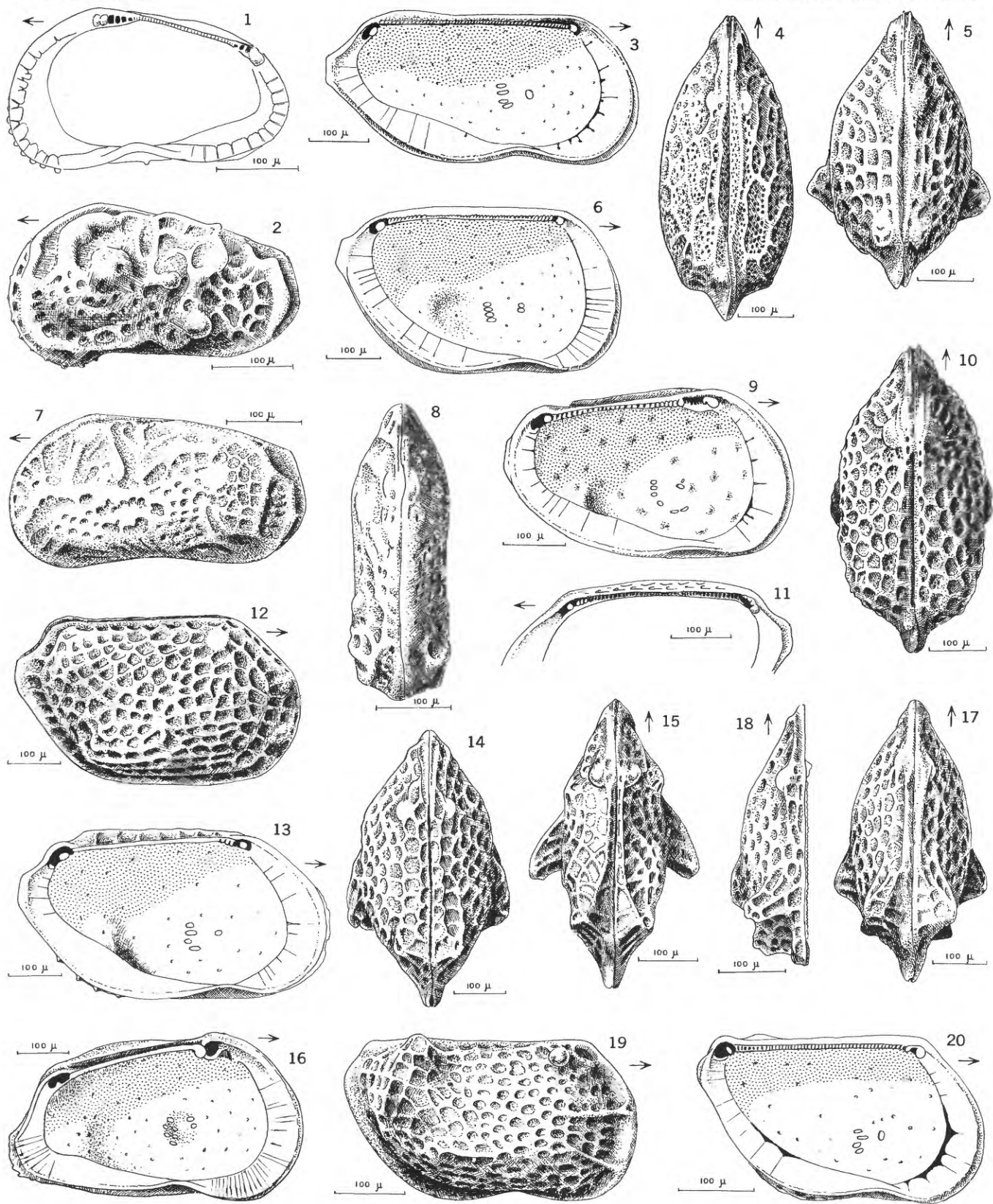
- FIGURES 1, 2. *Platycosta amicus* Holden, n. sp. (p. F29).
 1. Dorsal view adult male carapace. R-320.35 m. Paratype USNM 184499.
 2. Internal view adult male right valve. S-45.11 m. Paratype USNM 184500.
- 3, 4. *Hermanites tschoppi* (Bold) (p. F27).
 3. Dorsal view adult female carapace. S-147.37 m. Hypotype USNM 184487. (See pl. 4, fig. 7, for lateral view.)
 4. Internal view adult male left valve. S-141.73 m. Hypotype USNM 184486. (See pl. 4, fig. 8, for lateral view.)
- 5-7. *Cyprideis beaconensis* (LeRoy) (p. F29).
 5, 7. Internal and dorsal views of male right valve. S-74.22 m. Hypotype USNM 184510. (See pl. 6, fig. 21, for lateral view.)
 6. Dorsal view adult female left valve. S-78.49 m. Hypotype USNM 184511. (See pl. 6, fig. 23, for lateral view.)
- 8, 9. *Semicytherura* sp. (p. F30).
 Right valve lateral and dorsal views of adult carapace. R-320.95 m. Specimen USNM 184512.
- 10-12. *Bythoceratina* sp. (p. F30).
 Lateral, internal, and dorsal views of adult posteriorly broken right valve. S-45.11 m. Specimen USNM 184515.
- 13, 14. *Hemicytherura pentagona* Hornibrook (p. F30).
 13. Right valve lateral view adult carapace. S-140.21 m. Hypotype USNM 184513.
 14. Dorsal view adult carapace. S-140.67 m. Hypotype USNM 184514.
- 15-17. *Parakrithella robusta* Holden, n. sp. (p. F30).
 15, 17. Dorsal line drawing and internal view adult male left valve. S-140.21 m. Paratype USNM 184522.
 16. Dorsal view adult female right valve. S-141.73 m. Paratype USNM 184519. (See pl. 6, fig. 15, for lateral view.)
- 18, 19. *Paracytheridea* sp. (p. F30).
 18. Lateral view adult left valve. R-320.50 m. Specimen USNM 184516.
 19. Dorsal view adult left valve. R-320.35 m. Specimen USNM 184517.
- 20, 21. *Callistocythere* sp. 1 (p. F31).
 From S-147.37 m.
 20. Dorsal view adult right valve. Specimen USNM 184530.
 21. Lateral view adult left valve. Specimen USNM 184529.



PLATYCOSTA, HERMANITES, CYPRIDEIS, SEMICYTHERURA, BYTHOCERATINA, HEMICYTHERURA, PARAKRITHELLA, PARACYTHERIDEA, AND CALLISTOCYTHERE

PLATE 14

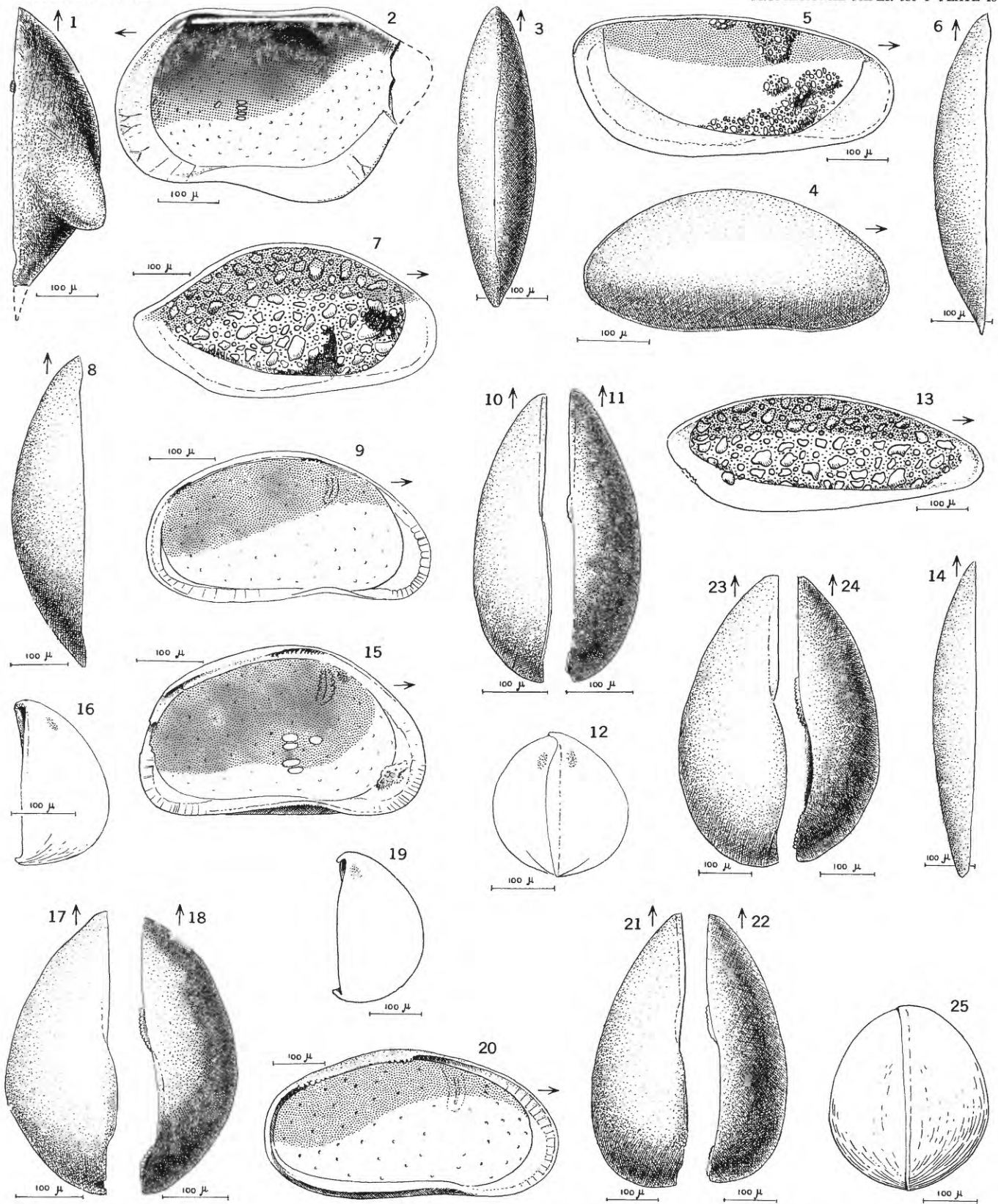
- FIGURES 1, 2. *Callistocythere crenata* (Brady) (p. F31).
 From S-44.20 m.
 1. Internal view adult right valve. Hypotype USNM 184528.
 2. Lateral view adult left valve. Hypotype USNM 184527.
3. *Loxoconcha antillea* Bold *diffusia* Holden, n. subsp. (p. F32).
 Internal view adult male left valve. R-318.52 m. Paratype USNM 184550.
- 4-6, 17. *Loxoconcha antillea* Bold sensu stricto (p. F32).
 4. Dorsal view adult male carapace. S-140.21 m. Hypotype USNM 184545.
 5. Dorsal view adult female carapace. S-140.21 m. Hypotype USNM 184544.
 6. Internal view adult female left valve. S-140.21 m. Hypotype USNM 184542. (See pl. 4, fig. 10, for lateral view.)
 17. Dorsal view adult female carapace. R-283.46 m. Hypotype USNM 184541.
- 7, 8. *Callistocythere* sp. 2 (p. F32).
 Left valve and dorsal views of adult carapace. R-320.95 m. Specimen USNM 184531.
- 9-11. *Loxoconcha uranouchiensis* Ishizaki (p. F32).
 9. Internal view adult female left valve. S-44.20 m. Hypotype USNM 184552.
 10. Dorsal view adult male carapace. S-73.47 m. Hypotype USNM 184553.
 11. Lateral hinge view adult female right valve. S-78.88 m. Hypotype USNM 184554.
- 12-15. *Loxoconcha longispina* Key (p. F32).
 12, 14. Right valve lateral and dorsal views adult female carapace. S-79.19 m. Hypotype USNM 184536.
 13. Internal view adult male left valve. S-78.88 m. Hypotype USNM 184532. (See pl. 5, fig. 3, for lateral view.)
 15. Dorsal view adult male carapace. S-147.37 m. Hypotype USNM 184538.
16. *Jugosocythereis canaliculata* Holden, n. sp. sensu stricto (p. F24).
 Internal view adult left valve. S-45.11 m. Holotype USNM 184442. (See pl. 4, fig. 22, for lateral view.)
- 18-20. *Loxoconcha* sp. 1 (p. F33).
 18, 20. Dorsal and internal views of adult female left valve. S-44.20 m. Specimen USNM 184555.
 19. Lateral view adult male right valve. S-73.46 m. Specimen USNM 184556.



CALLISTOCYTHERE, LOXOCONCHA, AND JUGOSOCYTHEREIS

PLATE 15

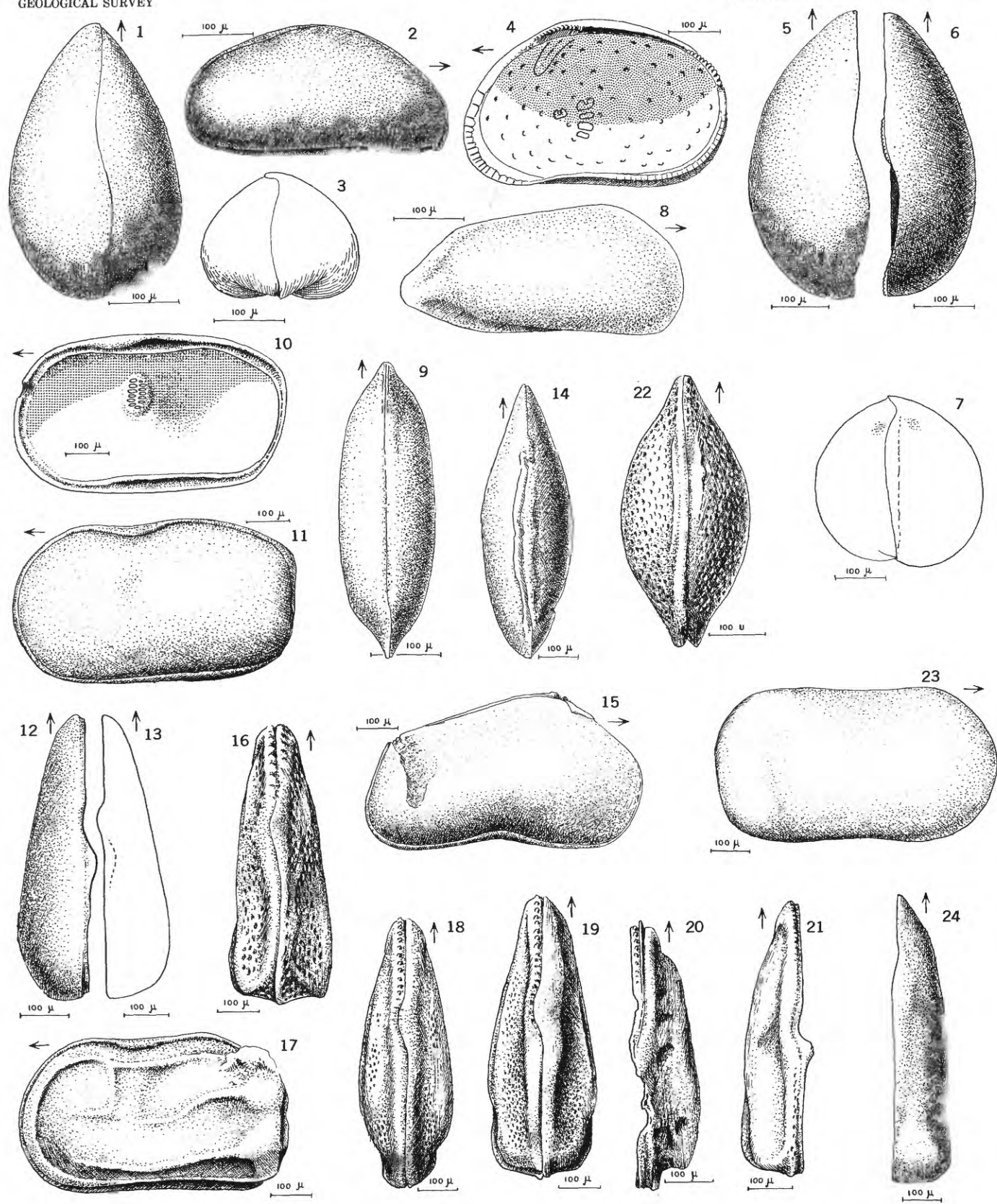
- FIGURES 1, 2. *Loxoconchella* sp. (p. F33).
Dorsal and internal views of adult posteriorly broken right valve. S-140.21 m. Specimen USNM 184565.
- 3, 4. *Paradoxostoma* sp. 1 (p. F34).
Dorsal and right valve lateral views of adult carapace. S-49.19 m. Specimen USNM 184567.
- 5, 6. *Paradoxostoma romei* McKenzie (p. F33).
Internal and dorsal views of adult left valve. R-31.55 m. Hypotype USNM 184566.
- 7, 8. *Pellucistoma* sp. (p. F34).
Internal and dorsal views of adult left valve. R-163.6 m. Specimen USNM 184569.
- 9-12. *Xestoleberis* sp. cf. *X. granulosa* Brady (p. F34).
9, 10. Internal and dorsal views of adult left valve. S-78.88 m. Specimen USNM 184585.
11. Dorsal view adult right valve. R-31.55 m. Specimen USNM 184586.
12. Anterior view adult carapace. S-78.88 m. Specimen USNM 184584.
- 13, 14. *Paradoxostoma* sp. 2 (p. F34).
Internal and dorsal views of adult left valve. R-320.34 m. Specimen USNM 184568.
- 15-18. *Xestoleberis* sp. 2 (p. F36).
From S-140.21 m.
15-17. Internal, anterior, and dorsal views of adult left valve. Specimen USNM 184600.
18. Dorsal view adult right valve. Specimen USNM 184601.
- 19-22. *Xestoleberis* sp. 1 (p. F35).
From S-147.37 m.
19. Anterior view adult male left valve. Specimen USNM 184597.
20. Internal view adult female left valve. Specimen USNM 184596.
21. Dorsal view adult female left valve. Specimen USNM 184598.
22. Dorsal view adult male right valve. Specimen USNM 184599.
- 23-25. *Xestoleberis* sp. cf. *X. curta* (Brady) (p. F35).
From S-73.41 m.
23. Dorsal view adult female left valve. Specimen USNM 184590.
24. Dorsal view adult female right valve. Specimen USNM 184591.
25. Anterior view adult female carapace. Specimen USNM 184592. (See pl. 17, fig. 1, for lateral view.)



LOXOCONCHELLA, PARADOXOSTOMA, PELLUCISTOMA, AND XESTOLEBERIS

PLATE 16

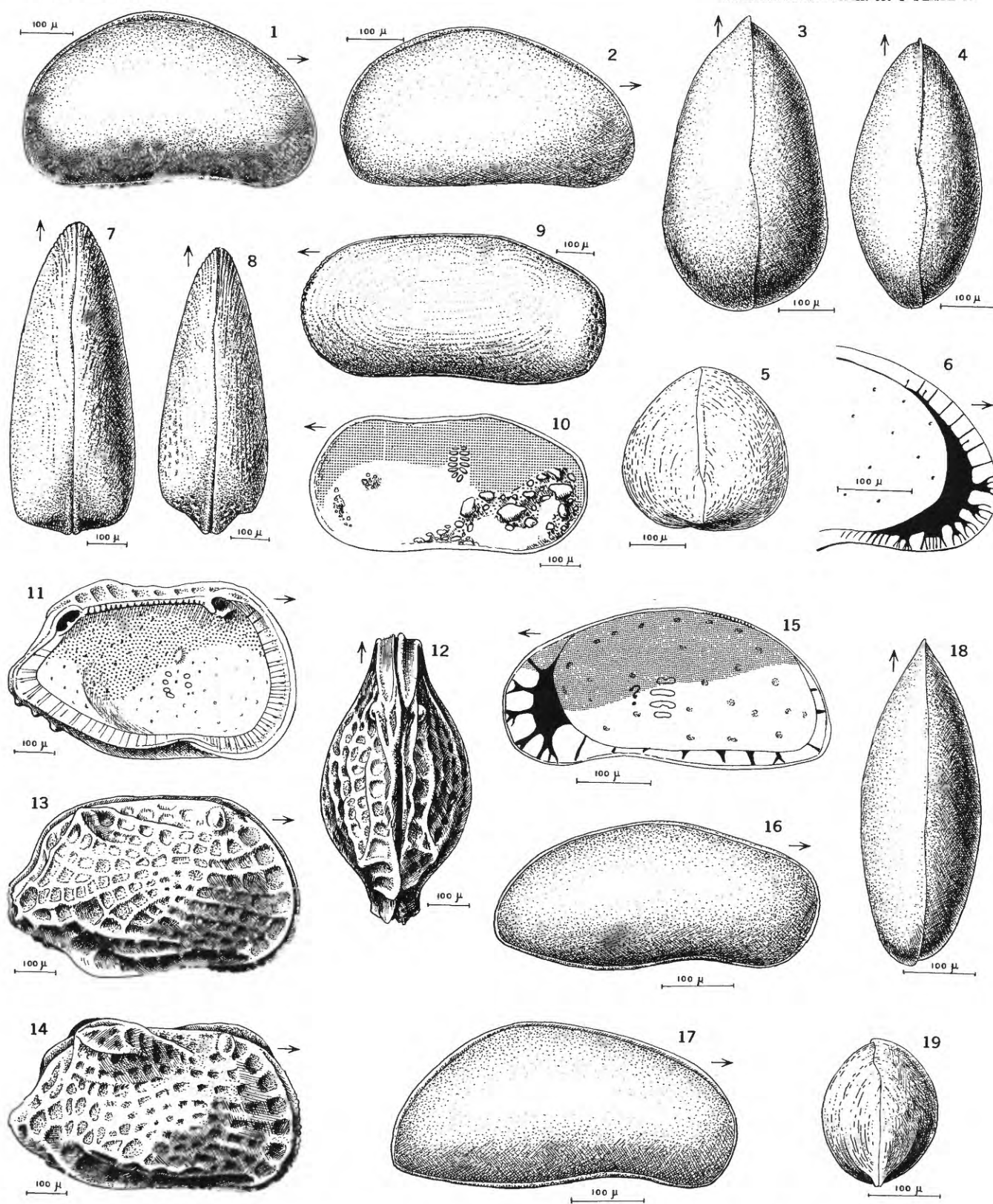
- FIGURES 1-3. *Xestoleberis* sp. cf. *X. briggsi* McKenzie (p. F35).
 From R-320.95 m.
 1. Dorsal view adult female carapace. Specimen USNM 184588.
 2. Right valve lateral view adult female carapace. Specimen USNM 184589.
 3. Anterior view adult female carapace. Specimen USNM 184587.
- 4-7. *Xestoleberis tumefacta* Brady (p. F34).
 4. Internal view adult right valve. S-45.11 m. Hypotype USNM 184580.
 5. Dorsal view adult left valve. S-44.20 m. Hypotype USNM 184581.
 6. Dorsal view adult right valve. S-44.20 m. Hypotype USNM 184582.
 7. Anterior view adult carapace. S-44.20 m. Hypotype USNM 184583.
- 8, 9. "*Cythere*" sp. aff. "*C. caudata* Brady (p. F36).
 8. Right valve view adult carapace. R-320.34 m. Specimen USNM 184576.
 9. Dorsal view adult carapace. R-320.34 m. Specimen USNM 184575.
- 10-13. *Cytherella* sp. 2 (p. F37).
 10, 13. Internal view and dorsal line drawing of adult female right valve. S-152.25 m. Specimen USNM 184608.
 11. Left valve lateral view adult female carapace. S-151.79 m. Specimen USNM 184607.
 12. Dorsal view adult female left valve. S-152.25 m. Specimen USNM 184609.
- 14, 15. Ostracode sp. (p. F36).
 Dorsal and right valve lateral views of adult(?) carapace. R-317.91 m. Specimen USNM 184577.
16. *Cytherelloidea semipunctata* Holden, n. sp. (p. F37).
 Dorsal view adult female carapace. R-284.47 m. Paratype USNM 184619.
- 17, 21. *Cytherelloidea* sp. cf. *C. umbonata* Edwards variation (p. F37).
 17. Left valve lateral view adult female carapace. R-173.28 m. Specimen USNM 184615.
 21. Dorsal view adult female left valve. R-338.94 m. Specimen USNM 184616. (See pl. 6, fig. 9, for lateral view.)
- 18, 19. *Cytherelloidea* sp. 2 (p. F38).
 From R-318.36 m.
 18. Dorsal view adult male carapace. Specimen USNM 184626.
 19. Dorsal view adult female carapace. Specimen USNM 184625.
20. *Cytherelloidea? japonica* Ishizaki (p. F38).
 Dorsal view adult broken female (?) right valve. S-44.20 m. Hypotype USNM 184628. (See pl. 6, fig. 12, for lateral view.)
22. *Aurila* sp. aff. *A. lincolnensis* (LeRoy) (p. F22).
 Dorsal view adult carapace. S-152.25 m. Specimen USNM 184423. (See pl. 11, fig. 12, for internal view.)
- 23, 24. *Cytherella* sp. 1 (p. F36).
 Lateral and dorsal views of adult female right valve. R-288.65 m. Specimen USNM 184606.



XESTOLEBERIS, "CYTHERE," *CYTHERELLA*, *CYTHERELLOIDEA*, *AURILA*, AND *OSTRACODE* SP.

PLATE 17

- FIGURE 1. *Xestoleberis* sp. cf. *X. curta* (Brady) (p. F35).
 Right valve lateral view adult female carapace. S-73.46 m. Specimen USNM 184592.
 (See pl. 15, fig. 25, for anterior view.)
- 2-6. *Xestoleberis datelinensis* Holden, n. sp. (p. F35).
 2, 4. Right valve lateral and dorsal views of adult male carapace. R-317.37 m. Holotype USNM 184594.
 3, 5. Dorsal and anterior views of adult female carapace. R-317.37 m. Paratype USNM 184593.
 6. Internal view adult female left valve anterior. R-318.36 m. Paratype USNM 184595.
- 7-10. *Cytherella textum* Holden, n. sp. (p. F36).
 7, 9. Dorsal and left valve lateral views of adult female carapace. R-284.00 m. Holotype USNM 184604.
 8. Dorsal view adult male carapace. R-284.00 m. Paratype USNM 184605.
 10. Internal view adult male right valve. R-335.74 m. Paratype USNM 184603.
- 11-14. *Quadracythere aequabilis* Holden, n. sp. (p. F24).
 11. Internal view adult male left valve. R-320.35 m. Paratype USNM 184437.
 12, 13. Dorsal and right valve lateral views of adult female carapace. R-336.58 m. Holotype USNM 184439.
 14. Right valve lateral view adult male carapace. R-320.35 m. Paratype USNM 184436.
- 15-19. *Parakrithella eopacifica* Holden, n. sp. (p. F31).
 15. Internal view adult male right valve. R-318.21 m. Holotype USNM 184523.
 16, 18, 19. Right valve lateral, dorsal, and anterior views of adult female carapace. R-320.95 m. Paratype USNM 184524.
 17. Right valve lateral view adult male carapace. R-320.95 m. Paratype USNM 184525.



XESTOLEBERIS, CYTHERELLA, QUADRACYTHERE, AND PARAKRITHELLA

