Foraminifera from the Arctic Slope of Alaska

By HELEN TAPPAN

Part 2, Jurassic Foraminifera

Description and illustrations of Jurassic Foraminifera, including the first Liassic Foraminifera discovered in the Western Hemisphere. Prepared in cooperation with the U. S. Department of the Navy, Office of Naval Petroleum and Oil Shale Reserves.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1955

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price $1.50 (paper cover)

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FORAMINIFERA FROM THE ARCTIC SLOPE OF ALASKA

By HELEN TAPPAN*

PART 2. JURASSIC FORAMINIFERA

ABSTRACT

A fauna of 111 species of Foraminifera was obtained from Jurassic strata of northern Alaska, ranging in age from Early Jurassic or Liassic of Europe (Sinemurian, Pliensbachian, and Toarcian) to Late Jurassic (Callovian and upper Oxfordian-Kimmeridgian).

This includes the first Lower Jurassic foraminiferal fauna to be recorded from the western hemisphere, and it correlates closely with the Liassic faunas of Germany, France, and England. A few of the species were found in outcrops, but the major part of the fauna was obtained from core samples from wells drilled in Naval Petroleum Reserve No. 4, in the Arctic Coastal Plain province of northern Alaska.

Thirty-three genera of Foraminifera are represented, belonging to 11 families. The family Nodosariidae has 74 species, 8 belong to the Lituolidae, 7 to the Tolypamminidae, 5 to the Verneuilinidae, 4 each to the Reophacidae, Trochamminidae, and Polymorphinidae, 2 to the Textulariidae and one each to the Rhizamminidae, Hyperamminidae, and Valvulinidae. Thirty-six of the species are described as new, and 4 new names are proposed for homonyms.

INTRODUCTION

This report is the second of a series describing the Foraminifera of northern Alaska. The material described was obtained during the field exploration and drilling program being conducted by the U. S. Navy in Naval Petroleum Reserve No. 4, and adjacent areas of the Arctic Slope of Alaska. The U. S. Geological Survey is cooperating with the U. S. Navy in the geologic aspects of this program. A general discussion of the investigations, with an outline map showing the location of the Reserve, may be found in the first of this series (Tappan, 1951b).

Only the foraminiferal faunas are described in this report; a preliminary report on the stratigraphy, structure, and other phases of the geology of the area may be found in a report by T. G. Payne and others (1952).

FIELD INVESTIGATIONS IN THE JURASSIC OF NORTHERN ALASKA

The earliest mention of Jurassic strata in northern Alaska was made by Leffingwell (1919). He described the Kingak shale as Early Jurassic in age, and as consisting of about 4,000 feet of black shale, conformably overlying the Shublik formation of Late Triassic age and probably underlying the Ignek formation of Jurassic? age. The type locality of the Kingak shale is at Kingak Cliff, near Camp 263, at the southeastern end of the Sadlerochit Mountains. The shales are thin bedded and friable, nearly black in color, and contain many concretions.

Fossils recorded from the Kingak shale include *Pentacrinus* cf. *P. subangularis* Miller (identified by Frank Springer), *Inoceramus* cf. *I. lucifer* Eichwald, *Hamnatoceras* cf. *H. howelli* (White), and *Harpoceras whiteavesi* (White) (identified by T. W. Stanton). These species occur throughout the lower 1,500 feet of the formation and were originally used as a basis for correlation with the European Liassic and Lower Oolitic strata. Some very similar species were found in the Kialagvik formation of the Alaska Peninsula, and various European paleontologists considered them to be Late Liassic (Toarcian) in age, although Stanton considered them to be of Middle Jurassic age.

After Leffingwell's early exploration, very little was done in this area, until the U. S. Geological Survey field parties began geologic studies in Naval Petroleum Reserve No. 4 in 1923.

Exploratory trips were made by Survey geologists in the Reserve in the next few years, but although a diligent search was made, no Jurassic rocks were recognized in the areas traversed (Smith, 1927, p. 117). As Jurassic rocks were oil bearing in southern Alaska, it was hoped that such would be the case in the north as well. However, it was not until 1949 that Jurassic rocks were found to crop out west of the Canning River region where they had first been recognized by Leffingwell.

George Gryc and Marvin D. Mangus worked in the region of the Shaviovik and Canning Rivers, in the summer of 1947, to determine the structural and stratigraphic relationships of this area with the other parts of northern Alaska. They found the Kingak shale exposed at only two localities on the Canning River, the best outcrop being opposite Cache Creek, where no less than 4,000 feet is exposed. A few beds and concretions of calcareous ironstone contain fossils, but practically no material of sand size was found in the entire section. The overlying Ignek formation was thought by Leffingwell to be Early Jurassic in age, but Gryc found it to be Cretaceous, probably in large part Late Cretaceous. Three fairly good outcrops of black shale with ironstone interbeds and concretions were found in the Shaviovik River traverse, and mapped as the Kingak shale, as the fauna and lithology were similar to that of the type section.

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In the summer of 1948, Charles L. Whittington and Edward G. Sable, of the U. S. Geological Survey, made a reconnaissance in the Sadlerochit River area. The Kingak shale is conformable on the Shublik formation of Late Triassic age, the contact being exposed in two localities, one in a bluff one mile east of Camp 13, and one on the first creek east of Limit Creek. According to Whittington and Sable (unpublished report), Leffingwell's type locality for the Kingak could not definitely be located. "Kingak," which means "nose," is applied by the natives of Barter Island to a high hill on the divide between the Hulahula and Sadlerochit Rivers, southeast of Camp 13. The rocks in and around this hill belong to the Ignek formation. Leffingwell's map indicates that Kingak Cliff is in the vicinity of Camp 13. The bluff one mile east of Camp 13 contains the basal 150 feet of the Kingak shale at its east end, but is largely composed of rocks of the Sadlerochit (Permian) and Shublik (Upper Triassic) formations. However, Whittington and Sable consider it more probable that the type section was in outcrops of the Kingak shale in cut banks along the Sadlerochit River and its tributaries in the vicinity of Camp 12, and that Leffingwell's "Kingak Cliff' is one of these cut banks on the Sadlerochit River near Camp 12.

The Kingak shale, composed principally of black silt or mud shale, is relatively incompetent, and has been greatly affected by the forces that produced the structure in the Sadlerochit region. Small-scale folds and faults are widespread. Whittington and Sable located the crinoid beds in the lower part of the Kingak shale, and found the ammonite-pelecypod faunas to occur considerably higher. Leffingwell had obtained a crinoid fauna, which was classified by Frank Springer as Early Jurassic in age but its stratigraphic position within the Kingak was unknown. The ammonite fauna had been correlated with that of the Jurassic beds at Kialagvik Bay on the Alaskan Peninsula, then thought to be Lower Jurassic. However, P. S. Smith (1939, p. 45) recorded these latter beds as the Kialagvik formation and placed them in the Middle Jurassic series.

In the summer of 1950, George Gryc and Ralph Imlay made another trip through the Canning River region, and obtained abundant ammonite faunas, which made possible detailed correlation with the European section, and proved the presence of beds of Early, Middle, and Late Jurassic age locally within the Kingak shale.

In 1949, William W. Patton, Jr., and Irvin L. Tailleur reported Jurassic rocks from a single locality on Fortress Creek in the area of the Okpikruak and Kiruktagiak Rivers. The presence of *Pseudolioceras* suggested that these rocks were of Bajocian age, although they were barren of microfossils.

The following summer, William W. Patton, Jr., and A. Samuel Keller found Jurassic beds in the Siksikpuk-Nanushuk Rivers area; fossils in these strata proved the presence of Middle and Upper Jurassic series in this area. Bajocian rocks were found on Tiglukpuk Creek; elsewhere rocks of Late Jurassic age rest directly on strata of Triassic age.

Rocks containing a pelecypod fauna, identified as Jurassic by R. W. Imlay, were later found as far west as the Kukpowruk River. These rocks of Middle and Late Jurassic age of the western section of northern Alaska differ in many respects from the Kingak shale of Early Jurassic age of the Canning-Sadlerochit Rivers area, and as no formational name has yet been proposed for them, they are here referred to only as Middle or Late Jurassic rocks.

FORAMINIFERAL STUDIES OF NORTHERN ALASKA

SOURCE OF MATERIAL

Samples used in this report include those from three surface areas of northern Alaska, the regions of the Canning River, the Sadlerochit River and the Siksikpuk-Nanushuk Rivers. Subsurface core material was obtained from five wells drilled by Arctic Contractors, in Naval Petroleum Reserve No. 4. These are Simpson Test Well 1, South Barrow Test Wells 2, 3 and 4, and Topagoruk Test Well 1. More recent drilling has shown the presence of rocks of Jurassic age in additional wells, but only those from which samples were studied for the present report are shown on the index map (fig. 3).

AREAS OF OUTCROP

A fairly complete Jurassic section crops out in northern Alaska. Probably the most extensive exposures are in the Canning-Shaviovik Rivers area, where beds of Early, Middle, and Late Jurassic age are exposed. Unfortunately, although megafossils that accurately zone the beds occur there, the microfauna is sparse. The Lower Jurassic rocks are best represented microfaunally in the Sadlerochit region and microfossils of Late Jurassic age have been found in both the Canning region and the Siksikpuk-Nanushuk

PLATE 6

Oblique aerial photograph, looking westward across the Canning River toward the exposure of the Kingak shale in the cut banks. The promontory in the center of the picture separates the two cut banks from which microfossil samples were collected by George Gryc, 1947.

OUTCROP OF KINGAK FORMATION ON THE CANNING RIVER

Two samples were found to contain identifiable Foraminifera, and these are listed below.

1. *Amoeboceras* zone (upper Oxfordian) of the Kingak shale, on the west bank of the Canning River, at lat 69°33′ N., long 146°23′ W., in northeastern Alaska. Collected by George Gryc, 1947.

Haplophragmoides canui Cushman
Ammobaculites alaskensis Tappan
Trochammina gryci Tappan

2. *Amoeboceras* zone (upper Oxfordian) of the Kingak shale, on the west bank of the Canning River, at lat 69°32′30″ N., long 146°23′ W., in northeastern Alaska. Collected by George Gryc, 1947.

Haplophragmoides canui Cushman
Trochammina canningensis Tappan
gryci Tappan

SADLEROCHIT RIVER REGION

Samples from the Sadlerochit River area contained a few more species of Foraminifera than samples from the Canning area, and represent a different part of the Jurassic system (fig. 5). The basal contact is exposed, with 2,640 feet of measured section of the Kingak shale, about 60 percent of which is exposed, most of it probably representing the Lower Jurassic (Liassic). The section was measured by pacing and by compass traverse. Dips are uniformly to the south, except for minor folds, but the degree of dip varies from nearly horizontal to nearly vertical. Minor folds and local slickensides also suggest that the structure may be somewhat complex. Whittington and Sable (personal communication, June 1952) believe it probable that this 2,640 feet of measured section includes some repetition of beds by isoclinal folding or faulting, although they are unable to estimate the percentage of repetition. The figures given here as to thickness of beds and their stratigraphic position are therefore only approximate.

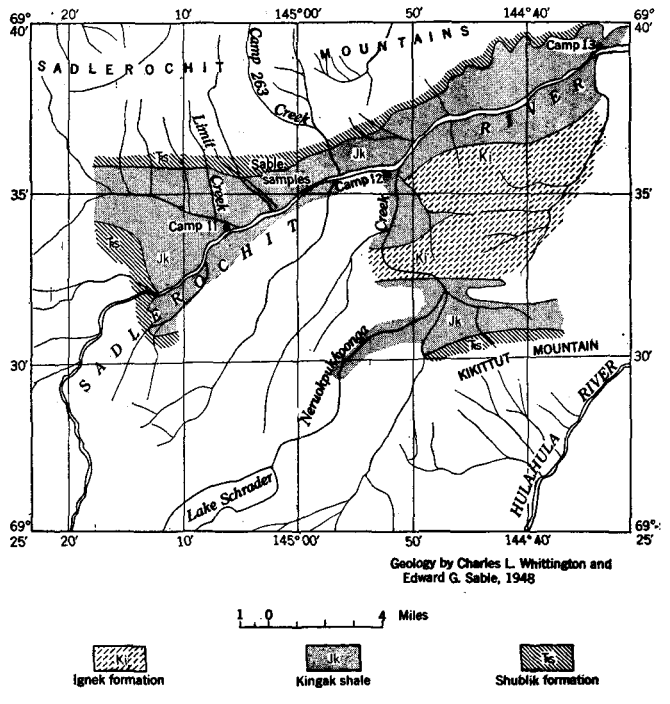

FIGURE 5.—Map of Sadlerochit River area, showing outcrop of Jurassic age and location of samples collected by Sable, 1948.

Foraminifera were obtained from exposures of the black shales of the Kingak shale, including some ironstone beds, at approximately lat 69°35′ N., long 145°04′ W., in the banks of a southward-flowing tributary which enters the Sadlerochit River approximately at lat 69°34′30″ N., long 145°03′ W., on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

60 feet. Highest beds exposed, 2,580–2,640 feet above base
Trochammina sablei Tappan
Eoguttulina metensis (Terquem)

930 feet. Not sampled.

Sample, 1,650 feet above the base.
Haplophragmoides barrowensis Tappan
Eoguttulina metensis (Terquem)

1,010 feet. Not sampled.

160 feet. Composite sample, from 480 to 640 feet above the base.
Involutina silicea Terquem
Haplophragmoides barrowensis Tappan
Ammobaculites alaskensis Tappan
Trochammina canningensis Tappan
sablei Tappan

SIKSIKPUK-NANUSHUK RIVERS REGION

The third area of Jurassic outcrop is in the region between the Siksikpuk River, tributary to the Chandler River, and the Nanushuk River, which flows into the Anaktuvuk River, southeast of Naval Petroleum Reserve No. 4, and in the Southern Foothills section (fig. 6). Eight samples were found to contain Foraminifera.

A. Upper Jurassic, on the west bank of Welcome Creek, approximately at lat 68°25′ N., long 150°55′ W., about 4 miles upstream from its confluence with Kanayut River, tributary to the Anaktuvuk River, in the foothills of the Brooks Range in northern Alaska. Collected by William W. Patton, Jr., 1950. About 30 to 50 feet of section is exposed above the Shublik formation of late Triassic age.

Glomospira pattoni Tappan
Gaudryina milleri Tappan
Lenticulina wisniowskii (Myatliuk)

B. A 30- to 50-foot section of the Upper Jurassic is poorly exposed above the Shublik formation, in the headwaters of the Anaktuvuk River, at approximately lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Bathysiphon anomalocoelia Tappan
Glomospira pattoni Tappan
Haplophragmoides canui Cushman
Spiroplectammina sp.
Gaudryina milleri Tappan
topagorukensis Tappan
Lenticulina wisniowskii (Myatliuk)
Astacolus sp.

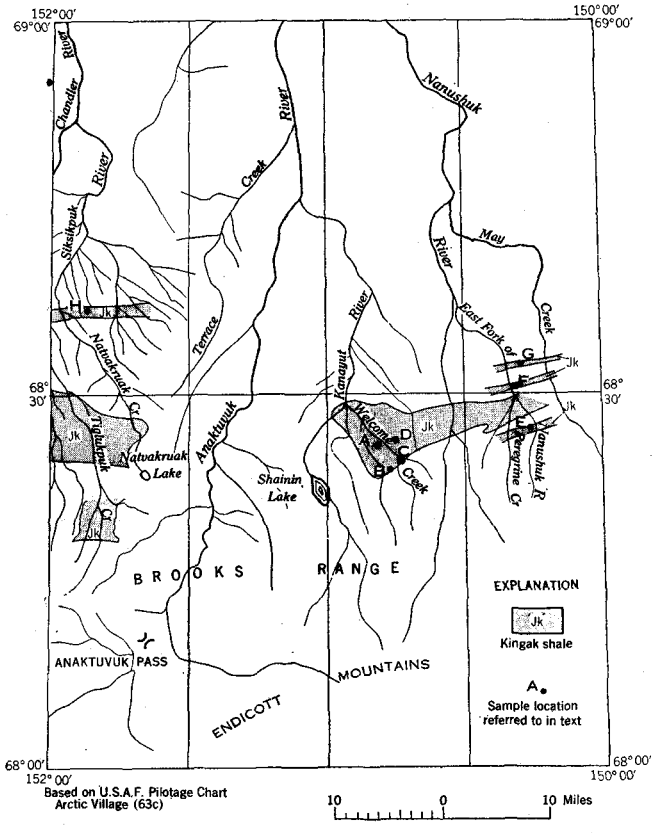

FIGURE 6.—Map of Siksikpuk-Nanushuk Rivers area, showing outcrop of Jurassic age and source of samples collected by Patton and Keller, 1950. Geology by W. W. Patton, Jr. and A. S. Keller.

C. An Upper Jurassic shale section, with minor interbeds of the *Aucella bronni* coquinoid limestone, was found on the east bank of Welcome Creek, approximately at lat 68°24′ N., long 150°50′ W., about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Involutina cheradospira (Loeblich and Tappan)
Glomospira pattoni Tappan
Gaudryina milleri Tappan

D. Upper Jurassic shale, with minor interbeds of the *Aucella bronni* coquinoid limestone, on the east bank of Welcome Creek, approximately at lat 68°26′ N., long 150°52′ W., about 5 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Glomospira pattoni Tappan
Gaudryina milleri Tappan

E. Upper Jurassic, on the west bank of the East Fork of the Nanushuk River, approximately at lat 68°25′ N., long 150°20′ W., about 14 miles airline southeast of the confluence with the Nanushuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Glomospira pattoni Tappan
Gaudryina milleri Tappan
Lenticulina wisniowskii (Myatliuk)

F. The lower part of the Upper Jurassic (Oxfordian-Kimmeridgian) section exposed in the area, approximately at the *Aucella bronni* level, is found in the east bank of the East Fork of the Nanushuk River, approximately at lat 68°30′ N., long 150°25′ W., in the foothills of the Brooks Range, northern Alaska. Collected by A. Samuel Keller, 1950.

Involutina cheradospira (Loeblich and Tappan)
Glomospira pattoni Tappan

G. Upper Jurassic, on the east bank of the East Fork of the Nanushuk River, approximately at lat 68°02′ N., long 150°27′ W., about 9 miles airline southeast of the confluence with the Nanushuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Glomospira pattoni Tappan
Gaudryina topagorukensis Tappan

H. A highly faulted section of the Upper Jurassic occurs about 3 miles east of the Siksikpuk River, approximately at lat 68°40′ N., long 151°54′ W., in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Bathysiphon anomalocoelia Tappan
Glomospira pattoni Tappan
Lenticulina wisniowskii (Myatliuk)

SUBSURFACE MATERIAL

In the Arctic Coastal Plain province, the strata of Jurassic age are covered by younger rocks of Mesozoic and Cenozoic age. Furthermore, the section represented in the subsurface that was penetrated by drilling is less complete than that of the outcrop areas. It is most nearly complete in the southernmost wells (Topagoruk Test Well 1), and more and more of the younger beds are bevelled progressively to the north. Lower Jurassic rocks are conformable on those of the Triassic, and the thinning of the Jurassic section over the structures is due to removal of the upper part of the section. This is particularly well shown in the Barrow area, where, within a distance of a few miles, the amount of section of Jurassic age ranges from none in South Barrow Test Well 1 to a maximum of 800 to 900 feet in South Barrow Test Well 3.

The cross section shown in figure 7 was prepared by the writer from seismic profiles made by United Geophysical Co., and the ages of the beds determined from paleontological studies of the well material. Uplift occurred after the deposition of at least the lower

Jurassic beds, which were bevelled at the crest of the structure, but before the deposition of the overlying Lower Cretaceous strata. Very little or no Jurassic remains in the area of South Barrow Test Wells 1, 2, and 4, but a considerable section is found on the south flank of the structure where South Barrow Test Well 3 was drilled. Most of the fauna described in the present report came from this well.

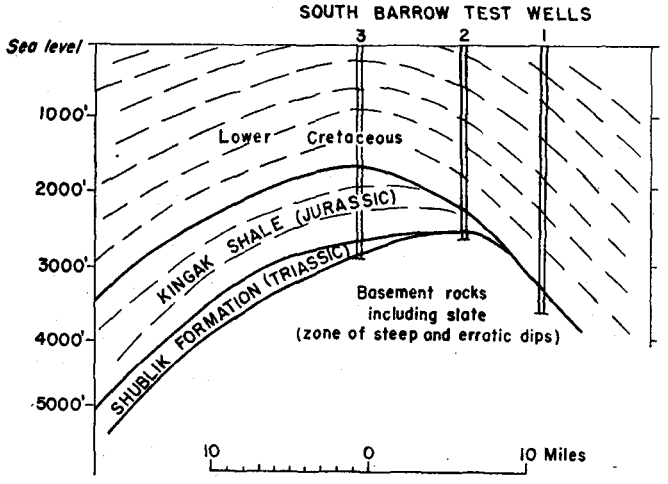

FIGURE 7.—Cross section of Barrow area, showing bevelling of the Jurassic strata to the north.

The unconformity may represent a part of Jurassic time, inasmuch as no rocks of Middle or Late Jurassic age have been found here. According to Smith and Mertie (1930, p. 269), many parts of Alaska were "undergoing most stupendous mountain-building movements" during at least a part of Jurassic time.

It was during this period that all the preexisting rocks were subjected to enormous forces that bent and buckled them into folds, some of which were overturned or so sharply appressed that they broke, great thrust faults being thus produced. This was the event which really first clearly blocked out the great mountain unit that has progressively developed into the present Brooks Range.

This strong folding in the Brooks Range was probably accompanied by lesser folding and uplift farther north, as in the Barrow-Simpson area. These northern structures suggest that strata of Early Jurassic age were beveled from their crests, perhaps at the same time that deposition continued to the south and east, where beds of Middle and Late Jurassic age are now found. Sedimentation did not occur again over these structures until late in Early Cretaceous time, as apparently the Okpikruak formation is missing, as are the rocks of later Jurassic age.

The lowest part of the Lower Jurassic section is not very fossiliferous, either in the outcrops or the well sections, and it is in the zone from about 400 to 600 feet above the base that the most abundant microfauna is found. This part of the section is well represented by cores from South Barrow Test Well 3, but has been removed from the structure where pierced by the other Barrow wells. It is present in Simpson Test Well 1, where about 700 feet of rocks of Jurassic age have been identified, but the core coverage is much less complete. Furthermore, in all wells, as in the outcrop area, some of the siltstone beds are too indurated to be broken down for the recovery of Foraminifera, and examination of fragments showed an apparent absence of any microfauna.

SIMPSON TEST WELL 1

Simpson Test Well 1 is located at lat 70°57'05" N., long 155°21'45" W., west of Cape Simpson, in northern Alaska. Rocks of Jurassic age consist of about 700 feet of section, from which four cores contained microfossils. Lithologic descriptions are from the geologic log by A. Samuel Keller.

Depth (feet) and kind of sample	*Lithology and fauna*
5,677–5,692 (Core)	Silt shale, light- to medium-gray, well-indurated micaceous
	Nodosaria mitis (Terquem and Berthelin)
5,860–5,870 (Cuttings)	*Nodosaria prima* d'Orbigny
5,866–5,874 (Core)	Silt shale, medium-gray, carbonaceous, micaceous, well-indurated
	Haplophragmoides barrowensis Tappan
	Ammobaculites alaskensis Tappan
	Trochammina sablei Tappan
	Vaginulina sherborni (Franke)
5,990–6,000 (Cuttings)	*Astacolus pediacus* Tappan
6,067–6,077 (Core)	Silt shale, light- to medium-gray, carbonaceous, well-indurated, with pyrite streaks.
	Reophax suevica Franke
	Lenticulina excavata (Terquem)
	Astacolus pediacus Tappan
6,173–6,183 (Core)	Sandstone, medium-gray to weak green-yellow, well-indurated.
	Marginulina utricula Terquem and Berthelin
6,183–6,193 (Core)	Same lithology as above, but with a highly calcareous zone and sandstone pebbles. Barren of microfossils.
6,237–6,247 (Core)	Siltstone, sandy green-yellow, well-indurated, massive bedding. Barren of microfossils.

SOUTH BARROW TEST WELL 2

This well is located at lat 71°15'51.34" N., long 156°37'55.25" W., south of Point Barrow, northern Alaska. Rocks of Jurassic age consist of about 120 feet of section, from which two cores were taken that contained microfossils. Lithologic descriptions are from the geologic log by A. Samuel Keller.

Depth (feet) and kind of sample	*Lithology and fauna*
2,332–2,341 (Core)	Fine sand, shale, and silt, cross-bedded and interlaminated, light to dark gray, moderately indurated. Barren.
2,341–2,356 (Core)	Alternating silt, shale, fine sand, and siltstone, non- to slightly calcareous, light gray, with some dark-gray streaks in the lower portion which is largely sandstone and siltstone. *Jaculella elliptica* (Deecke) *Reophax densa* Tappan *metensis* Franke *suevica* Franke *Involutina aspera* Terquem *Haplophragmoides kingakensis* Tappan *Trochammina canningensis* Tappan *sablei* Tappan *Astacolus pediacus* Tappan *Marginulina prima* d'Orbigny
2,356–2,375 (Core)	Sandstone, silty, light gray, moderately to well-indurated. At 2,356 feet contained the following Foraminifera. *Lenticulina excavata* (Terquem) *Marginulina prima* d'Orbigny *Frondicularia terquemi* d'Orbigny
2,391–2,400 (Core)	Silt to fine sandstone, light-gray, highly argillaceous, well-indurated. Barren.
2,400–2,420 (Core)	Silt to fine sandstone, light-gray, with dark shale streaks. Barren.

SOUTH BARROW TEST WELL 3

This well is located at lat 71°09′40″ N., long 156°34′45″ W., south of Point Barrow, northern Alaska.

As the cores from this well supplied the major part of the fauna of Jurassic age, a range chart is given (chart 1) showing each occurrence of each species of Jurassic age found in this well. As can be seen by comparing the cored intervals with the foraminiferal occurrences, various barren zones were encountered. A graphic lithologic log is presented in the left-hand column, so the lithology can be correlated with the fauna. Lithologic data were prepared by Florence Rucker.

In general, the more fossiliferous zones consist of shaly clay, and the barren zones of siltstone and sandstone. Associated fossils include a few ammonites, identified by Ralph W. Imlay, which are also listed at the appropriate depths on the chart. One ophiuroid, a few brachiopods, and pelecypods comprise the remaining megafauna. A few ostracodes were found in the core samples, but they are comparatively rare.

On the evidence supplied by the ammonites, the strata from 1,772 to 2,063 feet are Early Toarcian in age, and from 2,069–2,198 feet are Late Pliensbachian. Foraminiferal evidence supports this correlation, for within the Pliensbachian part of the section occur *Ammobaculites fontinensis* (Terquem), *Dentalina tenuistriata* Terquem, *Marginulina interrupta* Terquem, *Nodosaria apheilolocula* Tappan, and *Nodosaria regularis* Terquem, all species found throughout the Lias γ and δ (Pliensbachian) of Germany and France. The uppermost Toarcian was probably removed from the Barrow structure with the strata of Middle and Late Jurassic age by pre-Cretaceous erosion.

The Foraminifera also suggest that earlier Liassic is represented below the section that contained the ammonites. *Vaginulinopsis matutina* (d'Orbigny) occurs from 2,100–2,485 feet in the well, and ranges from Lias β to δ (Sinemurian to Pliensbachian) in Germany and France. *Marginulina radiata* Terquem is found from 2,478–2,496 feet in the well, and is restricted to Lias α (Hettangian) and β (Sinemurian) in France and Germany. *Glomospira perplexa* Franke occurred in South Barrow Test Well 3 at 2,587–2,589 feet, and is restricted to Lias α (Hettangian) in Germany. These species would suggest that the Hettangian and Sinemurian as well as the Lower Pliensbachian are probably represented, although it is difficult to delimit exact contacts until additional information is obtained from other wells and outcrops as to the complete ranges of these and other species.

SOUTH BARROW TEST WELL 4

This well is located at lat 71°15′55.24″ N., long 156°37′44.89″ W., 447 feet N. 28° E. of South Barrow Test Well 2. About 120 feet of strata of Jurassic age overlie the argillite "basement." Dips of 2°–5° in the overlying strata of Cretaceous age, as compared to possible dips of 10°–15° in the Jurassic indicate a possible angular unconformity between them. The strata of Jurassic age consist of fine-grained silty sandstone, according to lithologic determinations by Florence Rucker.

Depth (feet) and kind of sample	*Fauna*
2,340–2,350 (Core)	Contains *Involutina silicea* Terquem *Planularia striata* (Issler)

TOPAGORUK TEST WELL 1

This well is located west of the Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain Province, northern Alaska.

About 910 feet of section is of Late Jurassic age (probably Oxfordian or Lower Kimmeridgian). It consists of hard pyritic grayish-black claystone and clay shale, with fine- to medium-sized rounded grains of clear quartz. The base of this interval is marked by a dense grayish black heavy glauconitic sandstone, with glauconite oölites in a matrix of hematite and black shale. The core at 7,042–7,052 feet, from which were obtained the Foraminifera below listed, is from the lower part of the clay shale.

There are about 800 feet of Middle or Lower Jurassic strata, some Middle-Jurassic ammonites having been identified by Ralph W. Imlay. The upper one-fourth

consists of medium-gray noncalcareous siltstone, with abundant intercalations of dark-gray clay, and the remainder consists of dark-gray micaceous clay shale, with streaks and lines of pyrite. The lithology is very similar to that of the Lower Jurassic of South Barrow Test Well 3, although slightly finer grained and somewhat harder. Cores were barren of Foraminifera.

Lithologic examination of the well material was made by Florence Rucker.

The Upper Jurassic core at 7,042–7,052 feet contained the following species:

Bathysiphon anomalocoelia Tappan
Glomospira pattoni Tappan
Involutina orbis (Lalicker)
Haplophragmoides canui Cushman
Ammobaculites alaskensis Tappan
Gaudryina leffingwelli Tappan
  topagorukensis Tappan
Trochammina canningensis Tappan
  topagorukensis Tappan
Darbyella volgensis Tappan
Lenticulina wisniowskii (Myatliuk)
Saracenaria oxfordiana Tappan
  phaedra Tappan
  topagorukensis Tappan
Marginulinopsis phragmites Loeblich and Tappan
Marginulina brevis Paalzow
  pinguicula Tappan
Rectoglandulina brandi Tappan
Dentalina ectadia Loeblich and Tappan
Frondicularia sp.
Lagena liasica (Kübler and Zwingli)
Globulina topagorukensis Tappan

CORRELATION

JURASSIC OF NORTH AMERICA

Very few Foraminifera of Jurassic age have been described from North America. A few Foraminifera of Middle and Late Jurassic age have been recorded from the western interior of the United States (Morey, 1931, Sandidge, 1933, Loeblich and Tappan, 1950a, b, and Lalicker, 1950), from Canada (Wickenden, 1933), and from western Texas (Albritton, 1937). No Foraminifera of Early Jurassic age have been described from the Western Hemisphere to date, other than the two Alaska species described by the writer in advance of the present report (Tappan, 1951a, Loeblich and Tappan, 1952).

Morey (1931, p. 327) first recorded Foraminifera of Jurassic age from the Sundance formation of Wyoming. He recorded *Clavulina, Robulus, Nodosaria, Frondicularia, Globigerina,* and one unidentified genus, but none were described or figured.

Sandidge (1933, p. 174) described a nodosarid foraminiferal fauna from Montana, also from the Sundance formation. Twelve species were described, figured, and referred to European species, and the strata were correlated with the French Bajocian.

Wickenden (1933, p. 157) described 28 species from samples of Jurassic age from three wells in Saskatchewan and Alberta. He compared them to species described from the Dogger of central Europe and the French Bajocian, and also stated that the fauna was similar in age and character to that described by Sandidge. Slightly more than half of the species belonged to the Nodosariidae.

Loeblich and Tappan (1950a) described a Late Jurassic (Oxfordian) fauna from South Dakota, containing 56 species, most (about 80 percent) being nodosarids, although seven other families were also represented, the Reophacidae, Lituolidae, Verneuilinidae, Miliolidae, Trochamminidae, Polymorphinidae, and Spirillinidae. Most of the species are calcareous, but some of these were very rare, and some of the arenaceous species were extremely abundant.

The second paper in the series (Loeblich and Tappan, 1950b) described a slightly older fauna, of Callovian (earliest Late Jurassic) age, from Wyoming, Montana, and North Dakota. Of 22 species described in this fauna, all but three are nodosarids, and the rest are members of the Ammodiscidae (=Tolypamminidae), Lituolidae, and Spirillinidae.

Lalicker (1950) described the Foraminifera from the type locality of the Ellis group in Montana, which includes strata of Bathonian, Callovian, and Oxfordian age. Most of the species were found in the Bathonian, a few from the Callovian, but the Oxfordian was found to be barren in this region. Most of the species recorded here also are Nodosariidae and Polymorphinidae, and a single species each represented the Ammodiscidae (=Tolypamminidae), Lituolidae, Ophthalmidiidae, and Rotaliidae to complete the fauna of 39 species.

Two Alaska species of Early Jurassic age were described by the writer (Tappan, 1951a) among "index species" for the various north Alaska strata, and were later illustrated in a preliminary report on the geology of the Arctic Slope (Payne and others, 1952).

In addition to the Jurassic of the western interior of the United States and Canada and that of Alaska, marine Jurassic strata have also been found in the Gulf Region of the United States and Mexico. This section is of Late Jurassic age, but represents an invasion of the sea from the south and is not very closely related to the northern rocks of Jurassic age. No Foraminifera have yet been described from the subsurface strata of Jurassic age found in Arkansas, Texas, Mississippi, and Alabama, but two species of *Robulus* were described by Albritton (1937) from the outcropping Malone formation (Upper Jurassic) of western Texas.

All Foraminifera described from the Jurassic of North America, exclusive of Alaska, are thus of Middle or Late Jurassic age. The following table (fig. 8) shows the relationship of the Jurassic strata of North America, from which Foraminifera have been recorded.

GERMAN LIAS

Bartenstein and Brand (1937) made a thorough study of the German Lias and Dogger, Brand discussing the micropaleontology of the Lias and Bartenstein the fauna of the Dogger. They zoned the German Jurassic on the basis of the Foraminifera, and as there is a fair agreement between their results and the foraminiferal ranges in South Barrow Test Well 3, a comparison is made of the faunal zones. The German Lias is usually subdivided into six zones, to which Greek letters have been applied. The correlation table of figure 9 shows the relationship of these German zones to the European stage names commonly used.

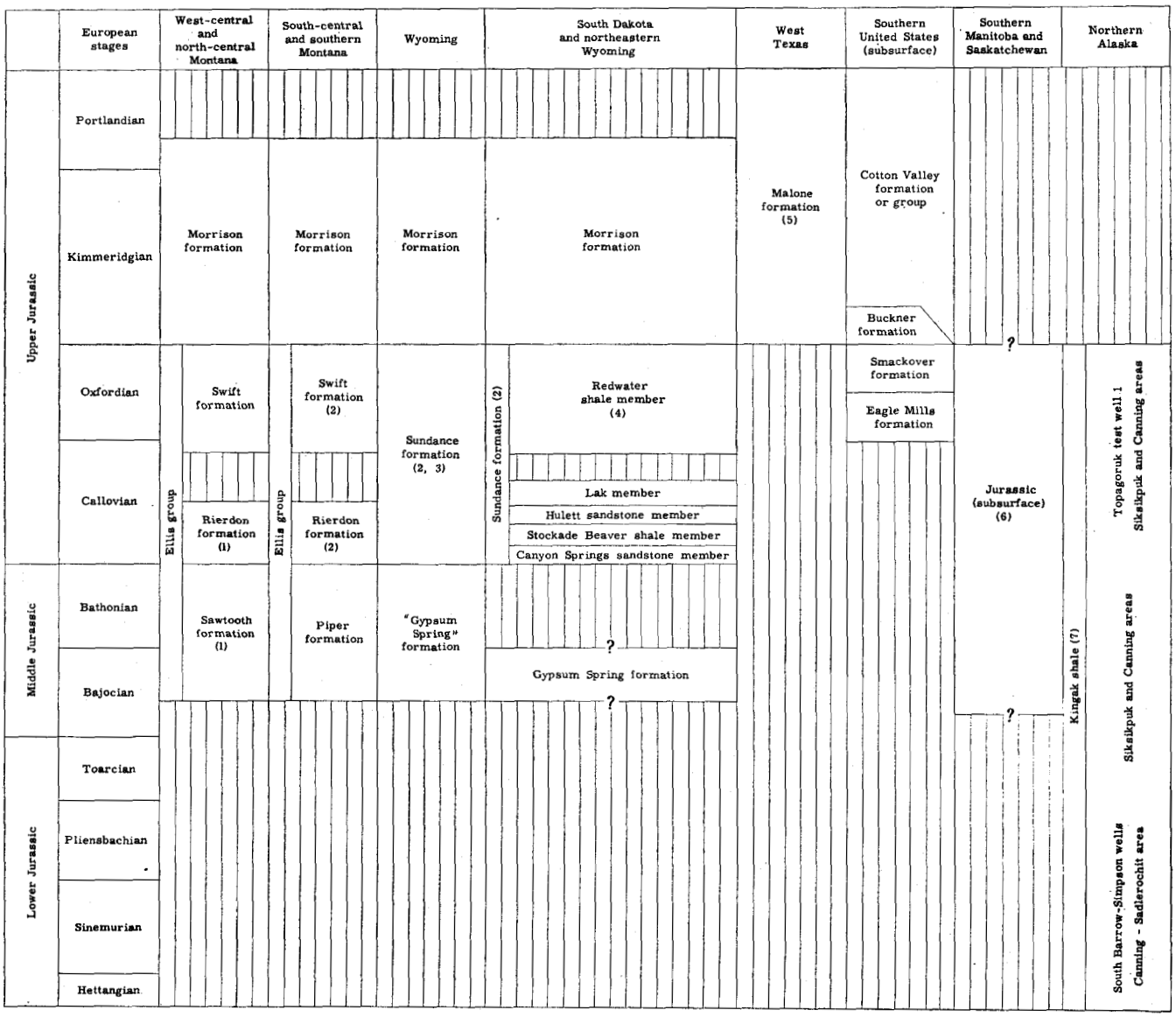

FIGURE 8.—Correlation of strata of Jurassic age of North America, from which Foraminifera have been described, by (1) Lalicker, 1950; (2) Loeblich and Tappan, 1950b; (3) Sandidge, 1933; (4) Loeblich and Tappan, 1950a; (5) Albritton, 1937; (6) Wickenden, 1933; and (7) Tappan, 1952. In part after Imlay, 1943 and 1948.

Beginning at the base of the section, Lias α has three faunal subzones, the Psilonoten Stufe, the Schlotheimia Stufe, and the Arieten Stufe.

The Psilonoten Stufe contains the following species that also occur in Alaska:

Reophax dentaliniformis Brady (=*R. liasica* Franke)
Cristellaria (*Astacolus*) *prima* d'Orbigny (=*Lenticulina prima* (d'Orbigny))
(*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann))
Marginulina radiata Terquem
Vaginulina curva Franke
Dentalina communis d'Orbigny (=*Dentalina pseudocommunis* Franke)
Eoguttulina liassica (Strickland)

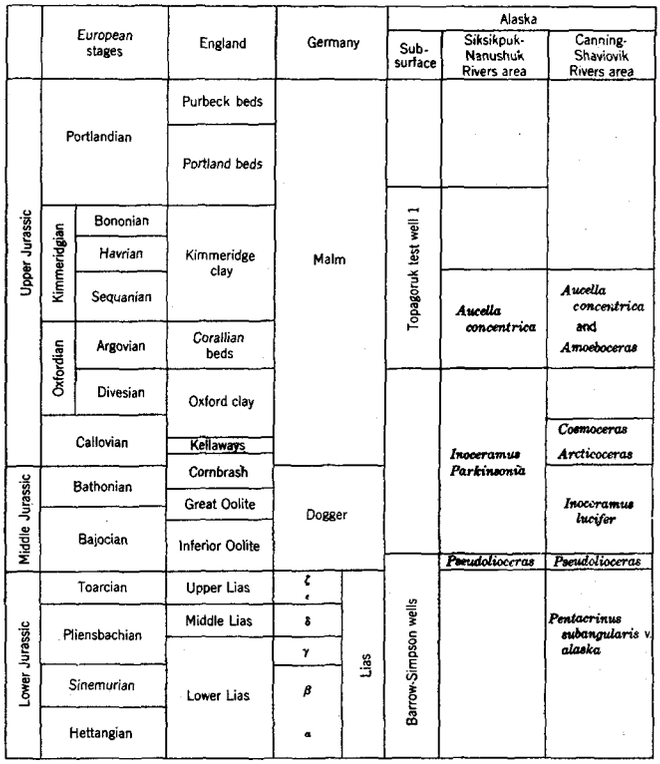

FIGURE 9.—North Alaskan Jurassic correlation table, showing ammonite zones and the equivalent European stages.

The Schlotheimia Stufe contains the following species that are also found in Alaska:

Reophax scorpiurus Montfort (=*R. suevica* Franke)
Trochammina globigeriniformis Parker and Jones (=*T. canningensis* Tappan)
Cristellaria (*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann))
Marginulina prima d'Orbigny
radiata Terquem
Nodosaria mitis (Terquem and Berthelin)
Dentalina communis (d'Orbigny (=*D. psuedocommunis* Franke)
terquemi d'Orbigny
Eoguttulina liassica (Strickland)

The Arieten beds contained the following species that are also found in Alaska:

Ammodiscus incertus d'Orbigny (=*Involutina silicea* Terquem)
Ammobaculites agglutinans (d'Orbigny) (=*A. alaskensis* Tappan)
Trochammina nana (Brady) (=*T. gryci* Tappan)
Cristellaria (*Astacolus*) *prima* d'Orbigny (=*Lenticulina prima* (d'Orbigny))
(*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann))
Marginulina prima d'Orbigny
radiata Terquem
Nodosaria mitis (Terquem and Berthelin)
Dentalina communis d'Orbigny (=*D. pseudocommunis* Franke)
exilis Franke
tortilis Franke
Frondicularia baueri Burbach
Eoguttulina liassica (Strickland)

Lias β is divided into three subzones, which from the base upward are called the Planicosta, Bifer, and Raricostatum subzones. Of these, the Bifer and Raricostatum subzones were not represented in the material studied by Bartenstein and Brand, but the Planicosta subzone contains the following species that are also found in Alaska:

Jaculella liassica Brand (=*J. elliptica* (Deecke))
Ammodiscus incertus d'Orbigny (=*Involutina silicea* Terquem)
Lituotuba incerta Franke (=*L. irregularis* Tappan)
Reophax dentaliniformis (Brady) (=*R. liasica* Franke)
Cristellaria (*Astacolus*) *matutina* d'Orbigny (=*Vaginulinopsis matutina* (d'Orbigny))
(*A.*) *prima* d'Orbigny (=*Lenticulina prima* (d'Orbigny))
(*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann))
(*A.*) *quadricostata* (Terquem) (=*Marginulina quadricostata* Terquem)
Marginulina prima d'Orbigny
sherborni Franke (=*Vaginulina sherborni* (Franke))
Nodosaria mitis (Terquem and Berthelin)
regularis Terquem
Dentalina communis (d'Orbigny) (=*D. pseudocommunis* Franke)
Pseudoglandulina multicostata (Bornemann) (=*Rectoglandulina multicostata* (Bornemann))
Frondicularia baueri Burbach
terquemi d'Orbigny
Lagena globosa (Montagu) (=*L. aphela* Tappan)
Eoguttulina liassica (Strickland)

Lias γ was also divided into three subzones; from the base upward they are the Jamesoni, Centaurus, and Capricornu zones.

Alaska species that were recorded from the Jamesoni zone include:

Ammodiscus incertus d'Orbigny (=*Involutina silicea* Terquem)
Cristellaria (*Astacolus*) *prima* d'Orbigny (=*Lenticulina prima* (d'Orbigny))
(*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann)
Marginulina prima d'Orbigny
sherborni Franke (=*Vaginulina sherborni* (Franke))
Dentalina communis (d'Orbigny) (=*D. pseudocommunis* Franke)
exilis Franke
terquemi d'Orbigny
Frondicularia baueri Burbach
terquemi d'Orbigny
Eoguttulina liassica (Strickland)

From the Centaurus zone were recorded the following species that also occur in Alaska:

Ammodiscus incertus d'Orbigny (=*Involutina silicea* Terquem)
Cristellaria (*Astacolus*) *prima* d'Orbigny (=*Lenticulina prima* (d'Orbigny))
(*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann))
Marginulina prima d'Orbigny
Nodosaria regularis Terquem
Dentalina communis d'Orbigny (=*D. pseudocommunis* Franke)
tenuistriata Terquem
terquemi d'Orbigny
tortilis Franke
Pseudoglandulina oviformis (Terquem) (=*Rectoglandulina oviformis* (Terquem))
Frondicularia baueri Burbach
terquemi d'Orbigny
Lagena globosa (Montagu) (=*L. aphela* Tappan)
Eoguttulina liassica (Strickland)

The Capricornu zone contains the following species here recorded from Alaska:

Jaculella liassica Brand (=*J. elliptica* (*Deecke*))
Ammodiscus incertus d'Orbigny(=*Involutina silicea* Terquem)
Reophax scorpiurus Montfort (=*R. suevica* Franke)
Ammobaculites agglutinans (d'Orbigny) (=*A. alaskensis* Tappan)
Cristellaria (*Astacolus*) *prima* d'Orbigny (=*Lenticulina prima* (d'Orbigny))
(*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann))
Marginulina prima d'Orbigny
sherborni Franke (=*Vaginulina sherborni* (Franke))
Nodosaria mitis (Terquem and Berthelin)
regularis Terquem
Dentalina communis d'Orbigny (=*D. psuedocommunis* Franke)
sublinearis Franke (=*D. bartensteini* Tappan)
tenuistriata Terquem
terquemi d'Orbigny
Pseudoglandulina multicostata (Bornemann) (=*Rectoglandulina multicostata* (Bornemann))
oviformis (Terquem) (=*Rectoglandulina oviformis* (Terquem))
Frondicularia baueri Burbach
terquemi d'Orbigny
Lagena globosa (Montagu) (=*L. aphela* Tappan)
Eoguttulina liassica (Strickland)

Lias δ is divided into the Margaritatus and overlying Spinatus zones. The Margaritatus zone contains the following Foraminifera, also found in Alaska:

Jaculella liassica Brand (=*J. elliptica* (Deecke))
Ammodiscus incertus d'Orbigny (=*Involutina silicea* Terquem)
Cristellaria (*Astacolus*) *prima* d'Orbigny (=*Lenticulina prima* (d'Orbigny))
(*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann))
Marginulina prima d'Orbigny
spinata interrupta Terquem (=*M. interrupta* Terquem)
Nodosaria hirsuta d'Orbigny (=*N. apheilolocula* Tappan)
mitis (Terquem and Berthelin)
regularis Terquem
Dentalina communis (d'Orbigny) (=*D. psuedocommunis* Franke)
terquemi d'Orbigny
Pseudoglandulina oviformis (Terquem) (=*Rectoglandulina oviformis* (Terquem))
Frondicularia baueri Burbach
terquemi d'Orbigny
Lagena globosa (Montagu) (=*L. aphela* Tappan)
Eoguttulina liassica (Strickland)

The Spinatus zone had the following species in common with Alaska:

Ammodiscus incertus d'Orbigny (=*Involutina silicea* Terquem)
Marginulina sherborni Franke (=*Vaginulina sherborni* (Franke))
Nodosaria prima d'Orbigny
Dentalina communis d'Orbigny (=*D. pseudocommunis* Franke)
tenuistriata Terquem
Frondicularia terquemi d'Orbigny
Eoguttulina liassica (Strickland)

Lias ζ comprises the Posidonien-schiefer and contains the following:

Dentalina communis (d'Orbigny) (=*D. pseudocommunis* Franke)
Eoguttulina liassica (Strickland)

Lias ζ is synonymous with the Jurensis-Stufe and contains the following Foraminifera also found in Alaska:

Ammodiscus incertus d'Orbigny (=*Involutina silicea* Terquem)
Cristellaria (*Lenticulina*) *varians* Bornemann (=*L. varians* (Bornemann))
Nodosaria regularis Terquem
Eoguttulina liassica (Strickland)

The Alaskan sequence in the Barrow wells thus contains 19 species found in Lias α of Germany, 18 found in Lias β, 22 common to Lias γ, 19 found in Lias δ, 2 in Lias ϵ and 4 in Lias ζ. Some of these species range throughout the Lias and are found in all zones, but others are more restricted, and the large number in common suggests a greater similarity of the Alaska section to Lias γ and δ of Germany (the Pliensbachian), although the lower beds in the Barrow area probably represent Lias α and β. The upper Lias contains fewer Foraminifera, both in Alaska and Germany, and the majority of species are long ranging.

Because the middle Jurassic of northern Alaska is almost barren of Foraminifera, no close correlation is possible with the German Dogger. On the basis of megafossils, only the lower portion of the Dogger is represented in northern Alaska.

JURASSIC OF ENGLAND AND FRANCE

Thirty-six species of Foraminifera found in Alaska have also been recorded from France and 18 from England. The work in England has been concerned largely with the Lower Lias, and as the most fossiliferous portion of the Jurassic system of Alaska is of Middle Lias and late Early Lias (Pliensbachian) age, only the long-ranging species are found in common. A report by Barnard (1950b) on Upper Lias Foraminifera, described a fauna from the "junction of the Middle and Upper Lias," and although a few species were found there that are here recorded from Alaska, the same time interval is represented by the less fossiliferous part of the section in Alaska. The similarity is thus less striking than that between the sections of Germany and Alaska where the most fossiliferous sections coincide in

time, or to a lesser extent, between the section in Alaska and that of France. Furthermore, although very detailed foraminiferal zonation and correlation with ammonite zones has been possible in England, it was on the basis of surface sampling. Complete ammonite zonation is not yet possible in Alaska, as good specimens of ammonites are less common in well samples, and as the foraminiferal data are based on a restricted horizontal range, only incomplete results can be obtained. Even the generalized correlation which has been possible is encouraging, and it is hoped that future surface collections and drilling information will completely reveal the Jurassic zonation in Alaska.

The following species here recorded from Alaska have been found in Jurassic strata of England. Some of these have been recorded under different names, but the synonomy given in the systematic descriptions will indicate the various names that have been applied to each species.

Involutina aspera Terquem
silicea Terquem
Ammobaculites alaskensis Tappan
Lenticulina prima (d'Orbigny)
varians (Bornemann)
Marginulina interrupta Terquem
prima d'Orbigny
Nodosaria berthelini Tappan
prima d'Orbigny
Dentalina pseudocommunis Franke
terquemi d'Orbigny
Rectoglandulina multicostata (Bornemann)
oviformis (Terquem)
Vaginulina anomala Blake
curva Franke
sherborni (Franke)
Vaginulinopsis matutina (d'Orbigny)
Frondicularia terquemi d'Orbigny
Eoguttulina liassica (Strickland)

The early papers of Terquem, Terquem and Berthelin, and d'Orbigny described a large number of species of Jurassic age from France, and many extremely minor variations in form, number of striae, etc., were made the basis for a multitude of names. Some of these have since been placed in synonomy by later workers, and a restudy of the types or of topotype material if the types are no longer in existence, will undoubtedly show that many more are synonymous. From an examination of the literature, the following species are apparently identical with those recorded from France, the synonymy under each species in the systematic part of this paper giving the name to which it was there referred.

Involutina aspera *Terquem*
silicea *Terquem*
Lituotuba irregularis *Tappan*
Haplophragmoides canui *Cushman*
Ammobaculites fontinensis (*Terquem*)
vetusta (*Terquem and Berthelin*)
Dorothia? squamosa (*Terquem and Berthelin*)
Lenticulina excavata (*Terquem*)
prima (*d'Orbigny*)
toarcense *Payard*
varians (*Bornemann*)
Astacolus arietis (*Terquem*)
Marginulina breviformis (*Terquem and Berthelin*)
demissa (*Terquem and Berthelin*)
interrupta *Terquem*
prima *d'Orbigny*
quadricostata *Terquem*
radiata *Terquem*
utricula *Terquem and Berthelin*
Nodosaria apheilolocula *Tappan*
berthelini *Tappan*
mitis (*Terquem and Berthelin*)
prima *d'Orbigny*
radiata (*Terquem*)
regularis *Terquem*
vermicularis (*Terquem*)
Rectoglandulina oviformis (*Terquem*)
turbinata (*Terquem and Berthelin*)
Dentalina pseudocommunis *Franke*
tenuistriata *Terquem*
terquemi *d'Orbigny*
Vaginulinopsis matutina (*d'Orbigny*)
Citharina fallax (*Payard*)
frankei *Tappan*
Frondicularia squamosa *Terquem and Berthelin*
terquemi *d'Orbigny*
Lagena liasica (*Kübler and Zwingli*)
Eoguttulina metensis (*Terquem*)
Paleopolymorphina vagina (*Terquem*)

CHARACTERISTICS OF THE JURASSIC FAUNA OF ALASKA

Of the 111 species of Foraminifera described from the Jurassic system of northern Alaska, 83 species were found in the Lower Jurassic of South Barrow Test Well 3, and 28 species in the other wells and outcrop sections representing strata of Early and Late Jurassic age. The Liassic fauna thus affords an excellent basis for comparison with other Mesozoic faunas. It differs from that of the underlying Triassic rocks largely in being more abundant and more varied. The most notable change is the great expansion of the Nodosariidae, a feature everywhere characteristic of the Jurassic. Although the Triassic fauna of Alaska includes about 50 percent of species of the Nodosariidae, only seven genera were represented, as compared to 16 genera of this family in the Jurassic of Alaska.

The arenaceous species show a greater variety, and a few additional genera are represented that become increasingly important in strata of later Mesozoic age. Such a form is *Triplasia* (the present species being the oldest known member of the genus) which reached a

climax and was particularly abundant during Cretaceous time in the Gulf Region, with a few remnant species occurring even to the present seas. *Dorothia* also makes its first appearance during Jurassic time.

The number of species of Foraminifera expanded greatly in Early Jurassic time from the number present in Late Triassic, for the Shublik formation contained a total of 26 species, and the overlying lower Kingak shale, with 83 species, had more than three times as many. This upsurge in fauna was not immediate, however, for even in South Barrow Test Well 3 the lower 400 feet of Jurassic strata contained only 37 species, and the section from 400 to 500 feet above the contact shows the greatest increase and the greatest total number of species. This is in the *Amaltheus* zone (upper Pliensbachian), and equivalent to the *margaritatus* zone of the Lias δ of Germany. A similar increase in fauna was noted in Germany by Bartenstein and Brand (1937), for Lias α had very few species, with a progressive increase in number of species occurring throughout Lias β, γ, and δ, with by far the greatest variety of species in Lias γ and δ. The uppermost Lias shows a slight decrease in variety and quantity, both in Germany and in the Alaskan section.

Another feature of the fauna of Lower Jurassic rocks is the greater amount of surface ornamentation of the species than was found in Foraminifera of the Upper Triassic strata. Although smooth and unornamented species are found in all strata, from the earliest occurrence of each genus to the Recent seas, they are much more frequent in the older beds. Only four of the Nodosariidae from Triassic rocks of northern Alaska had any type of ornamentation, and then only such minor features as low ribs, weak striae, or faint median sulcus. In the fauna of Jurassic age, many species developed strong keels, some became spinose, ribs were more sharply elevated, and in some the entire wall was hispid. Barnard (1950a) demonstrated a definite evolutionary trend in the development of ornamentation among the *Frondicularia* of the English Lias. He stated that the many-ribbed species (the *Frondicularia sulcata* group, which would include such species as *F. squamosa*) occurred earlier in the Lias, with a progressive reduction in the number of ribs in later beds, and the smooth or nearly smooth species occurring latest (such as *F. terquemi*). This zonation was very marked in fossils of Jurassic age from England, but does not hold true in Alaska, for *F. terquemi* and *F. squamosa* coincide in range and only *F. lustrata* (which is intermediate between the other two in number of ribs) is found in younger strata. Possibly the complete ranges are not as yet known, however, as these are based on a single well, and additional information may show a greater degree of correlation.

A prominent characteristic of the family Nodosariidae is the radiate aperture found in most genera. According to Barnard (1950a, p. 391).

> The Lias species were not so clearly differentiated as modern forms; many characters were certainly in a less developed stage. The radiate aperture, cited as a characteristic of the Lagenidae, was present in only comparatively few lower Jurassic Foraminifera. Some of the forms with circular apertures, however, could be accounted for by the resorption of the radiate aperture at the end of the apertural chamberlet, leaving a circular aperture beneath.

This absence of a radiate aperture is not a feature of the species from Lower Jurassic rocks in Alaska, as most of them have extremely well developed radiate apertures, as can be seen on the figures. Possibly the apparent absence of a radiate aperture in many of the earlier nodosarids is due to resorption, as Barnard stated, and as he demonstrated in certain species, but it seems probable to the present writer that in many Jurassic nodosarids this absence is due either to poor preservation or lack of observation. Nodosarids with radiate apertures have been found in strata as early as the Permian, and a few of the Triassic species of Alaska showed distinct radiate apertures. In these Triassic species poor preservation obscured many apertural details, however, as some were represented only by pyritic casts. Various other authors recently have also shown definite radiate apertures on Liassic nodosarids (Bartenstein and Brand figure some of these), but many of the older papers described and illustrated the species of Jurassic age in such an ambiguous fashion that there is no indication whatever as to the apertual characters. It is only in recent years that attention has been focused upon the aperture (or upon wall structure, internal characteristics, and other features), and many early descriptions failed to include characters now considered to be of major importance. Restudy of these species may show radiate apertures to be much more prevalent than would be assumed by an examination of the literature.

In addition to the rapid increase in number, variety, and ornamentation of foraminiferal species, another characteristic of Jurassic Foraminifera, as compared to both earlier and later faunas, is the wide degree of variation found in a single species. It is therefore particularly important that Jurassic species be based whenever possible upon a suite of specimens rather than upon a single "type." If a small number of specimens are studied, probably two or three times as many "species" could be described from the same fauna, using the end members of the variations as "species,"

and this has undoubtedly been done in some of the older publications. However, when large suites are examined, all gradations between these end members can be found, and the number of apparent species is reduced considerably. Actually, an informal statistical analysis must be made for each group of specimens. Although no graphs were constructed (the abundance of specimens of Foraminifera makes this a problem of almost prohibitive magnitude), it can be seen at a glance that the number of chambers varies between certain limits, as do the size, the various proportions, and even the amount of ornamentation. All these factors and their degree of variation should be shown in each specific description. When a series of specimens such as is illustrated for *Ammobaculites alaskensis* Tappan, *Vaginulina curva* Franke, or *Marginulina bergquisti* Tappan, is compared with a single figure, or a description based on a single specimen, it is easy to see why varied synonymies develop. Certain specimens of *Vaginulina curva* might by themselves be referred to *Astacolus*, and others to *Marginulina*, but a study of the entire suite reveals that the species is best referred to *Vaginulina*. Other species grade from *Nodosaria* into *Marginulina*, or to *Dentalina* or even *Rectoglandulina*, so not only could more than one species be described on variations of these Jurassic forms, but many could likewise be as readily referred to one genus as to another. Many of the nodosarid genera first appeared in Jurassic time, and apparently were not as yet completely stable in their characteristics.

The present paper is illustrated by large numbers of figures of many of these most variable species, and in addition, many paratypes and hypotypes have been mounted and catalogued, so that one can readily see which features were considered to be characteristic of each species. Measurements are given for the type specimens, as is usual in specific descriptions, but in addition, upper and lower size limits are given for each species possible, a feature which has often been neglected in foraminiferal studies of recent years.

ACKNOWLEDGMENTS

This study was made possible only by the full cooperation of the geologists of the Navy Oil Unit of the U. S. Geological Survey. Only those aiding in the present section of the report are mentioned here, and a more complete list of persons who have assisted the writer is given in the first section of this report (Tappan, 1951b).

Aid was given in obtaining material and information about the outcrops and well sections by Ralph L. Miller, chief of Fuels Branch and formerly Geologist in charge, Navy Oil Unit; George Gryc, present chief, Navy Oil Unit; and Thomas G. Roberts, formerly geologist in charge of the Fairbanks laboratory, Navy Oil Unit, U. S. Geological Survey. Harlan R. Bergquist, micropaleontologist, Fairbanks laboratory, first discovered the Jurassic fauna in the well sections, and also in some of the outcrop areas. The rocks of Jurassic age of the Siksikpuk-Nanushuk Rivers area were first recognized as such by Dr. Bergquist after a comparison with subsurface material, and the correlation was later substantiated by field studies.

Although it was stated in the first section of this report (Tappan, 1951b) that "all outcrop material and well samples used in this study were obtained prior to 1950," some later material has since been added, as the Jurassic samples of the Siksikpuk-Nanushuk Rivers area were collected during the summer of 1950, and the Jurassic samples from Topagoruk Test Well 1 were obtained during the winter of 1950–51. As these two areas contain a Middle and Upper Jurassic section not represented in earlier collections, it was deemed advisable to add their faunas to the present study.

The Jurassic microfossil samples were collected and stratigraphic sections measured during the geologic mapping from 1947 through 1950 by George Gryc, A. Samuel Keller, Marvin D. Mangus, William W. Patton, Edward G. Sable, and Charles L. Whittington.

Lithologic examination of the well samples was made by A. Samuel Keller and Miss Florence Rucker. Identification of ammonite faunas by Ralph W. Imlay aided greatly in the zonation and correlation of Alaskan Jurassic rocks. All samples used in this study have been washed and picked in Washington by Alfred R. Loeblich, Jr., and the writer, portions of the unwashed samples and cores having been supplied from the Fairbanks Laboratory for that purpose.

For European Jurassic material used in comparison with that of Alaska, I am indebted to Dr. Tom Barnard of the University College, London, who sent a series of specimens from the Lower Lias of England; to Dr. W. A. Macfadyen, Kent, England, who sent Jurassic samples from England and to Dr. Helmut Bartenstein, Celle, Germany, who sent Jurassic microfossil samples from Germany. This European material has been extremely valuable for comparisons in the present study.

Acknowledgment is also made of the continued assistance of Alfred R. Loeblich, Jr., in the preparation of material for study, and in the preparation of the manuscript and illustrations. All illustrations of Foraminifera are shaded camera-lucida drawings by the writer. All figured specimens and numerous additional paratypes and hypotypes are deposited in the U. S. National Museum.

SYSTEMATIC DESCRIPTIONS

Family RHIZAMMINIDAE

Genus BATHYSIPHON M. Sars, 1872

Bathysiphon anomalocoelia Tappan, n. sp.

Plate 7, figures 1–3

Test free, large, elongate, tubular, open at both ends, flattened, usually represented only by short fragments; wall finely arenaceous, about 0.05 mm in thickness, rather smoothly finished.

Length of holotype 1.85 mm, greatest breadth 0.49 mm, greatest thickness 0.23 mm. Other specimens are from 0.26 to 0.78 mm in breadth.

Remarks.—This species resembles *Bathysiphon vitta* Nauss, from the Lea Park shale of Cretaceous age, of Alberta, in general size and shape, but has a thinner wall and is of somewhat greater breadth.

Types and occurrence.—Paratype of figure 3 (USNM P70) from a core at 2,099–2,109 feet, unfigured paratypes (USNM P71) from a core at 2,109–2,119 feet, unfigured paratype (USNM P72) from a core at 2,130–2,140 feet, holotype (fig. 2) (USNM P68) and unfigured paratype (USNM P75) from a core at 2,170–2,179 feet, all of Upper Pliensbachian age; unfigured paratypes (USNM P73) from a core at 2,281–2,300 feet, unfigured paratypes (USNM P74) from a core at 2,300–2,320 feet, paratype of figure 1 (USNM P69) from a core at 2,468–2,478 feet, and unfigured paratypes (USNM P758) from a core at 2,527–2,547 feet, all of Early Lias age; all from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured paratypes (USNM P751) from Upper Jurassic rocks about three miles east of the Siksikpuk River, at approximately lat 68°40′ N., long 151°54′ W., in the foothills of the Brooks Range, in northern Alaska. Collected by William W. Patton, 1950.

Unfigured paratypes (USNM P763) from Upper Jurassic rocks (Oxfordian or Lower Kimmeridgian), from a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Unfigured paratype (USNM P1076) from Upper Jurassic rocks, on the west bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the headwaters of the Anaktuvuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, 1950.

Family HYPERAMMINIDAE

Subfamily HYPERAMMININAE

Genus JACULELLA H. B. Brady, 1879

Jaculella elliptica (Deecke)

Plate 7, figures 4–6

Rhabdammina elliptica Deecke, 1884, Abh. Geol. Specialkarte von Elsass-Loth., v. 4, no. 1, p. 23, pl. 1, figs. 1–1b.

Jaculella liassica Brand, 1937, in Bartenstein and Brand, Abh. Senckenberg. Naturf. Ges., no. 439, p. 129, pl. 2B, fig. 1, pl. 3, figs. 4a, b, pl. 4, fig. 3, pl. 5, fig. 4, pl. 7, fig. 5.

Test free, consisting of a proloculus and elongate, flaring, somewhat irregular and flattened second chamber; wall finely arenaceous, with a roughened appearance; aperture at the open end of the conical tube.

Length of hypotype of fig. 4 is 1.04 mm, greatest breadth 0.26 mm, thickness 0.08 mm. Length of hypotype of fig. 6 is 0.81 mm.

Remarks.—This species resembles *Jaculella acuta* Brady, from the present seas, in general appearance and degree of flaring, but differs in being quite small, about one-seventh the length of Brady's species. The Alaskan form agrees closely with those figured by Brand, particularly his paratype of pl. 2B, fig. 1. Deecke's specimen is similar in every respect, except for being more coarsely arenaceous. However, as this character often reflects the character of the local sea bottom, rather than a selective feature of a species, the two are considered synonymous.

Types and occurrence.—Figured hypotypes (USNM P76a–c) and unfigured hypotypes (USNM P77), from the Kingak shale of Early Jurassic age from a core at 2,341–2,356 feet, in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Family REOPHACIDAE

Subfamily REOPHACINAE

Genus REOPHAX Montfort, 1808

Reophax densa Tappan, n. sp.

Plate 8, figures 1–6

Test free, large, elongate, tapering, larger specimens usually flattened in preservation; chambers numerous, as many as 13 in the microspheric forms (figs. 2–4, 6), increasing gradually in size from the tiny proloculus, only about 5 to 8 chambers in the less tapered megalospheric forms, which are nearly parallel-sided from the rounded proloculus, chambers low and broad, increasing very slowly in height as added, final chamber about twice the height of the preceding ones; sutures distinct, horizontal, constricted; wall finely to coarsely arenaceous, surface rough; aperture terminal, simple.

Length of microspheric holotype 2.00 mm, greatest breadth 0.68 mm, length of megalospheric paratype (fig. 1) 1.33 mm, greatest breadth 0.44 mm. Other specimens vary in length from 0.39 to 2.05 mm.

Remarks.—Reophax sundancensis Loeblich and Tappan, from Upper Jurassic rocks, resembles the megalospheric specimens (figs. 1, 5) of this species in the gradual tapering, rounded base and slightly inflated

chambers, but is somewhat smaller in size. The microspheric generation of the present species is much larger, has more numerous chambers and a more tapered form than is found in *R. sundancensis*.

Types and occurrence.—Paratype of fig. 5 (USNM P82) and unfigured paratypes (USNM P83) from a core of Early Toarcian age at 1,979–1,999 feet; paratypes of figs. 2, 4, and 6 (USNM P80) and unfigured paratypes (USNM P81) from a core at 2,099–2,109 feet, paratype of fig. 1 (USNM P84) and unfigured paratypes (USNM P85) from a core at 2,109–2,119 feet, holotype (fig. 3) (USNM P78) and unfigured paratypes (USNM P79) from a core at 2,130–2,140 feet, unfigured paratypes (USNM P86) from a core at 2,140–2,150 feet, unfigured paratypes (USNM P87) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; unfigured paratypes (USNM P88) from a core (Lower Lias) at 2,363–2,380 feet, and unfigured paratypes (USNM P757) from a core (Lower Lias) at 2,527–2,547 feet, all from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured paratypes (USNM P89) from a core at 2,341–2,356 feet in the Kingak shale of Early Jurassic age in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Reophax liasica Franke

Plate 7, figures 15–19

Reophax scorpiurus Montfort f. *liasica* Franke, 1936, Abh. Preuss. Geol. Landesanstalt, Neue Folge, v. 169, p. 19, pl. 1, fig. 18.

Reophax dentaliniformis Brady, Bartenstein and Brand, 1937 (not Brady, 1881), Abh. Senckenberg. Naturforsch. Gesell. v. 439, p. 133, pl. 1A, fig. 4, pl. 1B, figs. 4–13, pl. 14A, figs. 1a, b, pl. 14B, fig. 1, pl. 15A, figs. 5a–c.

Test free, of medium size, elongate, uniserial, with slightly curved axis; two to four chambers, increasing rapidly in size as added, final chamber pyriform in outline, widest near the base, tapering to a distinct neck, final chamber comprises ½ to ⅝ the length of the test; sutures distinct, constricted, horizontal; wall finely arenaceous, surface smoothly finished; aperture terminal, rounded.

Length of hypotype of fig. 15, 0.42 mm, greatest breadth 0.13 mm. Length of hypotype of fig. 17, 0.78 mm, greatest breadth 0.34 mm. Length of hypotype of fig. 18, 0.70 mm, greatest breadth 0.23 mm. Other specimens are from 0.34 to 1.20 mm. in length.

Remarks.—This species differs from *Reophax scorpiurus* Montfort in being somewhat smaller but much more robust, thicker, less tapering, with fewer chambers, more rounded base, pyriform final chamber and broader and thicker neck, and is certainly sufficiently different to be considered a distinct species, rather than a variety.

The specimens referred to *R. dentaliniformis* Brady by Bartenstein and Brand are also closer to the Alaskan forms than to Brady's form, or to that referred to *R. dentaliniformis* by Franke, and here placed under *R. suevica* Franke.

Reophax liasica Franke is also similar to *R. deckeri* Tappan from the Lower Cretaceous series, in the rapidly enlarging pyriform chambers and slightly curved test, but is larger, has fewer chambers and a more rapid increase in chamber size. It differs from *Reophax suevica* Franke in being smaller, less tapering, in having fewer chambers and a less coarsely arenaceous wall.

Types and occurrence.—Unfigured hypotypes (USNM P96) from a core at 1,743–1,748 feet, unfigured hypotypes (USNM P97) from a core at 1,999–2,018 feet, unfigured hypotypes (USNM P98) from a core at 2,018–2,028 feet, hypotypes of figs. 15, 16, and 19 (USNM P92a–c) and unfigured hypotypes (USNM P93) from a core at 2,028–2048 feet, unfigured hypotypes (USNM P99) from a core at 2,048–2,068 feet, all of Early Toarcian age; unfigured hypotypes (USNM P100) from a core at 2,068–2,078 feet, hypotype of fig. 18 (USNM P90) and unfigured hypotypes (USNM P91) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P101) from a core at 2,130–2,140 feet, unfigured hypotypes (USNM P102) from a core at 2,150–2,160 feet, all of Late Pliensbachian age; unfigured hypotypes (USNM P103) from a core (Lower Lias) at 2,199–2,218 feet, hypotype of fig. 17 (USNM P94) and unfigured hypotypes (USNM P95) from a core (Lower Lias) at 2,231–2,251 feet; all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Reophax metensis Franke

Plate 7, figures 11–14

Reophax metensis Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, v. 169, p. 19, pl. 1, figs. 17a, b; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., v. 439, p. 133, pl. 10, fig. 8, pl. 13, figs. 1a–b, 4.

Test free, large, elongate; two or three large rounded chambers, in a straight or slightly curved uniserial arrangement, increasing rapidly in size as added, final chamber pyriform in outline, widest near the base and tapering to a distinct neck, final chamber occupying ½ to ¾ the length of the test; sutures distinct, constricted, straight; wall coarsely arenaceous, surface rough, probably with a chitinous lining, as many of the larger tests are flattened in preservation but not crushed; aperture terminal on the elongate neck, rounded to elongate.

Length of hypotype of fig. 11, 1.30 mm, breadth 0.68 mm. Length of hypotype of fig. 13, 2.03 mm, greatest breadth 0.88 mm. Length of hypotype of fig. 14, 1.95

mm, breadth 0.99 mm. Other specimens are from 0.60 to 2.05 mm in length.

Remarks.—This species differs from *Reophax liasica* Franke in being larger, the final chamber more inflated, and the wall more coarsely arenaceous, and roughened in appearance. It differs from *Reophax deckeri* Tappan, from the Lower Cretaceous series, in the larger size, and fewer and more rapidly enlarging chambers.

Types and occurrence.—Unfigured hypotypes (USNM P110) from a core at 1,739–1,743 feet, unfigured hypotypes (USNM P111) from a core at 1,999–2,018 feet, unfigured hypotypes (USNM P112) from a core at 2,028–2,048 feet, unfigured hypotypes (USNM P113) from a core at 2,048–2,068 feet, all of Lower Toarcian age; unfigured hypotypes (USNM P114) from a core at 2,068–2,078 feet, unfigured hypotypes (USNM P115) from a core at 2,099–2,109 feet, unfigured hypotypes (USNM P116) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P117) from a core at 2,130–2,140 feet, unfigured hypotypes (USNM P118) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P119) from a core at 2,150–2,170 feet, hypotype of figure 12 (USNM P108) and unfigured hypotypes (USNM P109) from a core at 2,170–2,179 feet, all of Upper Pliensbachian age; hypotype of fig. 11 (USNM P106) and unfigured hypotypes (USNM P107) from a core at 2,199–2,218 feet, unfigured hypotypes (USNM P120) from a core at 2,251–2,271 feet, unfigured hypotypes (USNM P121) from a core at 2,271–2,281 feet, unfigured hypotypes (USNM P122) from a core at 2,281–2,300 feet, unfigured hypotypes (USNM P123) from a core at 2,300–2,320 feet, hypotype of fig. 13 (USNM P104) and unfigured hypotypes (USNM P105) from a core at 2,511–2,527 feet, and unfigured hypotypes (USNM P756) from a core at 2,527–2,547 feet, all from the Lower Lias; in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Hypotype of fig. 14 (USNM P124) and unfigured hypotypes (USNM P125) from a core at 2,341–2,356 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Reophax suevica Franke

Plate 7, figures 7–10

Reophax suevica Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, v. 169, p. 19, pl. 1, fig. 19.

Reophax dentaliniformis Brady, Franke, 1936 (not Brady, 1881), Ibid., p. 19, pl. 1, fig. 20.

Reophax dentaliniformis Brady f. *liasica* Franke, 1936, Ibid., p. 20, pl. 1, fig. 21.

Reophax scorpiurus Montfort, Bartenstein and Brand, 1937 (part) (not Montfort, 1808), Abh. Senckenberg. Naturforsch. Gesell., v. 439, p. 134, pl. 4, fig. 7.

Test free, of medium size, somewhat curved, tapering; 5 to 7 uniserial chambers increasing rapidly in size, final chamber subpyriform, occupying ¼ to ⅓ the length of the test; sutures distinct, constricted, straight; wall coarsely arenaceous, surface rough; aperture terminal, rounded, produced on a slight neck.

Length of hypotype of fig. 7, 1.30 mm, greatest breadth 0.34 mm, greatest thickness 0.21 mm. Other specimens vary from 0.55 to 1.30 mm. in length.

Remarks.—Franke described three species of *Reophax* under separate names, but all appear to be variations of a single species. His holotype of *R. suevica* is similar to the specimen here shown in fig. 10, and the specimens he referred to *R. dentaliniformis* and forma *liasica* are similar to the specimens here shown in figs. 8 and 9. The synonymy is somewhat complicated by the fact that Franke himself made a homonym of his *R. dentaliniformis* f. *liasica*, by proposing in the same publication and on an earlier page the species *R. scorpiurus* f. *liasica*, which thus takes priority.

It seems extremely unlikely that the species *R. dentaliniformis*, or any species in the biologic sense, could occur at such different times as the Early Jurassic and the Recent, and not be found in strata of intermediate ages. Furthermore, the Jurassic form differs from the Recent species in having somewhat broader and more pyriform chambers, a more curved test, coarser grained and more roughly finished wall, and a thicker neck.

Franke's holotype of *R. suevica* lies within the median size range of the species, as determined by the abundant assemblage in Alaska. It also takes priority over the other names which he used, as it occurs earlier in the publication.

The specimens referred to *R. dentaliniformis* by Bartenstein and Brand seem closer to the species Franke referred to *R. scorpiurus* f. *liasica*, and which is here considered to be *R. liasica* Franke. The specimen referred to *R. scorpiurus* by Bartenstein and Brand (1937, pl. 4, fig. 7) is very close in appearance to the Alaskan specimens of figs. 7 and 8.

Reophax suevica Franke differs from *R. liasica* Franke in the more slender test, more numerous chambers, less rapid increase in chamber size, higher early chambers and more coarsely arenaceous wall.

Types and occurrence.—Hypotypes of figs. 7–9 (USNM P126a–c) and unfigured hypotypes (USNM P127) all from a core in Lower Jurassic rocks, at 2,341–2,356 feet, in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Unfigured hypotypes (USNM P130) from a core at 1,743–1,748 feet, unfigured hypotypes (USNM P131)

from a core at 1,758–1,778 feet, from the Lower Toarcian; hypotype of fig. 10 (USNM P128) and unfigured hypotypes (USNM P129) from a core at 2,170–2,179 feet from the Upper Pliensbachian, and unfigured hypotypes (USNM P132) from a core at 2,251–2,271 feet, unfigured hypotypes (USNM P133) from a core at 2,300–2,320 feet, unfigured hypotypes (USNM P134) from a core at 2,511–2,527 feet, and unfigured hypotypes (USNM P753) from a core at 2,527–2,547 feet, all from the Lower Lias, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured hypotypes (USNM P135) from Lower Jurassic rocks in a core at 6,067–6,077 feet, in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson in northern Alaska.

Family TOLYPAMMINIDAE

Subfamily INVOLUTININAE

Genus INVOLUTINA Terquem, 1862

Involutina aspera Terquem

Plate 8, figures 10–13

Involutina aspera Terquem, 1863, Mém. Acad. Imp. Metz, v. 44, p. 431 (221), pl. 10, figs. 21a–b.

not *Ammodiscus asper* Macfadyen, 1941, Roy. Soc. London, Phil. Trans., B, no. 516, v. 231, p. 15, pl. 1, fig. 1.

Ammodiscus infimus (Strickland) Franke, 1936, Abh. Preuss. geol. Landesanst. Neue Folge, v. 169, p. 15, pl. 1, figs. 14a, b.

Ammodiscus asper Barnard, 1950, Quart. Jour. Geol. Soc. London, v. 105, pt. 3, no. 419, p. 351, text figs. 1a, i, ii.

Test free, large, discoidal, biconcave, consisting of a globular proloculus and planispirally wound tubular second chamber of as many as seven volutions, which increase very slowly and regularly in diameter; spiral suture distinct and sometimes appears as a clear line between the chamber whorls; wall arenaceous, of medium to coarse grains with very little cement, surface rough and granular in appearance, due to the protruding sand grains; aperture at the open end of the coiled tubular chamber.

Greatest diameter of hypotype of fig. 11, 0.68 mm, least diameter 0.62 mm, greatest thickness 0.10 mm. Greatest diameter of specimen of fig. 12, 0.91 mm, thickness 0.13 mm. Greatest diameter of specimen of fig. 13, 1.87 mm, thickness 0.21 mm.

Remarks.—This species is distinguished by the very rough and granular wall and regular coiling. It has been recorded throughout the Lias of Europe, although at times confused with *I. silicea* Terquem, and has also been referred to *Ammodiscus infimus* (Strickland). Macfadyen (1941, p. 16) stated that Strickland's species is a *Cornuspira*, hence distinct from the present species.

Types and occurrence.—Hypotypes of figs. 10 and 13 (USNM P138a–b) and unfigured hyptoypes (USNM P139) all from the Kingak shale of Early Jurassic age, in a core at 2,341–2,356 feet, in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Unfigured hypotypes (USNM P144) from a core at 1,743–1,748 feet, unfigured hypotypes (USNM P145) from a core at 1,758–1,778 feet, unfigured hypotypes (USNM P146) from a core at 1,979–1,999 feet, hypotype of fig. 12 (USNM P142) and unfigured hypotypes (USNM P143) from a core at 2,028–2,048 feet, hypotype of fig. 11 (USNM P140) and unfigured hypotypes (USNM P141) from a core at 2,048–2,068 feet, all of Early Toarcian age; and unfigured hypotypes (USNM P147) from a core at 2,068–2,078 feet, unfigured hypotypes (USNM P148) from a core at 2,099–2,109 feet, unfigured hypotypes (USNM P149) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P150) from a core at 2,130–2,140 feet, unfigured hypotypes (USNM P151) from a core at 2,150–2,170 feet, unfigured hypotypes (USNM P152) from a core at 2,170–2,179 feet, of Late Pliensbachian age; and unfigured hypotypes (USNM P153) from a core at 2,231–2,251 feet, unfigured hypotypes (USNM P154) from a core at 2,251–2,271 feet, unfigured hypotypes (USNM P155) from a core at 2,271–2,281 feet, unfigured hypotypes (USNM P156) from a core at 2,281–2,300 feet, unfigured hypotypes (USNM P157) from a core at 2,323–2,343 feet, and unfigured hypotypes (USNM P759) from a core at 2,527–2,547 feet (all Lower Lias), from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156° 34′45″ W., in northern Alaska.

In a recent joint paper (Loeblich and Tappan, 1954, p. 306), the author has shown the genus *Ammodiscus* Reuss to be synonymous with *Spirillina* Ehrenberg, and not an agglutinated form. As the type species of *Involutina* (*I. silicea* Terquem) is an agglutinated species, the genus *Involutina* should be used for the species previously referred to *Ammodiscus*. Thus the present species is again placed in the genus in which it was originally described.

Involutina cheradospira (Loeblich and Tappan)

Plate 8, figure 9

Ammodiscus cheradospirus Loeblich and Tappan, 1950, Jour. Washington Acad. Sci., v. 40, no. 1, p. 6, pl. 1, figs. 1–2b.

Test free, of medium size, discoidal, somewhat irregularly planispiral, periphery rounded; proloculus followed by a long, undivided, tubular second chamber which increases gradually in size as added; spiral suture

distinct, depressed; wall finely arenaceous, with considerable cement, rather smoothly finished; aperture formed by the open end of the tube.

Greatest diameter of figured hypotype 0.65 mm, least diameter 0.49 mm, thickness 0.10 mm.

Remarks.—This species was originally described from the Rierdon formation (Callovian) of Montana.

Types and occurrence.—Figured hypotype (USNM P136) from Upper Jurassic rocks (*Aucella bronni* zone) on the east bank of Welcome Creek, approximately at lat 68°24′ N., long 150°50′ W., about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured hypotype (USNM P137) from Upper Jurassic rocks (*Aucella bronni* zone) in the east bank of the East Fork of the Nanushuk River, approximately at lat 68°30′ N., long 150°25′ W., in the foothills of the Brooks Range, northern Alaska. Collected by A. Samuel Keller, 1950.

Involutina orbis (Lalicker)

Plate 8, figure 14

Ammodiscus orbis Lalicker, 1950, Univ. Kansas Paleon. Contr., Art. 2, p. 11, pl. 1, fig. 2.

Test free, discoid, consisting of an undivided tubular chamber, which coils in a flat spire about the globular proloculus, forming about 4 to 5 volutions; spiral suture distinct, depressed; wall finely arenaceous; aperture formed by the open end of the tube.

Greatest diameter of figured hypotype 0.39 mm, least diameter 0.34 mm, greatest thickness 0.05 mm. Greatest diameter of unfigured hypotype 0.42 mm.

Remarks.—This species is about ½ to ¼ the size of *Involutina aspera* Terquem, which is found in the lower part of the Kingak shale, and it is less coarsely arenaceous. *Involutina orbis* (Lalicker) was described from the Sawtooth formation (Middle Jurassic) of the Ellis group of Montana, and the holotype was of a size comparable to that of the present figured specimen. This species is about ⅓ the size of *I. cheradospira* (Loeblich and Tappan), from the Rierdon formation (Upper Jurassic) of Montana.

Types and occurrence.—Figured hypotype (USNM P771) and unfigured hypotype (USNM P770) from Upper Jurassic rocks (Oxfordian or Kimmeridgian) in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Involutina silicea Terquem

Plate 9, figures 1–4

Involutina silicea Terquem, 1862, Mém. Acad. Imp. Metz, ann. 42, p. 450, pl. 6, figs. 11a, b.

Ammodiscus incertus (d'Orbigny) Crick and Sherborn, 1891, (not d'Orbigny, 1839) Jour. Northampton. Nat. Hist. Soc., v. 6, p. 209, fig. 1; Bartenstein and Brand, 1937, Abh. Senckenberg. naturf. Ges., v. 439, p. 130, pl. 2B, fig. 4, pl. 3, figs. 5 a–c, pl. 4, fig. 4, pl. 5, figs. 5a, b, pl. 8, fig. 5, pl. 10, fig. 4, pl. 11A, fig. 3.

Ammodiscus asper (Terquem) Macfadyen, 1941 (not Terquem, 1863) Roy. Soc. London, Phil. Trans., ser. B, no. 576, v. 231, p. 15, pl. 1, fig. 7.

Involutina silicea Terquem, Loeblich and Tappan, 1954, Jour. Washington Acad. Sci., v. 44, no. 10, p. 310, figs. 2a, b.

Test free, large, discoidal, with bluntly rounded periphery; proloculus followed by an undivided, somewhat irregularly planispiral tubular chamber of four to five volutions, numerous surficial constrictions crossing this undivided chamber, but no true septa are present; spiral suture distinct and depressed; wall finely arenaceous, with a large proportion of cement, so that the test may have an almost porcellaneous appearance; aperture at the open end of the tube, somewhat slitlike, because of a slight tendency for the whorl to overlap the preceding volution at the lateral margins.

Greatest diameter of hypotype of fig. 1, 1.38 mm, least diameter 1.35 mm, greatest thickness 0.21 mm. Other specimens range from 0.34 to 1.51 mm in greatest diameter.

Remarks.—This species somewhat resembles *I. cheradospira* (Loeblich and Tappan), from the Upper Jurassic, but differs in the more irregular coiling and larger size. It differs from *I. aspera* Terquem in the large amount of cement in the wall, as the test has an almost porcellaneous appearance, and that of *I. aspera* is definitely granular in appearance. The coiled tube is also much thicker in the present species and coiling more irregular, with occasional constrictions along the tubular chamber.

Terquem originally distinguished the species *Involutina aspera* and *Involutina silicea* by the more rugose texture and smaller number of whorls in the former. His description stated that *I. silicea* had from 10 to 12 whorls. However, his original figure of the type of *I. silicea* shows only four whorls, and his figure of the type of *I. aspera* shows an equal number. The writer has reexamined the type of the present species, deposited in the Muséum National d'Histoire Naturelle, Paris, and has recently refigured it (Loeblich and Tappan, 1954, fig. 2). The lectotype shows 7 whorls when the specimen is dampened, and Terquem's figure showed only the later more distinct whorls. As these coiled forms vary considerably in size, and therefore also in the number of whorls, this character seems of less importance than the diameter of the tubular chamber, which is shown on the figured type of each species, and which is greater in *I. silicea*, the size of the test as compared to the number of whorls (there are fewer whorls

in *I. silicea*, in tests of equal diameter) and the described and figured more rugose wall texture of *I. aspera* and the "serpuliforme" appearance and irregularly constricted wall (which Terquem interpreted as chambers) of *I. silicea*. The specimens figured in the present paper resemble Terquem's type, but are slightly smaller. The Alaskan specimens are only up to 1.5 mm. in diameter, but have only 5 to 6 whorls. The lectotype, with 7 whorls, was about the same size. If some of Terquem's other specimens (his types were scattered in various institutions over France) had the 10 to 12 whorls his description mentioned, the tests would of course be larger, and probably up to 2 mm. in diameter as he stated. The Alaskan specimen of fig. 4 shows irregular constrictions across the tubular chamber, much as in Terquem's specimens, but these are growth constrictions and do not indicate true septa.

According to Macfayden (1941, p. 17, footnote), specimens sent to Brady by Terquem and labelled "*Involutina* (*Cornuspira*) *silicea* Terquem, Lias Moyen, Metz", are in the Brady collection at the British Museum (Natural History), London. Macfayden stated that these specimens were "all of the form that I have identified as *Ammodiscus asper* (Terquem)" and on this basis he stated that *Involutina* was probably a synonym of *Ammodiscus*, subject to confirmation by the type specimens. Macfayden's figured specimen is similar to those here figured, especially in the comparatively great diameter of the tubular chamber, and does not appear the same as the regularly spiral rugose tests with smaller tube diameter which were described as *Involutina aspera*.

Loeblich and Tappan (1954, p. 306) have recently shown the genus *Ammodiscus* to be a synonym of *Spirillina*, and the agglutinated forms previously placed in *Ammodiscus* should now be referred to *Involutina*. The present species is the type species of *Involutina*.

Types and occurrence.—Unfigured hypotypes (USNM P165) from a core at 2,028–2,048 feet, unfigured hypotypes (USNM P166) from a core at 2,048–2,068 feet, of Lower Toarcian age; and hypotype of fig. 1 (USNM P158) and unfigured hypotypes (USNM P159) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P167) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P168) from a core at 2,150–2,170 feet, all of Upper Pliensbachian age; and hypotype of fig. 2 (USNM P161) and unfigured hypotypes (USNM P160) from a core at 2,199–2,218 feet, unfigured hypotypes (USNM P169) from a core at 2,251–2,271 feet, unfigured hypotypes (USNM P170) from a core at 2,323–2,343 feet, unfigured hypotypes (USNM P171) from a core at 2,363–2,380 feet, hypotype of fig. 3 (USNM P162) and unfigured hypotypes (USNM P163) from a core at 2,478–2,496 feet, unfigured hypotypes (USNM P172) from a core at 2,511–2,527 feet, unfigured hypotypes (USNM P760) from a core at 2,527–2,547 feet, and hypotype of fig. 4 (USNM P164) from a core at 2,587–2,589 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured hypotype (USNM P173) from a core at 2,340–2,350 feet, from the Kingak shale of Early Jurassic age in South Barrow Test Well 4, at lat 71°15′55.24″ N., long 156°37′44.89″ W., in northern Alaska.

Unfigured hypotypes (USNM P174) from the Kingak shale, from the upper part of a 160 foot section, 480–640 feet above the basal contact, at approximately lat 69°35′ N., long 145°04′ W., in the banks of a south-flowing tributary which enters the Sadlerochit River at lat 69°34′30″ N., long 145°03′ W., on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Genus GLOMOSPIRA Rzehak, 1888

Glomospira pattoni Tappan, n. sp.

Plate 8, figures 15–17

Test free, small; consisting of a proloculus and irregularly spirally wound tubular second chamber of varied diameter, later portion of tubular chamber tending to coil in a single plane; spiral suture distinct; wall finely arenaceous with considerable cement, surface smoothly finished; aperture at the open end of the tube.

Greatest diameter of holotype (fig. 17) 0.47 mm, least diameter 0.34 mm, greatest thickness 0.21 mm. Greatest diameter of paratype of fig. 16, 0.62 mm, thickness 0.13 mm. Other specimens range between 0.23 and 0.75 mm in diameter.

Remarks.—This species differs from *Glomospira gordialis* Jones and Parker, in having a much less regular spiral chamber, being especially irregular in the early portion, rather than like *Involutina* at first and later becoming irregular. It tends to resemble the genus *Ammodiscoides* Cushman in having the early portion conically spiral and the later portion in a plane, but is too irregular in development to be placed within that genus. It is here named in honor of Mr. William Patton, who collected surface samples of Jurassic age used in this study.

Types and occurrence.—Holotype of fig. 17 (USNM P175), paratype of fig. 16 (USNM P176) and unfigured paratypes (USNM P177) all from Upper Jurassic rocks at approximately lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range in northern Alaska. Collected by William W. Patton, 1950.

Unfigured paratypes (USNM P178) from Upper Jurassic rocks, at approximately lat 68°24′ N., long 150°51′ W., in the east bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, in northern Alaska. Collected by William W. Patton, 1950.

Unfigured paratypes (USNM P748) from Upper Jurassic rocks in the east bank of the East Fork of the Nanushuk River, at lat 68°30′ N., long 150°25′ W., in the foothills of the Brooks Range, northern Alaska. Collected by A. Samuel Keller, 1950.

Unfigured paratype (USNM P750) from Upper Jurassic rocks, about three miles east of the Siksikpuk River, at approximately lat 68°40′ N., long 151°54′ W., in the foothills of the Brooks Range, in northern Alaska. Collected by William W. Patton, 1950.

Paratype of fig. 15 (USNM P765) and unfigured paratype (USNM P766) from the Upper Jurassic, in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Unfigured paratypes (USNM P1077) from Upper Jurassic rocks, on the west bank of Welcome Creek, about 4 miles upstream from its confluence with Kanayut River, tributary to the Anaktuvuk River, approximately at lat 68°25′ N., long 150°55′ W., in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured paratype (USNM P1078) from Upper Jurassic rocks (*Aucella bronni* zone) approximately at lat 68°26′ N., long 150°52′ W., on the east bank of Welcome Creek, about 5 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured paratypes (USNM P1079) from Upper Jurassic rocks on the west bank of the East Fork of the Nanushuk River, at lat 68°25′ N., long 150°20′ W., about 14 miles airline southeast of the confluence with the Nanushuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured paratype (USNM P1080) from Upper Jurassic rocks, in the east bank of the East Fork of the Nanushuk River, at lat 68°02′ N., long 150°27′ W., about 9 miles airline southeast of the confluence with the Nanushuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Glomospira perplexa Franke

Plate 9, figure 10

Glomospira perplexa Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, v. 169, p. 18, pl. 1, fig. 12; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., v. 439, p. 133.

Test free, large, consisting of an irregularly spiral tube, winding about the proloculus in various planes, only about three volutions observed; spiral suture distinct, depressed; wall finely arenaceous, with considerable cement, surface smooth and almost porcellanous in appearance; aperture at the open end of the tube.

Greatest diameter of figured hypotype 0.99 mm, least diameter 0.91 mm, greatest thickness 0.60 mm.

Remarks.—Only a few specimens have been found in Alaska. They are close to Franke's type from the Lower Lias of Germany, both in size and in the diameter of the tubular chamber. The Alaskan specimens differ in being somewhat more regular in the spiral winding, as the species was originally described as being extremely irregular. As the genus is notably variable in this character, it seems probable that individual specimens could differ to this extent in the regularity of coiling and be conspecific nevertheless.

Types and occurrence.—Figured hypotype (USNM P179) and unfigured hypotype (USNM P1081) from the Kingak shale of Early Jurassic age, in a core at 2,587–2,589 feet (Hettangian?), in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus LITUOTUBA Rhumbler, 1895

Lituotuba irregularis Tappan, n. sp.

Plate 9, figures 5–9

Lituotuba incerta Franke, Bartenstein and Brand, 1937 (not Franke, 1928), Abh. Senckenberg Naturf. Ges., no. 439, p. 131, pl. 3, fig. 6.

Tolypammina jurensis Franke, Payard, 1947 (not Franke, 1936), Foram. Lias Supérieur Detroit Poitevin, Thesis, Paris, p. 58, pl. 1, fig. 22.

Test free, with a proloculus and long tubular second chamber which is at first planispirally coiled, later uncoiling and very irregular in growth, occasionally with a zigzaglike development, test easily broken because of its delicate nature, and may be represented merely by tubular fragments which might be mistaken for fragments of *Bathysiphon* but for their association with other more complete specimens; wall finely arenaceous, with very little cement, surface rough due to the protruding grains; aperture at the open end of the tube.

Length of holotype (fig. 5), 0.55 mm, greatest breadth of coil 0.34 mm, greatest breadth of straight tubular portion 0.13 mm. Other specimens range from 0.18 to 0.73 mm in breadth of coil and from 0.08 to 0.23 mm in breadth of a single tube.

Remarks.—Bartenstein and Brand figured specimens that seem identical with the Alaskan form, but differ

from *Lituotuba incerta* Franke (to which they referred it), from the Upper Cretaceous, in having a less regular coil of fewer whorls, and in being more irregular throughout the development, even the diameter of tube and coil being much more variable.

Tolypammina jurensis Franke of Payard, from the French upper Lias, is similar in the early coil followed by an irregular uncoiled portion, and in general dimensions, although the Alaskan specimens have fewer whorls and somewhat more irregular coiling. It differs from *T. jurensis* Franke in being free, rather than attached, in the absence of branching, and in having a definite coil, which was neither described nor figured for Franke's species.

Types and occurrence.—Unfigured paratypes (USNM P187) from a core at 2,018–2,028 feet, unfigured paratypes (USNM P188) from a core at 2,028–2,033 feet, paratypes of figs. 6 and 9 (USNM P183a–b) and unfigured paratypes (USNM P184) from a core at 2,028–2,048 feet, all of Early Toarcian age; and unfigured paratypes (USNM P189) from a core at 2,140–2,150 feet, holotype (fig. 5) (USNM P180), paratype of fig. 8 (USNM P185) and unfigured paratypes (USNM P186) from a core at 2,150–2,160 feet, paratype of fig. 7 (USNM P181) and unfigured paratypes (USNM P182) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; and unfigured paratypes (USNM P190) from a core at 2,271–2,281 feet, unfigured paratypes (USNM P191) from a core at 2,281–2,300 feet, and unfigured paratypes (USNM P192) from a core at 2,300–2,320 feet, all from the Lower Lias Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Family LITUOLIDAE

Subfamily HAPLOPHRAGMIINAE

Genus HAPLOPHRAGMOIDES Cushman, 1910

Haplophragmoides barrowensis Tappan

Plate 11, figures 1–5

Haplophragmoides? barrowensis Tappan, 1951, Contr. Cushman Found. Foram. Research, v. 2, pt. 1, p. 1, pl. 1, figs. 5a–b.

Test free, discoid, planispiral and evolute, periphery bluntly rounded; chambers numerous, increasing rapidly in size as added, usually forming about 2½ whorls, with 9 to 12 chambers in the final whorl; sutures radial, straight or slightly curved, those of earliest whorls indistinct, those of the final whorl somewhat constricted and slightly thickened; wall arenaceous, with large grains in a ground mass of finer material, surface rough; aperture obscure, but apparently at the base of the final chamber.

Greatest diameter of holotype 1.01 mm, least diameter 0.70 mm, greatest thickness 0.26 mm. Other specimens range from 0.47 to 1.04 mm in greatest diameter.

Remarks.—This species is similar to the Recent *Alveolophragmium jeffreysi* (Williamson), but differs in being approximately twice as large, more evolute, more compressed, and in possessing more chambers in the final whorl. Due to the poor preservation, the exact character of the aperture cannot be determined for the Alaskan species. The aperture of *Alveolophragmium* is in the face of the final chamber, and that of *Haplophragmoides* is at the base of the final chamber.

Types and occurrence.—Unfigured hypotypes (USNM P195) from a core of Early Toarcian age at 1,999–2,018 feet; hypotypes of figs. 4 and 5 (USNM P193a, b) and unfigured hypotypes (USNM P194) from a core at 2,068–2,078 feet, unfigured paratypes (USNM 106479) from a core at 2,099–2,109 feet, holotype of fig. 1 (USNM 106477) and unfigured paratypes (USNM 106478) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P196) from a core at 2,130–2,140 feet, unfigured hypotypes (USNM P197) from a core at 2,140–2,150 feet, and unfigured hypotypes (USNM P198) from a core at 2,150–2,170 feet, all from the (Upper Pliensbachian) Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured paratypes (USNM 106480) from Lower Jurassic rocks in a core at 5,866–5,874 feet in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson, northern Alaska.

Hypotypes of figs. 2 and 3 (USNM P199a, b) and unfigured hypotypes (USNM P200) from the black shales of the Kingak shale, at 480–640 feet above the basal contact, unfigured hypotypes (USNM P201) from the black shales of the Kingak shale, from 1,650 feet above the basal contact with the underlying Upper Triassic Shublik formation, all of Early Jurassic age, at lat 69°35′ N., long 145°04′ W., in the banks of a southward-flowing tributary which enters the Sadlerochit River at approximately lat 69°34′30″ N., long 145°03′ W., on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Haplophragmoides canui Cushman

Plate 9, figures 11–15

Haplophragmoides canui Cushman, 1930, Bull. Soc. Linn. Normandie, ser. 8, v. 2, p. 133, pl. 4, figs. 1a, b.

Test free, of medium size, planispirally coiled, involute and biumbilicate, varying from thick to compressed according to the preservation, periphery

rounded; 9 to 11 chambers in the final whorl, increasing very gradually in size as added; sutures straight, radiate, slightly depressed or may be visible as a thick dark line between the chambers, sometimes obscure; wall finely arenaceous, surface smoothly finished; aperture obscured by the poor preservation.

Greatest diameter of hypotype of fig. 12, 0.60 mm, thickness 0.21 mm, greatest diameter of hypotype of fig. 13, 0.78 mm, thickness 0.39 mm, and greatest diameter of hypotype of fig. 14, 0.55 mm, least diameter 0.47 mm, thickness 0.31 mm. Other specimens range from 0.42 to 0.91 mm in diameter.

Remarks.—This species is highly variable in thickness and general appearance, due to distortion in various planes in preservation.

The type specimen from France is of medium size, 0.45 mm in diameter and 0.25 mm in thickness, both well within the limits of the Alaskan series of specimens. Some of the Alaskan specimens are more compressed at the margins, but this is probably due to preservation, and they are similar to the type in number of chambers, excavated umbilical area and radial sutures.

Types and occurrence.—Hypotypes of figs. 11 and 15 (USNM P202a, b) and unfigured hypotypes (USNM P203) from Upper Jurassic rocks at approximately lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, in northern Alaska. Collected by William W. Patton, 1950.

Hypotypes of figs. 12 and 14 (USNM P204a, b) and unfigured hypotypes (USNM P207) all from the *Amoeboceras* zone (Upper Oxfordian) of the Kingak formation, on the west bank of the Canning River, at lat 69°33′ N., long 146°23′ W., in northeastern Alaska. Collected by George Gryc, 1947.

Hypotype of fig. 13 (USNM P205) and unfigured hypotypes (USNM P206) from the *Amoeboceras* zone (upper Oxfordian) of the Kingak shale, on the west bank of the Canning River, at lat 69°32′30″ N., long 146°23′20″ W., in northeastern Alaska. Collected by George Gryc, 1947.

Unfigured hypotypes (USNM P767 and P784) from Upper Jurassic rocks in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain of northern Alaska.

Haplophragmoides kingakensis Tappan, n. sp.

Plate 10, figures 1–6

Test free, large, planispiral and involute, biumbilicate, periphery broadly rounded; 5 to 7 chambers in the final whorl, increasing rapidly in breadth as added, inflated; sutures nearly straight, radial, slightly depressed; wall rather coarsely arenaceous, with little cement, surface rough; aperture at the base of the final chamber, on the periphery.

Greatest diameter of paratype of fig. 3, 0.31 mm, greatest diameter of paratype of fig. 4, 0.42 mm, greatest diameter of holotype of fig. 5, 0.78 mm, least diameter 0.57 mm, thickness 0.42 mm, and greatest diameter of paratype of fig. 6, 0.82 mm, thickness 0.29 mm. Other specimens range from 0.29 to 0.78 mm in maximum diameter.

Remarks.—This species differs from *Haplophragmoides canui* Cushman in the smaller number of chambers in the final whorl, more inflated chambers, and more deeply incised sutures. It differs from *H. tryssa* Loeblich and Tappan from the Upper Jurassic, in being larger, in having more chambers to the whorl and in being less compressed, with a more truncate periphery. It is about one-half to one-third the size of *H. latidorsatum* (Bornemann) var. *crassitestum* Perner, from the Jurassic of Bohemia, which it otherwise resembles in general appearance.

Types and occurrence.—Paratype of fig. 4 (USNM P211) and unfigured paratypes (USNM P212) from a core at 1,999–2,018 feet, paratypes of figs. 1 and 2 (USNM P213a, b) and unfigured paratypes (USNM P214) from a core at 2,028–2,048 feet, all of Early Toarcian age; and holotype of fig. 5 (USNM P208) and unfigured paratypes (USNM P209) from a core at 2,130–2,140 feet, paratype of fig. 3 (USNM P210) from a core at 2,150–2,170 feet, all of Late Pliensbachian age; and unfigured paratypes (USNM P215) from a core at 2,231–2,251 feet, unfigured paratypes (USNM P216) from a core at 2,511–2,527 feet, and unfigured paratypes (USNM P752) from a core at 2,527–2,547 feet, all from the (Lower Lias) Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Paratype of fig. 6 (USNM P217) and unfigured paratypes (USNM P218) from a core at 2,341–2,356 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Genus AMMOBACULITES Cushman, 1910

Ammobaculites alaskensis Tappan, n. sp.

Plate 12, figures 1–10

Lituola agglutinans (d'Orbigny) Blake, 1876, The Yorkshire Lias, p. 452, pl. 17, fig. 40.

Haplophragmium coprolithiforme Schwager, Deecke, 1884, Abh. Geol. Spez. Elsass-Lothringen, v. 4, no. 1, p. 20, pl. 1, fig. 5; Häusler, 1890, Abh. Schweitz. Pal. Gesell., v. 17, p. 33, pl. 4, figs. 7, 20; Paalzow, 1922, Abh. Naturhist. Gesell. Nürnberg, v. 22, no. 1, p. 31, pl. 5, fig. 3.

Haplophragmium agglutinans (d'Orbigny) Häusler, 1890, Abh. Schweitz. Pal. Gesell., v. 17, p. 32, pl. 3, figs. 32–36, pl. 4, figs. 5, 6, 18.

Ammobaculites agglutinans (d'Orbigny) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, v. 169, p. 127, pl. 12, fig. 25; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., v. 439, p. 186, pl. 4, fig. 14, pl. 5, fig. 78, pl. 6, figs. 40a, b, pl. 8, figs. 38a–c, pl. 10, figs. 45a, b, pl. 11A, figs. 19a, b, pl. 11B, figs. 28a, b, pl. 12A, fig. 22, pl. 13, fig. 23, pl. 14B, fig. 19.

Test free, early portion close-coiled, biumbilicate, later uniserial, with a considerable size range, the specimens of smaller diameter attaining a larger number of chambers (fig. 7), those with a larger coil usually with fewer uniserial chambers (figs. 1, 8), periphery broadly rounded; chambers inflated centrally, increasing very gradually in size, 5 to 8 in the coil, followed by 2 to 8 uniserial chambers, somewhat broader than high, early chambers may be somewhat evolute in coiling (fig. 8); sutures distinct, straight, constricted, frequently represented by a darker area between the chambers; wall finely arenaceous, with occasional larger grains, surface rather smoothly finished; aperture terminal, rounded.

Length of holotype (fig. 1), 1.51 mm, greatest breadth of coil 0.60 mm, greatest breadth of uniserial portion 0.42 mm. Length of paratype of fig. 5, 0.75 mm, greatest breadth of coil 0.42 mm, greatest breadth of uniserial portion 0.31 mm. Length of paratype of fig. 7, 1.25 mm, greatest breadth of coil 0.26 mm. Length of paratype of fig. 8, 1.09 mm, greatest breadth of coil 0.62 mm.

Remarks.—This is an abundant and extremely variable species, and the large suite of specimens shows all gradations between the smaller and narrower forms and the evolutely coiled or large flattened forms.

Although often recorded in Europe as *Haplophragmium* or *Ammobaculites agglutinans* (d'Orbigny), it is not conspecific with *Spirolina agglutinans* d' Orbigny, 1846, which was from the Tertiary of the Vienna Basin. It is about one-half as large as d'Orbigny's species, is less compressed, has a wider umbilical depression, and lower and more numerous uniserial chambers. Häusler figured specimens with involute coiling, as is most common, and others with evolute coiling like the specimen here shown in figure 8.

H. coprolithiforme, from the Dogger (Middle Jurassic) of Germany differs from this species in having a less well developed coil, which is of lesser diameter than the later uniserial chambers. It is also proportionately shorter and thicker.

Types and occurrence.—Unfigured paratypes (USNM P227) from a core at 1,979–1,999 feet, unfigured paratypes (USNM P228) from a core at 2,018–2,028 feet, unfigured paratypes (USNM P229) from a core at 2,028–2,033 feet, unfigured paratypes (USNM P230) from a core at 2,028–2,048 feet, unfigured paratypes (USNM P231) from a core at 2,048–2,068 feet, of Early Toarcian age; and unfigured paratypes (USNM P232) from a core at 2,068–2,078 feet, paratype of fig. 4 (USNM P221) and unfigured paratypes (USNM P222) from a core at 2,099–2,109 feet, holotype of fig. 1 (USNM P219) and unfigured paratypes (USNM P220) from a core at 2,109–2,119 feet, paratype of fig. 7 (USNM P225) and unfigured paratypes (USNM P226) from a core at 2,130–2,140 feet, paratypes of figs. 3, 6, 8 and 9 (USNM P223a–d) and unfigured paratypes (USNM P224) from a core at 2,140–2,150 feet, unfigured paratypes (USNM P233) from a core at 2,150–2,170 feet, unfigured paratypes (USNM P234) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; unfigured paratypes (USNM P235) from a core at 2,231–2,251 feet, unfigured paratypes (USNM P236) from a core at 2,251–2,271 feet, unfigured paratypes (USNM P237) from a core at 2,320–2,323 feet, unfigured paratypes (USNM P238) from a core at 2,363–2,380 feet, and unfigured paratypes (USNM P239) from a core at 2,468–2,478 feet, all from the (Lower Lias) Kingak shale of Early Jurassic age in South Barrow Test well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Paratypes of figs. 2 and 10 (USNM P768a, b) and unfigured paratypes (USNM P769) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Unfigured paratypes (USNM P240) from a core at 5,866–5,874 feet, in Lower Jurassic rocks in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson, in northern Alaska.

Paratype of fig. 5 (USNM P241) and unfigured paratypes (USNM P242) from the *Amoeboceras* zone (Upper Oxfordian) of the Kingak shale, on the west bank of the Canning River, at lat 69°33′ N., long 146°23′ W., in northeastern Alaska. Collected by George Gryc, 1947.

Unfigured paratypes (USNM P243) from the upper part of a 160-foot black shale section (Lower Jurassic) of the Kingak shale of Early Jurassic age from 480–640 feet above the basal contact with Triassic rocks, at lat 69°35′ N., long 145°04′ W., in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat 69°34′30″ N., long 145°03′ W., on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Ammobaculites barrowensis Tappan, n. sp.

Plate 11, figures 7–12

Test free, large, robust, early portion planispiral, followed by a poorly developed uniserial portion, periphery broadly rounded; chambers much inflated, 4 to 5 in the coil, increasing rapidly in size as added, two or three rectilinear chambers of about equal size, final chamber somewhat produced orally, giving the chamber a pyriform outline; sutures distinct, depressed, straight and radial or very slightly curved backwards at the periphery in the coiled portion, straight and horizontal in the rectilinear portion; wall medium to coarsely arenaceous, with considerable cement, surface rather smoothly finished; aperture terminal, rounded.

Length of holotype (fig. 10) 1.66 mm, greatest breadth of coil 0.88 mm, greatest breadth of uniserial portion 0.68 mm, length of paratype of fig. 11, 1.77 mm, breadth of coil 0.88 mm, breadth of uniserial portion 0.65 mm, and length of paratype of fig. 12, 1.61 mm, greatest breadth of coil 1.20 mm, breadth of uniserial portion 0.86 mm. Other specimens range in length from 1.04 to 2.08 mm, and in breadth of coil from 0.39 to 1.20 mm.

Remarks.—This species resembles *Ammobaculites goodlandensis* Cushman and Alexander, from the Lower Cretaceous, in size and in the relatively large coil and much reduced uniserial portion, but differs in having fewer chambers in the coil and more smoothly inflated chambers, rather than the extremely inflated and angular chambers of *A. goodlandensis.*

The present species differs from the associated *A. alaskensis*, n. sp., in being larger, shorter, and broader, with a more pyriform final chamber.

Types and occurrence.—Unfigured paratypes (USNM P251) from a core at 2,231–2,251 feet, paratype of fig. 11 (USNM P247) and unfigured paratypes (USNM P248) from a core at 2,251–2,271 feet, holotype of fig. 10 (USNM P244) and paratypes of figs. 7, 8, and 12 (USNM P245a–c) and unfigured paratypes (USNM P246) from a core at 2,320–2,323 feet, unfigured paratype (USNM P252) from a core at 2,323–2,343 feet, and paratype of fig. 9 (USNM P249) and unfigured paratypes (USNM P250) from a core at 2,478–2,496 feet, all from the (Lower Lias) Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Ammobaculites fontinensis (Terquem)

Plate 11, figure 6

Haplophragmium fontinense Terquem, 1870, Mém. Acad. Imp. Metz, Ann. 51, (ser. 2, ann. 18), p. 337, pl. 24, figs. 29, 30a–b; **Paalzow, 1922,** Abh. Nat. Gesell. Nürnberg, vol. 22, no. 1, p. **32, pl. 4, figs. 4, 5.**

Ammobaculites fontinensis (Terquem) Franke, 1936, Abhandl. Preuss. Geol. Landesanst., Neue Folge, v. 169, p. 127, pl. 12, fig. 24; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., v. 439, p. 186, pl. 5, figs. 79a, b, pl. 6, fig. 43, pl. 8, figs. 37a–d, pl. 10, fig. 44, pl. 11B, fig. 27, pl. 12A, figs. 21a–b, pl. 13, fig. 22.

Test free, elongate, flattened, early portion in an evolute planispiral coil, later chambers uncoiled, periphery lobulate, 6 to 7 chambers in the last whorl of the coil, about 2½ whorls visible, chambers increasing gradually in size, the final two to four chambers uncoiling and proportionately higher than those of the coil, but not much broader, the coil being approximately one-third greater in diameter than the breadth of the uniserial chambers; sutures slightly depressed, distinct when specimens are dampened, somewhat curved backwards at the periphery in the coiled portion, straight and nearly horizontal in the uniserial portion; wall finely arenaceous; aperture terminal, simple.

Length of figured hypotype 0.75 mm, greatest breadth of coil 0.39 mm, greatest breadth of uniserial portion 0.23 mm, greatest thickness 0.10 mm. Unfigured hypotypes range from 0.39 to 0.47 mm in length, from 0.23 to 0.29 mm. in breadth of coil and from 0.10 to 0.23 mm in greatest breadth of uniserial portion.

Remarks.—This species has more chambers in the coil than any of the other Alaskan Jurassic species, the sutures are more curved and the periphery more lobulate. It is the only species in Alaska that consistently has an evolute coil. Occasional specimens of *A. alaskensis,* n. sp. have an evolute coil, but they are comparatively rare and do not have the compressed test characteristic of the present form.

Types and occurrence.—Figured hypotype (USNM P253) and unfigured hypotypes (USNM P254) all from a core of Early Toarcian age at 2,028–2,048 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°-34′45″ W., in northern Alaska.

Ammobaculites vetusta (Terquem and Berthelin)

Plate 13, figures 1–3

Haplophragmium vetustum Terquem and Berthelin, 1875, Mém. Soc. Geol. France, 2nd ser., v. 10, mém 3, p. 53, pl. 4, figs. 16a–d.

Test free, tiny, narrow, elongate, early portion coiled, later somewhat irregularly uniserial and rectilinear; about 4 to 5 chambers in the planispiral coil, followed by as many as 9 inflated uniserial chambers, increasing somewhat in relative height as added, final chamber pyriform in outline, with a short neck; sutures con-

stricted, distinct, straight; wall arenaceous, with little cement, surface granular in appearance; aperture terminal, rounded.

Length of hypotype of fig 1, 0.75 mm, greatest breadth of coil 0.18 mm, greatest breadth of uniserial portion 0.16 mm. Other specimens range from 0.23 to 1.22 mm in length.

Remarks.—This species somewhat resembles *Ammobaculites dentonensis* Tappan, from the Early Cretaceous, in the relatively small coil, inflated and somewhat irregularly arranged uniserial chambers and the pyriform final chamber. It differs in being only about one-half as large, and more finely arenaceous. *Ammobaculites vetusta* differs from *A. alaskensis*, n. sp. in being much smaller and narrower, and in having a minute coil instead of the broad and prominent coil characteristic of *A. alaskensis*.

Types and occurrence.—Unfigured hypotypes (USNM P259) from a core at 1,979–1,999 feet, unfigured hypotypes (USNM P260) from a core at 1,999–2,018 feet, unfigured hypotypes (USNM P261) from a core at 2,028–2,048 feet, hypotypes of figs. 2 and 3 (USNM P257a–b) and unfigured hypotypes (USNM P258) from a core at 2,048–2,068 feet, all of Early Toarcian age; unfigured hypotype (USNM P262) from a core at 2,130–2,140 feet of Late Pliensbachian age, unfigured hypotype (USNM P263) from a core at 2,199–2,218 feet, hypotype of fig. 1 (USNM P255) and unfigured hypotypes (USNM P256) from a core at 2,231–2,251 feet, unfigured hypotypes (USNM P264) from a core at 2,251–2,271 feet, unfigured hypotypes (USNM P265) from a core at 2,271–2,281 feet, and unfigured hypotypes (USNM P754) from a core at 2,527–2,547 feet, of Early Lias age; all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus TRIPLASIA Reuss, 1854

Triplasia kingakensis Loeblich and Tappan

Plate 13, figures 4–11

Triplasia kingakensis Loeblich and Tappan, 1952, Smithsonian Misc. Coll., v. 117, no. 15, p. 7, pl. 1, figs. 1–8.

Test large, elongate, early portion planispiral, with a comparatively large and well-developed coil of about 6 chambers, followed by 4 to 5 uniserial chambers which increase gradually in size as added in the megalospheric forms (figs. 4, 5, 7, 8, and 10) and flare more rapidly in the microspheric forms (figs. 6, 9), uniserial chambers usually triangular, but occasional specimens develop a somewhat weaker fourth angle, so that the test is irregularly quadrate in section (figs. 11a, b) and in addition two specimens were found which never developed the third angle but remain in a *Flabellammina* stage of development (figs. 6, 10) and other specimens have a poorly developed third angle, with all gradations occurring between these extremes; sutures moderately distinct, depressed, arched near the axis and curving downward at the angles; wall arenaceous, of medium sized to coarse particles, with considerable cement, smoothly finished; aperture terminal, rounded, on a slight neck.

Length of holotype (fig. 9) 1.53 mm, greatest breadth 0.94 mm; length of paratype of fig. 5, 1.74 mm, greatest breadth 0.73 mm; greatest breadth of paratype of fig. 8, 0.52 mm. Other specimens range from 0.91 to 1.69 mm in length.

Remarks.—This species resembles *Triplasia acutocarinata* (Alexander and Smith) in the flaring character of the test, but differs in being smaller, in having less excavated sides and broader and more rounded angles, and a larger initial coil. It is quite variable in shape, ranging from narrow to widely flaring, and from flattened to triangular or quadrangular in section in the later portion. The third and fourth angles are less prominent than the two in the plane of the coil.

Types and occurrence.—Holotype (fig. 9) (USNM P266), figured paratypes (figs. 4–8, 10–11) (USNM P267a–g) and unfigured paratypes (USNM P268) all from the Lower Jurassic Kingak shale (Lower Toarcian) in a core at 2,028–2,048 feet, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., south of Point Barrow, northern Alaska. This species has a very short vertical range, as it was present in only a 20 foot zone of the extensive cored section of Early Jurassic age.

Family TEXTULARIIDAE

Subfamily SPIROPLECTAMMININAE

Genus SPIROPLECTAMMINA Cushman, 1927

Spiroplectammina sp.

Plate 13, figure 12

Test free, small, flattened, early portion planispiral, later biserial with parallel margins, periphery rounded; about 7 chambers in the coil, followed by three pair of biserially arranged chambers, which are of approximately the same size as the earlier coiled chambers; sutures indistinct, except when specimen is dampened, slightly curved backward in the coil, oblique in the biserial portion, at about 30° from the horizontal; wall arenaceous, of medium sized grains, surface rough; aperture at the base of the final chamber.

Length of figured specimen 0.49 mm, greatest breadth of coil 0.21 mm, greatest breadth of biserial portion 0.18 mm.

Remarks.—Only a single specimen of this genus has been found in the Alaskan strata of Jurassic age, and it does not fit into any previously described species.

Because of the limited amount of material, it is not described as new.

The specimen resembles *Spiroplectammina ammovitrea* Tappan, from the Lower Cretaceous, in the comparatively large coil and parallel-sided biserial portion, but is slightly larger and has lower and more oblique biserial chambers.

Types and occurrence.—Figured specimen (USNM P269) from Upper Jurassic rocks at approximately lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about six miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, 1950.

Subfamily TEXTULARIINAE

Genus TEXTULARIA Defrance, 1824

Textularia areoplecta Tappan, n. sp.

Plate 13, figures 13–16

Test free, small, narrow, elongate, biserial throughout; early chambers increasing rapidly in breadth and later ones more gradually, so that the later portion of the test has subparallel sides, chambers low; sutures slightly depressed, somewhat oblique; wall finely arenaceous, surface granular in appearance; aperture at the base of the apertural face of the final chamber.

Length of holotype (fig. 14) 0.29 mm, breadth 0.08 mm, thickness 0.05 mm; length of paratype of fig. 13, 0.23 mm, breadth 0.10 mm; length of paratype of fig. 15, 0.36 mm, breadth 0.10 mm. Other specimens are between 0.18 and 0.39 mm in length.

Remarks.—This species differs from *Textularia agglutinans* d'Orbigny of Bartenstein and Brand, 1937 (not d'Orbigny, 1839), in having a more tapered base, more oblique sutures and in being somewhat smaller in size and comparatively narrower. It differs from *Textularia pikettyi* Terquem, from the Middle Lias of France, in being about one-half as large, with a more blunt periphery and comparatively higher chambers. It resembles *Textularia inversa* (Terquem), from the French Bajocian (Middle Jurassic), in general appearance and blunt periphery, but differs in having a broader test and more oblique sutures, and is about one-fourth as large.

Types and occurrence.—Holotype (fig. 14) (USNM P270) and unfigured paratypes (USNM P271) from a core at 1,979–1,999 feet, paratype of fig. 13 (USNM P272) and unfigured paratypes (USNM P273) from a core at 1,999–2,018 feet, unfigured paratypes (USNM P277) from a core at 2,018–2,028 feet, unfigured paratypes (USNM P278) from a core at 2,028–2,048 feet, paratype of fig. 15 (USNM P274) and unfigured paratypes (USNM P275) from a core at 2,048–2,068 feet, all of Early Toarcian age; paratype of fig. 16 (USNM P276) from a core at 2,150–2,170 feet, unfigured paratypes (USNM P279) from a core at 2,170–2,179 feet, all from the (Upper Pliensbachian) Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

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Family VERNEUILINIDAE

Genus GAUDRYINA d'Orbigny, 1839

Gaudryina dyscrita Tappan, n. sp.

Plate 13, figures 17–18

Test free, small, elongate, compressed, tapering, early portion triserial, later biserial; chambers numerous, slightly inflated, increasing gradually in size as added, and increasing proportionally in height, triserial portion usually occupying about one-half the length of the test, followed by higher biserial chambers; sutures indistinct unless specimen is dampened, nearly horizontal, straight; wall finely arenaceous, surface rough; aperture obscure, due to compression of the test.

Length of holotype (fig. 18) 0.44 mm, greatest breadth 0.16 mm; and length of paratype of fig. 17, 0.42 mm, breadth 0.13 mm. Other specimens range from 0.36 to 0.49 mm in length.

Remarks.—This species resembles *Textilaria racemata* Terquem and Berthelin, from the Middle Lias of France, in possessing low early triserial chambers, with higher biserial chambers, but is slightly larger, with a shorter triserial portion. It differs from *Gaudryina kelleri*, n. sp., in being smaller, narrower and more compressed, and in being much less robust in general appearance.

Types and occurrence.—Holotype (fig. 18) (USNM P280), paratype of fig. 17 (USNM P281) and unfigured paratypes (USNM P282) all from a core at 2,179–2,199 feet, and unfigured paratypes (USNM P283) from a core at 2,170–2,179 feet, all from the (Upper Pliensbachian) Kingak shale of Early Jurassic age, in South Barrow Test Well 3, lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska. This species has a restricted vertical range, having been observed in about 30 feet of section only.

Gaudryina kelleri Tappan, n. sp.

Plate 13, figure 19

Test free, narrow, elongate, tapering, early portion triserial, later regularly biserial; chambers numerous, low, increasing gradually in size as added; sutures distinct, slightly depressed, nearly horizontal; wall finely arenaceous, with occasional larger grains; aperture a low arch at the base of the final chamber.

Length of holotype 0.55 mm, breadth 0.18 mm, thickness 0.13 mm. Paratypes range from 0.39 to 0.73 mm in length.

Remarks.—This species somewhat resembles *Gaudryina foeda* (Reuss) from the Upper Cretaceous of Bohemia, in the rounded chambers, short triserial stage and elongate biserial portion. It differs in being much smaller, and has more depressed sutures. The species is named in honor of A. Samuel Keller, who collected outcrop samples of Jurassic age used in this study.

Types and occurrence.—Holotype (USNM P761) and unfigured paratypes (USNM P762) from a core at 2,527–2,547 feet (Hettangian? age) in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Gaudryina leffingwelli Tappan, n. sp.

Plate 14, figure 5

Test free, of medium size, flaring; triserial in the early portion, with a few of the later chambers biserially arranged, chambers inflated and nearly globular, increasing gradually in size as added; sutures distinct on well-preserved specimens, slightly depressed; wall arenaceous, surface roughened; aperture not seen, due to crushing of the specimens in preservation.

Length of holotype 0.39 mm, breadth 0.26 mm. Paratypes range in length from 0.26 to 0.57 mm.

Remarks.—This species superficially resembles *Verneuilinoides tryphera* Loeblich and Tappan, from the Redwater shale member of the Sundance formation (Upper Jurassic) of Wyoming and South Dakota, but is larger and more robust, with more inflated chambers and a short biserial development. The species is named in honor of E. de K. Leffingwell, in recognition of his early exploration in the Mesozoic rocks of northern Alaska.

Types and occurrence.—Holotype (USNM P772) and unfigured paratypes (USNM P764 and P773) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Gaudryina milleri Tappan, n. sp.

Plate 8, figures 7–8

Test free, of medium size, subcylindrical, tapered at the base; chambers numerous, low and broad, slightly inflated, increasing gradually in size as added, triserially arranged in the early portion, for about one-half the length, then biserial in plan; sutures somewhat obscure, a few slightly depressed but generally visible best when specimen is dampened; wall arenaceous, of medium to coarse grains, surface roughened; aperture at the base of the last chamber.

Length of holotype, 0.96 mm, breadth 0.42 mm. Other specimens range from 0.47 to 1.04 mm in length.

Remarks.—This species is large and robust, being about three times as long as *Gaudryina leffingwelli* n. sp. or *G. topagorukensis*, n. sp. The chambers are larger, the test more cylindrical and the base more rounded. The specific name is in honor of Ralph L. Miller, chief of Fuels Branch and formerly Geologist in charge, Navy Oil Unit, U. S. Geological Survey.

Types and occurrence.—Holotype (USNM P1082), figured paratype (USNM P1083) and unfigured paratypes (USNM P1084), all from Upper Jurassic rocks, approximately at lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured paratypes (USNM P1085), from Upper Jurassic rocks, on the west bank of Welcome Creek, approximately at lat 68°25′ N., long 150°55′ W., about 4 miles upstream from its confluence with Kanayut Creek, tributary to the Anaktuvuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured paratypes (USNM P1086), from Upper Jurassic rocks (*Aucella bronni* zone), on the east bank of Welcome Creek, approximately at lat 68°24′ N., long 150°50′ W., about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured paratype (USNM P1087) from Upper Jurassic strata (*Aucella bronni* zone) on the east bank of Welcome Creek, approximately at lat 68°26′ N., long 150°52′ W., about 5 miles upstream from the confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, 1950.

Unfigured paratypes (USNM P1088) from Upper Jurassic rocks on the west bank of the East Fork of the Nanushuk River, approximately at lat 68°25′ N., long 150°20′ W., about 14 miles airline southeast of the confluence with the Nanushuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Gaudryina topagorukensis Tappan, n. sp.

Plate 14, figure 4

Test free, elongate, flattened, early portion triserial, later biserial; chambers increasing gradually in size as added, slightly inflated, of somewhat greater breadth than height; sutures distinct, slightly depressed, horizontal; wall finely arenaceous; aperture textularian in the adult.

Length of holotype 0.31 mm, breadth 0.13 mm, thickness of biserial portion 0.13 mm. Paratypes range from 0.29 to 0.31 mm in length.

Remarks.—This species resembles some specimens of *Verneuilinoides tryphera* Loeblich and Tappan, from Upper Jurassic strata of the western Interior, as they are of similar size and proportions. The present species has a definite biserial stage, however, which places it in the genus *Gaudryina*. It differs from the associated *Gaudryina leffingwelli*, n. sp. in being slightly shorter and much narrower, with the sides subparallel rather than flaring. The triserial portion is shorter than in *G. leffingwelli*. The present species is about one-half to two-thirds the size of the Lower Jurassic *Gaudryina dyscrita*, n. sp., and *G. kelleri*, n. sp., and has more rounded chambers.

Types and occurrence.—Holotype (USNM P774) and unfigured paratypes (USNM P775) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Unfigured paratype (USNM P1089) from Upper Jurassic rocks, on the east bank of the East Fork of the Nanushuk River, at lat 68°02′ N., long 150°27′ W., about 9 miles airline southeast of the confluence with the Nanushuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured paratype (USNM P1090), from Upper Jurassic rocks, in the headwaters of the Anaktuvuk River, approximately at lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about 6 miles upstream from the confluence with Kanayut River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Family VALVULINIDAE

Subfamily EGGERELLINAE

Genus DOROTHIA Plummer, 1931

Dorothia (?) *squamosa* (Terquem and Berthelin)

Plate 14, figures 1–3

Textilaria squamosa Terquem and Berthelin, 1875, Mém. Geol. Soc. France, ser. 2, v. 10, no. 3, p. 64, pl. 5, fig. 14.

Test free, stout, elongate, with a rounded base and nearly parallel sides; chambers spiral, 4 or 5 to a whorl in the early portion, decreasing in number in later whorls, until the test becomes biserial, chambers low and broad; sutures usually visible as a clear dark line, nearly horizontal; wall finely arenaceous, surface rough; aperture low, at the inner margin of the final chamber.

Length of hypotype of fig. 1, 0.52 mm, breadth 0.18 mm; length of hypotype of fig. 2, 0.47 mm, breadth 0.21 mm; length of hypotype of fig. 3, 0.36 mm, breadth 0.23 mm. Other specimens range from 0.42 to 0.62 mm in length.

Remarks.—This species is common in the one horizon where it has been found, but is restricted in range. In general size and appearance, the Alaskan specimens are similar to the type of Terquem and Berthelin. As the early chamber arrangement has not been described for the type, the species is referred questionably to *Dorothia*.

Types and occurrence.—Figured hypotypes (USNM P284a–c) and unfigured hypotypes (USNM P285) all from a core at 2478–2496 feet (Sinemurian? age), and unfigured hypotypes (USNM P755) from a core at 2,527–2,547 feet, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′-40″ N., long 156°34′45″ W., in northern Alaska.

Family TROCHAMMINIDAE

Subfamily TROCHAMMININAE

Genus TROCHAMMINA Parker and Jones, 1859

Trochammina canningensis Tappan, n. sp.

Plate 14, figures 15–19

Haplophragmium globigeriniforme (Parker and Jones) Häusler, 1890 (part) (not *Lituola nautiloidea* Lamarck var. *globigeriniformis* Parker and Jones, 1865), Abh. Schweiz. Paläon. Gesell., v. 17, p. 36, pl. 4, fig. 17 (not figs. 13, 16).

Trochammina globigeriniformis (Parker and Jones) Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell. Abh. 439, p. 189, pl. 1A, fig. 21, pl. 4, fig. 13, pl. 5, fig. 76.

Test free, small, subglobular, trochoid; from 5 to 12 chambers in the 1½ to 2 whorls visible dorsally, only the 4 to 7 chambers of the last whorl visible on the ventral side where the chambers reach to the umbilicus, chambers globular and inflated, increasing rapidly in size as added; sutures distinct, slightly depressed; wall finely arenaceous; aperture slightly ventral from the periphery, at the base of the final chamber.

Greatest diameter of holotype (fig. 18) 0.31 mm, thickness 0.29 mm. Other specimens range from 0.16 to 0.55 mm in diameter.

Remarks.—This species is fairly common and has a wide distribution in Alaska. It is distinguished by its *Globigerina*-like form, from the other Alaskan species. It is slightly larger than the holotype of *T. globigeriniformis* (Parker and Jones) and has more chambers per whorl than does the Recent species. The holotype of Parker and Jones' species has but three chambers visible ventrally. Brady and others have referred an extremely large form to *T. globigeriniformis*, but it is probably not conspecific. A specimen apparently identical with the Alaskan form was figured by Häusler, and referred to Parker and Jones' species. Two other specimens figured by Häusler seem closer to *T. sablei*, n. sp.

Types and occurrence.—Holotype (fig. 18) (USNM P286), paratype of fig. 15 (USNM P287) and unfigured paratypes (USNM P288) from the Kingak shale of Late Jurassic age, in the *Amoeboceras* zone of the upper Oxfordian, at approximately lat 69°32′30″ N., long 146°23′20″ W., on the west bank of the Canning River, in northeastern Alaska. Collected by George Gryc, 1947.

Paratype of fig. 16 (USNM P289) and unfigured paratypes (USNM P290) from the Kingak shale of Early Jurassic age, in the upper part of a 160-foot composite sample of black shale, from 480–640 feet above the basal contact with the Shublik formation of Late Triassic age, at lat 69°35′ N., long 145°04′ W., in the banks of a south-flowing tributary, which enters the Sadlerochit River at approximately lat 69°34′30″ N., long 145°03′ W., on the south slope of the Sadlerochit Mountains in northeastern Alaska. Collected by Edward G. Sable, 1948.

Unfigured paratypes (USNM P295) from a core of Early Toarcian age at 1,999–2,018 feet; paratype of fig. 19 (USNM P291) and unfigured paratypes (USNM P292) from a core at 2,109–2,119 feet, unfigured paratypes (USNM P296) from a core at 2,130–2,140 feet, unfigured paratypes (USNM P297) from a core at 2,140–2,150 feet, unfigured paratypes (USNM P298) from a core at 2,150–2,170 feet, paratype of fig. 17 (USNM P293) and unfigured paratypes (USNM P294) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; and unfigured paratypes (USNM P299) from a core (Lower Lias) at 2,251–2,271 feet; all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured paratypes (USNM P300) from a core at 2,341–2,356 feet, in the Kingak shale of Early Jurassic age, in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Unfigured paratypes (USNM P776) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain of northern Alaska.

Trochammina gryci Tappan, n. sp.

Plate 14, figures 12–14

Trochammina nana (Brady) Bartenstein and Brand, 1937 (not *Haplophragmium nanum* Brady, 1881), Abh. Senckenberg. Naturforsch. Gesell., Abh. 439, p. 190, pl. 2B, figs. 40a, b, text figs. 20a–c.

Test free, trochoid, high-spired, periphery broadly rounded; chambers increasing gradually in size as added, all chambers of the approximately three whorls visible dorsally, only the 8 to 10 of the final whorl visible ventrally, chambers somewhat inflated; sutures slightly depressed, radial; wall finely arenaceous; aperture at the base of the final chamber, ventral in position.

Greatest diameter of holotype in fig. 13, 0.44 mm, least diameter 0.36 mm, thickness 0.26 mm. Other specimens range from 0.31 to 0.49 mm in diameter.

Remarks.—The Alaskan specimens are slightly higher spired than those figured by Bartenstein and Brand, but the specimens of this genus are very frequently distorted in preservation, and the Alaskan and German specimens are probably conspecific. They differ from the Recent *Trochammina nana* (Brady) in having a more convex dorsal surface and a wider ventral umbilicus and are about twice as large. The present species differs from the Upper Jurassic (Oxfordian) *Trochammina lathetica* Loeblich and Tappan in being higher spired and about twice as large.

Types and occurrence.—Holotype (USNM P301), paratypes of figs. 12 and 14 (USNM P302a–b) and unfigured paratypes (USNM P303) from the *Amoeboceras* zone (Upper Oxfordian) of the Kingak shale, at approximately lat 69°32′30″ N., long 146°23′20″ W., on the west bank of the Canning River in northeastern Alaska. Collected by George Gryc, 1947.

Unfigured hypotypes (USNM P604) from the *Amoeboceras* zone (Upper Oxfordian) of the Kingak shale, at approximately lat 69°33′ N., long 146°23′ W., on the west bank of the Canning River in northeastern Alaska. Collected by George Gryc, 1947.

Trochammina sablei Tappan, n. sp.

Plate 14, figures 6–9

Haplophragmium globigeriniforme (Parker and Jones) Häusler, 1890 (part) (not *Lituola nautiloidea* Lamarck var. *globigeriniformis* Parker and Jones, 1865), Abh. Schweiz. Paläon. Gesell., v. 17, p. 36, pl. 4, figs. 13, 16 (not fig. 17).

Test free, discoidal, trochoid but low-spired, periphery rounded; chambers numerous, 6 to 8 in the final whorl, about 2½ whorls visible dorsally, earlier whorls partly concealed ventrally, chambers rounded in side view, inflated; sutures slightly depressed, straight or moderately curved; wall finely arenaceous; aperture obscure.

Greatest diameter of holotype (fig. 6) 0.44 mm, least diameter 0.34 mm, thickness 0.13 mm. Other specimens range from 0.18 to 0.49 mm in diameter.

Remarks.—This species is variable in preservation, some specimens being inflated (as figs. 6 and 8) and others much compressed (figs. 7 and 9). The specimens figured by Häusler are quite similar to the Alaskan specimens and the present species differs from the Recent *Trochammina globigeriniformis* (Parker and Jones) in having a distinct spire of about 2½ whorls, with 6 to 8 chambers in the final whorl, rather than only 3 to 4, and in being smaller and more compressed.

Types and occurrence.—Unfigured paratypes (USNM P309) from a core at 1,999–2,018 feet, paratype of fig. 8 (USNM P307) and unfigured paratypes (USNM P308) from a core at 2,028–2,033 feet, holotype of fig. 6 (USNM P304), paratypes of figs. 7 and 9 (USNM P305a–b) and unfigured paratypes (USNM P306) all from a core at 2,028–2,048 feet, unfigured paratype (USNM P310) from a core at 2,048–2,068 feet, all of Early Toarcian age; unfigured paratypes (USNM P311) from a core at 2,130–2,140 feet, unfigured paratypes (USNM P312) from a core at 2,140–2,150 feet, unfigured paratypes (USNM P313) from a core at 2,150–2,160 feet, unfigured paratypes (USNM P314) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; unfigured paratypes (USNM P315) from a core at 2,251–2,271 feet, unfigured paratypes (USNM P316) from a core at 2,271–2,281 feet, unfigured paratypes (USNM P317) from a core at 2,300–2,320 feet, and unfigured paratype (USNM P318) from a core at 2,320–2,323 feet, all from the (Lower Lias) Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured paratype (USNM P319) from a core at 2,341–2,356 feet in the Kingak shale of Early Jurassic age in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Unfigured paratypes (USNM P322) from Lower Jurassic rocks in a core at 5,866–5,874 feet, in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″W., west of Cape Simpson, in northern Alaska.

Unfigured paratypes (USNM P320) from the Kingak shale, in the lower part of a 160-foot section of black shale, from 480–640 feet stratigraphically above the basal contact with the Shublik formation of Late Triassic age, and unfigured paratypes (USNM P321) from the Kingak shale in a 60-foot zone of black shale, the highest beds exposed, 2,580–2,640 feet above the Triassic contact, all of Early Jurassic age, at lat 69°35′ N., long 145°04′ W., in the banks of a southward-flowing tributary which enters the Sadlerochit River at approximately lat 69°34′30″ N., long 145°03′ W., on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Trochammina topagorukensis Tappan, n. sp.

Plate 14, figures 10–11

Test free, trochoid, plano-convex, high-spired, periphery subacute; chambers numerous, from 4 to 6 in a whorl, with about 4 in the whorl in the early portion, increasing to about 6 in later whorls, and reduced again in the final whorl to 4, chambers inflated ventrally but not dorsally; sutures distinct, slightly depressed, approximately radiate ventrally, but curving backwards at the periphery on the dorsal side; wall finely arenaceous, surface granular in appearance; aperture not observed due to the poor preservation and crushed character of the specimens.

Greatest diameter of holotype 0.31 mm, height of spire 0.21 mm.

Remarks.—This species resembles *Trochammina gryci*, n. sp. in the high spire, but differs in being somewhat smaller, in having only 4 to 6 chambers per whorl, rather than 8 to 10, and in the chambers being globular and inflated ventrally and the sutures curved and oblique dorsally, instead of straight and radial.

Types and occurrence.—Holotype (USNM P777), figured paratype (USNM P778) and unfigured paratypes (USNM P779) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Family NODOSARIIDAE

Genus DARBYELLA Howe and Wallace, 1933

Darbyella volgensis Tappan, new name

Plate 15, figure 10

Cristellaria magna Myatliuk, 1939 (not *Cristellaria magna* Costa, 1856), Neftianyi geologo-razvedochnyi Institut, Trudy, ser. A, v. 120, pp. 52, 71, pl. 3, figs. 32, 34.

Test free, lenticular, trochoid, periphery with a slight keel; only the 8 to 11 chambers of the final whorl visible ventrally around the depressed umbilicus, with the earlier chambers and the central boss also visible on the dorsal side; sutures distinct, slightly curved backward at the periphery, thickened, but flush or only slightly elevated; wall calcareous, surface smooth, except for the slightly elevated sutures; apertural angle broken on the three Alaskan hypotypes, but originally described by Myatliuk as a small rounded opening at the peripheral angle.

Greatest diameter of figured hypotype 0.62 mm, least diameter 0.52 mm, thickness 0.23 mm. Greatest diameter of larger unfigured hypotype 0.60 mm, least diameter 0.47 mm. Greatest diameter of smaller unfigured hypotype 0.21 mm.

Remarks.—*Cristellaria magna* Myatliuk, 1939, was preoccupied by *Cristellaria magna* Costa, 1856, hence a new name is here proposed for the Jurassic species. The types are from Upper Jurassic strata (Lower Volga series) in the Saratov District, U. S. S. R. The species is here referred to the genus *Darbyella* Howe and Wallace, 1933, because of its trochoid character. In view of the many species which show gradations between *Lenticulina* and *Darbyella* (such as the present species *Lenticulina wisniowskii* (Myatliuk), and *Lenticulina toarcense* Payard, as well as many other Jurassic

and Lower Cretaceous forms) it seems probable that these genera may later be proved to be synonymous. However, this cannot be certain until a restudy is made of the type species of *Darbyella*, and as the present species fits the generic description, it is so referred.

The Alaskan specimens are smaller than the average of Myatliuk's species, but fall within the size limits given in the original description. Only 3 specimens have been found in Alaska, and they have a few less chambers in the final whorl (8) than Myatliuk recorded (11). As the number of chambers per whorl is greater in adult specimens than in the smaller forms, this is considered to be due to the juvenile character of the Alaskan specimens, and they are believed conspecific because of the general agreement of characters.

Types and occurrence.—Figured hypotype (USNM P800) and unfigured hypotypes (USNM P801) from Upper Jurassic rocks in a core at 7,042–7052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Genus LENTICULINA Lamarck, 1804

Lenticulina excavata (Terquem)

Plate 16, figures 4–7

Cristellaria excavata Terquem, 1864, Acad. Imp. Metz., Mém. Ann. 44 (ser. 2, ann. 11), pt. 2, p. 418, pl. 10, figs. 2a-b.

Test free, lenticular, planispiral, occasional specimens not completely involute (fig. 6), periphery carinate; 8 to 11 chambers in the final whorl, increasing gradually in size as added; sutures distinct, gently curved, flush with the surface; wall calcareous, surface smooth; aperture radiate, slightly produced at the dorsal angle.

Greatest diameter of hypotype of fig. 7, 0.73 mm, thickness 0.34 mm. Other hypotypes range from 0.26 to 0.91 mm in diameter.

Remarks.—The type figures of Terquem, although somewhat diagrammatic, are very like the specimens here shown in figs. 4 and 7, having a lesser number of chambers per whorl than does *Lenticulina prima* (d'Orbigny), which it otherwise resembles in the presence of an excavated umbilical area. This species was described from the *Ammonites davoei* zone of the middle-Lias of France.

Types and occurrence.—Hypotype of fig. 5 (USNM P323) from a core at 1,778–1,798 feet, unfigured hypotypes (USNM P324) from a core at 2,028–2,048 feet, all of Early Toarcian age; hypotype of fig. 7 (USNM P325) and unfigured hypotypes (USNM P326) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P327) from a core at 2,130–2,140 feet, unfigured hypotypes (USNM P328) from a core at 2,140–2,150 feet, unfigured hypotype (USNM P329) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; unfigured hypotypes (USNM P330) from a core at 2,300–2,320 feet, hypotype of fig. 4 (USNM P331) and unfigured hypotypes (USNM P332) from a core at 2,320–2,323 feet, hypotype of fig. 6 (USNM P333) and unfigured hypotypes (USNM P334) from a core at 2,468–2,478 feet, all (Lower Lias) from the Kingak shale of Early Jurassic age in South Barrow Test Well No. 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured hypotypes (USNM P335) from a core in the Kingak shale of Early Jurassic age at 2,356 feet, in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Unfigured hypotype (USNM P336) from a core at 6,067–6,077 feet, in Lower Jurassic rocks in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson, in northern Alaska.

Lenticulina prima (d'Orbigny)

Plate 16, figures 8–11

Cristellaria prima d'Orbigny, 1850, Prod. paléon. strat. univ. des anim. moll., Paris, vol. 1, p. 242; Terquem, 1858, Mém. Acad. Imp. Metz., ann. 39, (ser. 2, ann. 6), p. 621, pl. 3, figs. 16a–b; Berthelin, 1879, Rev. Mag. Zool., 3rd ser., v. 7, p. 29, pl. 1, figs. 5, 6; Macfadyen, 1936, Roy. Micr. Soc. London, Jour, ser. 3, v. 56, pl. 1, figs. 266a–b.

Lenticulina prima (d'Orbigny) Payard, 1947, Foram. Lias Supérieur, p. 91, pl. 7, figs. 8–10.

Test large, flattened to lenticular, planispiral, with the final chamber occasionally showing a tendency to uncoil (fig. 11), umbilical area excavated, periphery carinate; chambers numerous in the coil, 10–13 in the last whorl, low and broad; sutures distinct, gently curved, very slightly depressed; wall calcareous, surface smooth; aperture at the dorsal angle, distinctly radiate on well preserved specimens.

Greatest diameter of hypotype of fig. 8, 1.04 mm, least diameter 0.86 mm, thickness 0.39 mm; greatest diameter of hypotype of fig. 9, 1.61 mm, greatest diameter of hypotype of fig. 10, 0.39 mm, greatest diameter of hypotype of fig. 11, 1.46 mm.

Remarks.—The specimens of figs. 9 and 11 are very similar to the types from the Lias of France, as figured by Macfadyen (1936), in the large size, slight keel, numerous chambers, slightly curved sutures and central depression.

Many uncoiled forms have been erroneously referred to this species, probably because one of d'Orbigny's specimens had a last chamber which did not reach the coil. This chamber was much smaller than the earlier chambers, and its small size and consequent failure to reach the coil was probably due to senility. Franke (1936) and Bartenstein and Brand (1937) figured only specimens with many uncoiled chambers, referring them to *Cristellaria (Astacolus) prima* d'Orbigny. However,

their specimens had a much smaller number of chambers in the coil (as few as 6) or in some instances (Bartenstein and Brand, 1937, pl. 2a, fig. 17) without a distinct coil at all. These specimens are unlike the types of d'Orbigny and should be referred to a distinct species of either *Astacolus* or *Vaginulinopsis*.

Types and occurrence.—Hypotype of fig. 9 (USNM P337) and unfigured hypotypes (USNM P338) from a core at 2,099–2,109 feet, hypotype of fig. 11 (USNM P339) and unfigured hypotypes (USNM P340) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P341) from a core at 2,130–2,140 feet, hypotype of fig. 8 (USNM P342) and unfigured hypotypes (USNM P343) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P344) from a core at 2,150–2,170 feet, all of Late Pliensbachian age; and hypotype of fig. 10 (USNM P345) from a core (Lower Lias) at 2,320–2,323 feet; all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Lenticulina toarcense Payard

Plate 15, figures 1–9

Cristellaria (*Lenticulina*) *subalata* Reuss Franke, 1936 (not *Cristellaria subalata* Reuss, 1854), Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 115, pl. 11, fig. 19; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 176, pl. 6, figs. 35a–c, pl. 9, figs. 54a–c, pl. 10, figs. 41a–b, pl. 11A, figs. 15a–b, pl. 11B, figs. 22a–b, pl. 12A, figs. 18a–c, pl. 12B, fig. 16, pl. 13, figs. 38a–c, pl. 14, figs. 16a–b, pl.15A, figs. 35a–c.

Lenticulina toarcense Payard, 1947, Foram. d. Lias Supérieur du Détroit Poitevin, Thesis, p. 88, pl. 7, fig. 1.

Test free, large, lenticular, biumbonate, normally symmetrically coiled and involute, but occasional specimens show a tendency to uncoil (fig. 2) or become slightly trochoid (figs. 1, 5), periphery keeled; chambers numerous, 8 to 11 in the final whorl; sutures gently curved, thickened and raised, meeting centrally at an elevated umbonal boss; wall calcareous, hyaline,smooth; aperture distinctly radiate, at the peripheral angle.

Greatest diameter of hypotype of fig. 1, 0.91 mm, greatest diameter of hypotype of fig. 2, 0.94 mm, least diameter 0.65 mm, thickness 0.34 mm, greatest diameter of hypotype of fig. 3, 0.78 mm, thickness 0.34 mm, greatest diameter of hypotype of fig. 7, 0.55 mm, and greatest diameter of hypotype of fig. 8, 1.09 mm. Other specimens range from 0.21 to 1.17 mm in diameter.

Remarks.—This species was described from the Toarcian (Upper Lias) of France, and was recorded from Toarcian to Aalenian (Upper Lias). It somewhat resembles *Lenticulina polygonata* (Franke), but differs in having more chambers in the coil, and a more rounded periphery. The specimens figured by Bartenstein and Brand were apparently identical with this species, with large umbonal boss and raised and limbate sutures, but were referred to the Upper Cretaceous species, *Cristellaria subalata* Reuss. The Cretaceous species differs in averaging about twice as large, has fewer chambers and a more prominent keel. The aperture of *Lenticulina toarcense* is more pronounced and distinctly radiate.

Types and occurrence.—Unfigured hypotypes (USNM P438) from a core at 1,979–1,999 feet, hypotypes of figs. 8, 9 (USNM P349a–b) and unfigured hypotypes (USNM P350) from a core at 2,028–2,033 feet, unfigured hypotypes (USNM P351) from a core at 2,028–2,048 feet, hypotypes of figs. 2 and 6 (USNM P352a–b) from a core at 2,048–2,068 feet, all of Early Toarcian age; unfigured hypotype (USNM P353) from a core at 2,140–2,150 feet, hypotypes of figs. 4 and 5 (USNM P354a–b) and unfigured hypotypes (USNM P355) from a core at 2,150–2,170 feet, hypotypes of figs. 1 and 3 (USNM P356a–b) and unfigured hypotypes (USNM P357) from a core at 2,170–2,179 feet, unfigured hypotypes (USNM P358) from a core at 2,179–2,199 feet, all of Late Pliensbachian age, and hypotype of fig. 7 (USNM P359) from a core (Lower Lias) at 2,468–2,478 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Lenticulina varians (Bornemann)

Plate 18, figure 1

Cristellaria varians Bornemann, 1854, Ueber Liasformation Umgegend Göttingen, p. 41, pl. 4, figs. 32–34; Blake,1876, in Tate and Blake, The Yorkshire Lias, p. 466, pl. 17, fig. 27, pl. 19, fig. 16; Crick and Sherborn, 1891, Jour. Northamptonshire Nat. Hist. Soc., v. 6, p. 213, pl. fig. 30; Crick and Sherborn, 1892, Ibid., v. 7, p. 70, pl. 2, figs. 15, 16.

Cristellaria (*Lenticulina*) *varians* Bornemann f. *typica* Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 112, pl. 11, figs. 9–11.

Cristellaria (*Lenticulina*) *varians* Bornemann f. *recta* Franke, 1936 (not *Cristellaria recta* d'Orbigny, 1840), Ibid., p. 113, pl. 11, fig. 12.

Cristellaria (*Lenticulina*) *varians* Bornemann and forma a. Bartenstein and Brand, 1937 (part), Abh. Senckenberg. Naturf. Gesell. no. 439, p. 176, pl. 1A, fig. 18, pl. 2A, figs. 16, 20, pl. 2B, fig. 32, pl. 3, fig. 31, pl. 5, fig. 60.

Lenticulina varians (Bornemann) forma *recta* (Franke) Payard, 1947, Foram. Lias Supérieur, p. 86, pl. 7, figs. 3–5.

Lenticulina varians (Bornemann) Barnard 1950b (part, not *Lenticulina* (*Flabellina*) *varians* (Bornemann) of Barnard), Quart. Jour. Geol. Soc. London, v. 106, pt. 1, p. 8, pl. 2, figs. 3–4 (not 5–6), text figs. 2a–c (not d–e).

Test free, planispiral, biumbonate, periphery keeled; chambers numerous, low and broad, from 8 to 12 in number, final one or two may tend to uncoil; sutures distinct, may be slightly thickened, nearly straight to slightly curved; wall calcareous, surface smooth; aperture radiate, at the dorsal angle.

Greatest diameter of figured hypotype 0.83 mm, least diameter 0.62 mm, thickness 0.39 mm. Other hypotypes range in diameter from 0.60 to 0.62 mm.

Remarks.—This species has more numerous chambers than the associated *Lenticulina excavata* and *L. toarcense*, and is strongly biconvex. It differs from *L. excavata* and *L. prima* in being strongly umbonate. The sutures are also less curved than in these associated species.

Many somewhat uncoiled specimens have been referred to this species by various authors, and the type specimen of Bornemann shows a tendency in this direction. The three Alaska specimens are not sufficiently large to have developed this feature.

Bartenstein and Brand (1937) recorded a more umbonate species with thickened sutures under this name, from their Dogger material.

Franke (1936) erected three varieties for this species, and placed *Cristellaria granulata* Bornemann, as a fourth variety of *C. varians*. Payard (1947) referred his specimens, and those figured and described by Bornemann (1854), Bartenstein and Brand (1937) and Wicher (1938) all to *Lenticulina varians* (Bornemann) forma *recta* (Franke). This can not be done, as the forma *typica* Franke must contain the type of the species and was so defined by Franke (the type specimen being that of Bornemann, 1854, pl. 4, fig. 33). On the plate description Payard identified his figured specimens only as *Lenticulina varians* (Bornemann), and none were referred to any forma. Franke defined the forma *recta* to include specimens in which the last chambers showed a tendency to uncoil, but as the species is variable, it seems to the writer that these should be considered only as adult or gerontic individuals, not requiring a distinct name. The name *recta* is not available in any case, as it was preoccupied by *C. recta* d'Orbigny, 1840.

At the other extreme, Barnard (1950b) included with this species a *Flabellina* whose early coil resembled *Lenticulina varians*. From his illustrations, it would appear that these *Flabellina* coils have much lower and wider chambers than does the true *Lenticulina varians*. Furthermore, it is better to separate this form as a distinct species (although perhaps a descendent of *L. varians*), rather than to use the same specific name for forms belonging to two distinct sub-genera. In fact, it is legally impossible to consider a single species as belonging to two genera or subgenera.

Types and occurrence.—Figured hypotype (USNM P346) and unfigured hypotypes (USNM P347) from a core (Upper Pliensbachian) at 2,170–2,179 feet in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Lenticulina wisniowskii (Myatliuk)

Plate 16, figures 1–3

Cristellaria wisniowskii Myatliuk, 1939, Neftianyi geologo-razvedochnyi Instit., Trudy, ser. A, fasc. 120, pp. 57, 73, pl. 4, figs. 43a, b.

Test free, lenticular, periphery acute; chambers numerous, about 7 to 8 in the final whorl, and sometimes asymmetrical so that the chambers reach to the umbilical region on the ventral side, but extend only about one-half the distance from the periphery on the opposite side, so that all chambers of approximately 1½ whorls may be visible; sutures distinct, thickened, slightly curved backwards; wall calcareous, perforate, surface smooth; aperture radiate, at the peripheral angle.

Greatest diameter of hypotype of fig. 1, 0.70 mm, least diameter 0.65 mm, thickness 0.26 mm. Greatest diameter of hypotype of fig. 3, 0.47 mm, least diameter 0.36 mm, greatest thickness 0.18 mm. Other specimens range from 0.26 to 0.52 mm in diameter.

Remarks.—The Alaskan specimens are similar to the Russian type in size, number of chambers, suture curvature, central boss and radiate aperture, although a few are somewhat asymmetrical. Because of the great variability in the Jurassic nodosarids, these somewhat trochoid forms are included in the present species with the otherwise similar planispiral forms.

Types and occurrence.—Hypotypes of figs. 1 and 3 (USNM P360a–b) and unfigured hypotypes (USNM P361) from Upper Jurassic strata at lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, in northern Alaska. Collected by William W. Patton, 1950.

Unfigured hypotypes (USNM P749) from Upper Jurassic rocks, about three miles east of the Siksikpuk River, at approximately lat 68°40′ N., long 151°54′ W., in the foothills of the Brooks Range, in northern Alaska. Collected by William W. Patton, 1950.

Hypotype of fig. 2 (USNM P780) and unfigured hypotypes (USNM P781) from Upper Jurassic rocks, in a core at 7,042–7,052 feet in Topagoruk Test Well 1, west of Topagoruk River, lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Unfigured hypotype (USNM P1091) from Upper Jurassic strata, on the west bank of Welcome Creek, approximately at lat 68°25′ N., long 150°55′ W., about 4 miles upstream from its confluence with Kanayut River, a tributary to the Anaktuvuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Unfigured hypotype (USNM P1092) from Upper Jurassic strata, on the west bank of the East Fork of the Nanushuk River, at lat 68°25′ N., long 150°20′ W., about 14 miles airline southeast of the confluence with the Nanushuk River, in the foothills of the Brooks Range, northern Alaska. Collected by William W. Patton, Jr., 1950.

Genus ASTACOLUS Montfort, 1808

Astacolus arietis (Terquem)

Plate 19, figures 1–5

Cristellaria arietis Terquem, 1866, Sixième Mèm. Foram. Lias de l'Indre Moselle, Metz, p. 510, pl. 21, fig. 30.

?*Cristellaria cinctella* Terquem, 1866, Ibid., p. 516, pl. 22, figs. 6a–b.

Test free, somewhat compressed, lenticular in edge view, planispirally coiled in the early stages, later tending to uncoil but the last chamber reaching quite far backwards, periphery with a keel; chambers numerous, as many as 15, low and broad, increasing rapidly in breadth, but very slowly in height; sutures distinct, dark in color, slightly curved; wall calcareous, hyaline, surface smooth; aperture at the peripheral angle, radiate.

Length of specimen in fig. 3, 1.14 mm, greatest breadth 0.78 mm, greatest thickness 0.34 mm. Other specimens range in length from 0.36 to 1.20 mm, and in breadth from 0.21 to 0.57 mm.

Remarks.—The type of this species, from the Middle Lias of France is similar to the specimen of fig. 3, in size, breadth, character of chambers and peripheral keel. *Astacolus cinctella* (Terquem) from the lower Lias (Sinemurian) may be a narrower form of the same species, as it is very similar to the Alaskan specimen of fig. 2, and resembles the type of *A. arietis* in the low broad chambers and peripheral keel, but has a slightly narrower test. Until the types are reexamined, this synonomy can only be suggested however.

Types and occurrence.—Hypotypes of figs. 1–3 (USNM P362a–c) and unfigured hypotypes (USNM P363) from a core at 2,099–2,109 feet, hypotype of fig. 5 (USNM P364) and unfigured hypotypes (USNM P365) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P366) from a core at 2,130–2,140 feet, unfigured hypotypes (USNM P367) from a core at 2,140–2,150 feet, hypotype of fig. 4 (USNM P368) and unfigured hypotypes (USNM P369) from a core at 2,150–2,170 feet, all from the Upper Pliensbachian; unfigured hypotypes (USNM P370) from a core (Lower Lias) at 2,468–2,478 feet, and unfigured hypotypes (USNM P371) from a core (Lower Lias) at 2,478–2,496 feet; all from the Kingak shale (Lower Jurassic) in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

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Astacolus calliopsis Tappan, n. sp.

Plate 17, figures 12–17

Test free, subovate in outline, compressed, early portion coiled, later uncoiling and becoming rectilinear, outer margin with a keel; 9 to 12 chambers, increasing slowly in height and rapidly in breadth as added, early chambers of the microspheric form (fig. 12) with an almost involute coil, and megalospheric specimens (fig. 16) with a less pronounced coil, later rectilinear chambers of comparatively greater thickness, final chambers nearly cylindrical; sutures distinct, dark in color, slightly curved; wall calcareous, hyaline, ornamented with 4 to 9 rather irregular and slightly oblique longitudinal costae which may appear, traverse two to four chambers and then disappear, terminal portion of final chamber smooth; aperture at the peripheral angle, radiate.

Length of holotype 0.55 mm, breadth 0.31 mm, thickness 0.18 mm, length of paratype of fig. 12, 0.52 mm, breadth 0.29 mm, thickness 0.18 mm, and length of paratype of fig. 16, 0.75 mm. Other specimens range in length from 0.29 to 0.81 mm.

Remarks.—*Astacolus calliopsis*, n. sp. resembles *Astacolus breoni* (Terquem) from the *davoei* beds of the French middle Lias, but is about one-fourth to one-third as large, much less compressed, has less regularly parallel ribs, and the final chamber is higher.

Types and occurrence.—Holotype (fig. 17) (USNM P372), paratype of fig. 15 (USNM P373) and unfigured paratypes (USNM P374) from a core at 2,109–2,119 feet, paratypes of figs. 13 and 14 (USNM P375a–b) and unfigured paratypes (USNM P376) from a core at 2,150–2,170 feet, of Late Pliensbachian age; paratype of fig. 16 (USNM P377) and unfigured paratypes (USNM P378) from a core (Lower Lias) at 2,468–2,478 feet, and paratype of fig. 12 (USNM P379) and unfigured paratypes (USNM P380) from a core (Lower Lias) at 2,478–2,496 feet, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Astacolus daintreei (Chapman)

Plate 18, figure 13

Cristellaria daintreei Chapman, 1904, Roy. Soc. Victoria, Proc., v. 16, n. s., pt. 2, art. 13, p. 194, pl. 22, fig. 13.

Test free, early portion planispiral and involute, later uncoiling and somewhat compressed, chambers low and broad, 6 to 9 in number, increasing very gradually in size as added; sutures distinct, curved and slightly depressed, with the next succeeding chamber somewhat raised adjacent to the suture, giving them a pseudolimbate appearance; wall calcareous, hyaline, surface smooth or faintly striate, the striations most prominent

across the inflated basal portion of each chamber, adjacent to the suture, but occasionally extending across the remainder of the chamber although less distinct; aperture at the peripheral angle, radiate.

Length of figured hypotype 0.60 mm, greatest breadth of coil 0.34 mm, breadth of uniserial portion 0.34 mm, thickness 0.21 mm. Other specimens range from 0.39 to 0.49 mm in length.

Remarks.—The Alaskan specimens are very similar to the type as figured by Chapman from the Jurassic of western Australia, and differ from other Jurassic species of this genus in the character of the ornamentation.

Types and occurrence.—This species has been noted in a single core in Alaska. The figured hypotype (USNM P381) and unfigured hypotypes (USNM P382) are from a core (Upper Pliensbachian) at 2,150–2,170 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Astacolus dubius (Franke)

Plate 18, figures 5–9

Cristellaria (*Astacolus*) *dubia* Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 107, pl. 10, fig. 17.

Test free, early portion planispiral but somewhat evolute, later portion uncoiling, although chambers extend far back toward the coil on the inner margin, periphery rounded to subacute; from 7 to 9 chambers in the coil surrounding the globular proloculus, followed by 2 to 3 uncoiling chambers, chambers increasing more rapidly in breadth than in height, but final chamber may be as much as twice as high as the preceding one; sutures distinct, slightly depressed to flush, very gently curved; wall calcareous, surface smooth; aperture radiate, at the dorsal angle.

Length of hypotype of fig. 6, 0.47 mm, of fig. 8, 0.99 mm, length of hypotype of fig. 9, 0.83 mm, breadth of coil 0.52 mm, greatest thickness 0.26 mm.

Remarks.—The Alaskan specimens of figs. 6 and 9 resemble closely that figured by Franke in size, the compressed test, character of the slightly evolute coil, curved sutures and few free chambers. Franke stated that his specimens had only one to two uncoiling chambers, while that here shown in fig. 3 has three. In all other respects they are nearly identical. Franke's types were from the Middle Lias of Germany.

The specimen here shown in fig. 8 somewhat resembles *Cristellaria amaena* Terquem, but the latter has an involute coil and the later chambers are higher and more numerous, and the sutures more horizontal than in *Astacolus dubius*. *Cristellaria acuminata* Terquem is also similar, but has an involute coil and much more flattened test.

According to Thalmann (1939, p. 426), *Cristellaria* (*Astacolus*) *dubia* Franke is preoccupied by *Robulina dubia* Seguenza, 1880. This would be true only if both species were later placed in the same genus, and by some workers *Cristellaria* is used for all coiled nodosarids, with the other genera considered as subgenera. If these two species were thus placed in *Cristellaria*, Franke's name would be a homonym. However, present American usage does not recognize *Cristellaria* as a generic name, the species which would be included in it being placed in one or another of some dozen genera. *Robulina dubia* Seguenza would thus be placed in *Lenticulina* or *Robulus*, and as Franke's species belongs to the genus *Astacolus* it seems to the writer that there is no homonymy, and the present species is referred to *Astacolus dubius* (Franke).

Types and occurrence.—Unfigured hypotypes (USNM P383) from a core at 1,979–1,999 feet, hypotypes of figs. 7–9 (USNM P384a–c) and unfigured hypotypes (USNM P385) from a core at 2,028–2,048 feet, unfigured hypotypes (USNM P386) from a core at 2,033–2,038 feet, hypotypes of figs. 5–6 (USNM P387a–b) and unfigured hypotypes (USNM P388) from a core (Lower Toarcian) at 2,048–2,068 feet, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Astacolus pediacus Tappan, n. sp.

Plate 17, figures 1–10

Test free, elongate, flattened, with early portion coiled or with an axis of a variable degree of curvature; chambers low and broad, early chambers with a marginuline type of development although compressed, later becoming rectilinear, with chambers extending backwards at the inner margin, 7 to 14 chambers may be present, final chamber somewhat higher than the previous ones; sutures distinct, oblique, slightly curved, dark in color; wall calcareous, hyaline, finely perforate; aperture at the peripheral angle, radiate.

Length of holotype 0.62 mm, breadth 0.29 mm, thickness 0.16 mm. Length of paratype of fig. 2, 0.91 mm, breadth 0.31 mm; length of paratype of fig. 5, 0.47 mm., breadth 0.31 mm. Other paratypes range in length from 0.26 to 2.88 mm.

Remarks.—This species resembles *Cristellaria protracta* Bornemann in the degree of coiling, and the oblique sutures, but differs in being larger and broader. It is similar to *Astacolus aphrastus* Loeblich and Tappan, from the Redwater shale member of the Sundance formation (Oxfordian) of South Dakota, in size and general appearance, but lacks the dorsal keel, is somewhat broader, with a better developed coil and less incised sutures.

It is also similar to *Cristellaria (Astacolus) stutzeri* Franke from the German Lias, but the type of Franke's species is much narrower.

Types and occurrence.—Paratype of fig. 1 (USNM P389) from well cuttings at 5,990–6,000 feet, and unfigured paratypes (USNM P390) from a core at 6,067–6,077 feet, from the Kingak shale of Early Jurassic age in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson, in northern Alaska.

Unfigured paratypes (USNM P391) from a core (Lower Toarcian) at 2,048–2,068 feet, unfigured paratype (USNM P392) from a core at 2,068–2,078 feet, unfigured paratypes (USNM P393) from a core at 2,099–2,109 feet, holotype of fig. 4 (USNM P394) and paratypes of figs. 2–3, 8–10 (USNM P395a–e) and unfigured paratypes (USNM P396) from a core at 2,109–2,119 feet, paratypes of figs. 5–6 (USNM P397a–b) and unfigured paratypes (USNM P398) from a core at 2,130–2,140 feet, paratype of fig. 7 (USNM P399) and unfigured paratypes (USNM P400) from a core at 2,150–2,170 feet, and unfigured paratypes (USNM P401) from a core at 2,170–2,179 feet (all Upper Pliensbachian) from the Kingak shale of Early Jurassic age in South Barrow Test Well 3 at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured paratypes (USNM P402) from a core at 2,341–2,356 feet in the Kingak shale of Early Jurassic age in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Astacolus sp.

Plate 17, figure 11

Test free, reniform in outline, somewhat compressed, consisting of a curved series of chambers, but without a a complete coil, periphery rounded; about 7 chambers, low and broad and thickest at the inner margin, increasing very little in size as added, final chamber equal in height to the preceding three; sutures slightly curved, not depressed; wall calcareous, hyaline, surface smooth; aperture at the peripheral angle, radiate.

Length of figured specimen 0.57 mm, greatest breadth 0.29 mm, thickness 0.18 mm.

Remarks.—This species is closest to the lower Oxfordian *Astacolus fraasi* (Schwager), but is somewhat broader, shorter and less compressed, the sutures are concave upwards, rather than convex upwards and the final chamber is higher, broader and more inflated. As a single specimen has been found in Alaska, it is not here described as a new species.

Type and occurrence.—Figured specimen (USNM P403) from Upper Jurassic rocks at approximately lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, in northern Alaska. Collected by William W. Patton, 1950.

Genus MARGINULINA d'Orbigny, 1826

Marginulina bergquisti Tappan, n. sp.

Plate 22, figures 1–8

Test free, of medium size, early portion incompletely coiled, later rectilinear, periphery broadly rounded, but marked by a series of nodes at the peripheral margin of the early coiled portion; about 3 to 4 chambers in the incomplete coil, following the rounded proloculus, and finally 2 to 7 rectilinear chambers; sutures distinct, slightly depressed, gently curved in the coil, faintly oblique in the early uncoiled portion, and becoming straight and more nearly horizontal in the later portion of larger specimens; wall calcareous, hyaline, surface smooth except for the row of 3 to 9 small nodes along the basal margin; aperture radiate, at the peripheral margin in the early portion, becoming more nearly central in the uniserial, subcylindrical later chambers.

Length of holotype 0.81 mm, greatest breadth of coil 0.34 mm, thickness 0.29 mm. Length of paratype of fig. 4, 1.59 mm, breadth 0.29 mm, length of paratype of fig. 5, 1.14 mm, breadth 0.34 mm, length of paratype of fig. 7, 0.52 mm, breadth 0.23 mm. Other paratypes range from 0.29 to 1.30 mm in length.

Remarks.—This species resembles *Cristellaria (Astacolus) denticulata-carinata* Franke, from the German Lias, in the incomplete coil and denticulate lower margin, but differs in being larger and broader, and has comparatively higher chambers. It is similar to *Cristellaria antiquata* d'Orbigny in size and character of chambers, but d'Orbigny's species is completely smooth, with a rounded periphery. *Cristellaria (Astacolus) basidentata* Franke has a less well developed and narrower coil.

Types and occurrence.—Unfigured paratypes (USNM P411) from a core at 1,979–1,999 feet, unfigured paratypes (USNM P412) from a core at 2,028–2,048 feet, unfigured paratypes (USNM P413) from a core at 2,048–2,068 feet all of early Toarcian age; unfigured paratypes (USNM P414) from a core at 2,068–2,078 feet, paratypes of figs. 1 and 3 (USNM P407a–b) and unfigured paratypes (USNM P408) from a core at 2,099–2,109 feet, holotype of fig. 8 (USNM P404), paratypes of figs. 2, 5–7 (USNM P405a–d) and unfigured paratypes (USNM P406) all from a core at 2,109–2,119 feet, unfigured paratypes (USNM P415) from a core at 2,130–2,140 feet, unfigured paratypes (USNM P416) from a core at 2,140–2,150 feet, unfigured paratypes (USNM P417) from a core

at 2,150–2,170 feet, paratype of fig. 4 (USNM P409) and unfigured paratypes (USNM P410) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; unfigured paratype (USNM P418) from a core (Lower Lias) at 2,231–2,251 feet, and unfigured paratypes (USNM P419) from a core (Lower Lias) at 2,478–2,496 feet; all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Marginulina breviformis (Terquem and Berthelin)

Plate 18, figures 2–3

Cristellaria breviformis Terquem and Berthelin, 1875, Mém. Soc. Geol. France, ser. 2, v. 10, no. 3, p. 42, pl. 3, fig. 14.
Marginulina breviformis (Terquem and Berthelin) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 75, pl. 7, fig. 21.
Marginulina simplex (Terquem) Franke, 1936 (part; not *Vaginulina simplex* Terquem, 1864, and not *Marginulina simplex* Karrer, 1862), Abh. Preuss. Geol. Landesanst. Neue Folge, no. 169, p. 75, pl. 7, fig. 24 (not figs. 22–23).

Test free, short, stout, rounded in section; early chambers tiny and broader than high, increasing rapidly in breadth as added, later chambers increasing in height also, with the final chamber occupying one-half to one-third the length of the test; sutures very oblique, flush with the surface; wall calcareous, hyaline, surface smooth; aperture radiate, at the dorsal angle.

Length of hypotype of fig. 2, 0.78 mm, breadth 0.29 mm; length of hypotype of fig. 3, 0.44 mm, breadth 0.21 mm. Other hypotypes range in length from 0.42 to 0.78 mm.

Remarks.—Franke referred to *Marginulina breviformis* a specimen very similar to that here shown in fig. 3, and one of the specimens he referred to *Marginulina simplex* (Franke, 1936, pl. 7, fig. 24) is very similar to that here shown in fig. 2. It differs from his other specimens of "*Marginulina simplex*", and from the type of *Vaginulina simplex* Terquem in being shorter, more robust, with more oblique sutures and lower chambers in the early portion, and comparatively high final chamber. These characters all resemble the type of *Cristellaria breviformis* Terquem and Berthelin.

Franke placed *Vaginulina simplex* Terquem in the genus *Marginulina*, but because of the oblique sutures, lack of any semblance of a coil and the rounded cross section of the test, it would seem to the writer to belong to *Vaginulina* or *Dentalina*. Terquem's specimens should be reexamined to determine which genus is correct, for if it were to be placed in *Marginulina*, a new specific name would be required, *Marginulina simplex* being used by Karrer in 1862 for a striate German Tertiary species, which is quite distinct. No new name is here proposed for that of Terquem, however, because of the probability that the species should remain in *Vaginulina*. At least part of the forms referred to it by Franke are here considered to belong to *Marginulina breviformis* (Terquem and Berthelin).

Types and occurrence—Unfigured hypotypes (USNM P483) from a core at 1,979–1,999 feet, unfigured hypotype (USNM P484) from a core at 1,999–2,018 feet, hypotypes of figs. 2–3 (USNM P485a–b) from a core at 2,028–2,048 feet, all of Early Toarcian age; unfigured hypotypes (USNM P486) from a core at 2,068–2,078 feet, and unfigured hypotype (USNM P487) from a core at 2,170–2,179 feet, of Late Pliensbachian age; from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Marginulina brevis Paalzow

Plate 18, figure 14

Marginulina brevis Paalzow, 1922, Abh. Naturf. Gesell., Nürnberg, v. 22, p. 21, pl. 2, fig. 18.

Test small, subovate in outline, subtriangular in section, being narrower at the outer margin and thickest at the inner margin, margins rounded; chambers few in number, six in the figured specimen, low and broad, increasing very slowly in size except for the final chamber, which occupies about one-half the length of the test; sutures distinct, flush, oblique; wall calcareous, surface smooth; aperture at the dorsal angle.

Length of figured hypotype 0.31 mm, greatest breadth 0.16 mm, greatest thickness 0.10 mm.

Remarks.—A single specimen, the holotype, was recorded from Germany, and it was somewhat larger than the specimen from Alaska, being 0.5 mm in length and 0.25 mm in breadth. It is similar in the subtriangular section, low and broad chambers and oblique sutures, and is probably conspecific. As only two specimens are known, it is impossible to accurately determine the size range.

Types and occurrence.—Figured hypotype (USNM P791) from a core at 7,042–7,052 feet, in Upper Jurassic rocks in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, northern Alaska.

Marginulina calva Tappan, n. sp.

Plate 18, figure 12

Test free, elongate, narrow, enlarging gradually from the rounded base; consisting of about 5 to 6 chambers which are low in the early portion, about twice as broad as high, but increase gradually in height, so that the later chambers are of about equal height and breadth; sutures distinct, straight, slightly oblique, with a suggestion of a coil in the change from nearly horizontal sutures in the early portion to the moderately oblique

later ones; wall calcareous, surface smooth; aperture radiate, somewhat produced at the outer margin.

Length of figured holotype 0.49 mm, breadth 0.13 mm, thickness 0.10 mm. Unfigured paratypes range from 0.49 to 0.55 mm in length.

Remarks.—This species is closest to the specimen of *Marginulina constricta* Terquem and Berthelin (1875, pl. 5, fig. 3a) which also has a rounded section, oblique sutures and produced aperture. However, Terquem and Berthelin selected no holotype, figuring 6 specimens which vary considerably in the degree of compression, curvature of the test and degree of constriction of the sutures. The flattened forms of figs. 3b, d, and f of Terquem and Berthelin were distinguished as *Vaginulina constricta* (Terquem and Berthelin) by Franke, 1936, and this was followed by Bartenstein and Brand (1937). Presumably this would restrict the selection of a lectotype to one of these three specimens. The remaining specimens were placed by Franke in the synonomy of his new species *Vaginulina parva* Franke. This also is a somewhat compressed species, judging from Franke's type specimen. The Alaskan specimens are thus distinct from *Vaginulina constricta* (Terquem and Berthelin), as based on figs. 3b, d, and f (1875), and are also distinct from *V. parva* Franke.

The specimen referred to *Marginulina simplex* (Terquem) by Franke (1936, pl. 7, fig. 23, but not figs. 22 or 24) is similar to the present species, but has a less produced apertural end and does not show the change in angle of the early sutures as in the present species. Terquem's type of *Vaginulina simplex* is also broader, with more oblique sutures.

Marginulina calva also resembles *Dentalina subtenuicollis* Franke, which is also found in Alaska, in general size and proportions. It differs in having more oblique sutures, a slight marginuline coil, and in being somewhat more slender.

Types and occurrence.—Unfigured paratype (USNM P514) from a core at 2,033–2,038 feet, holotype in fig. 12 (USNM P515) and unfigured paratype (USNM P516) from a core at 2,048–2,068 feet, all of Early Toarcian age; from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Marginulina demissa (Terquem and Berthelin)

Plate 18, figures 15–20

Nodosaria variabilis Terquem and Berthelin, 1875 (not *Nodosaria variabilis* Neugeboren, 1852), Mém. Soc. Geol. France, ser. 2, v. 10, no. 3, p. 20, pl. 1, figs. 19a–f.

Dentalina demissa Terquem and Berthelin, 1875, Ibid., p. 28, pl. 2, figs. 10–10g.

Test free, small, elongate, consisting of a series of subglobular chambers, chambers of megalospheric test increasing very slightly in size as added (fig. 18) but chambers enlarging gradually in the microspheric forms (figs. 15, 17), proloculus with an apical spine; sutures distinct, constricted, horizontal; wall calcareous, hyaline, ornamented with 7 to 14 longitudinal ribs, which are low and blunt and increase by intercalation; aperture terminal, on a short neck and slightly eccentric in position.

Length of hypotype of fig. 15, 0.57 mm, breadth 0.21 mm. Length of hypotype of fig. 17, 0.91 mm, breadth 0.26 mm. Other specimens range from 0.26 to 0.94 mm in length.

Remarks.—Apparently Terquem and Berthelin separated the megalospheric forms (as fig. 18), naming them *Nodosaria variabilis*, from the more tapered microspheric forms which they placed in *Dentalina demissa*. As both were described in the same publication, the former would have priority because of appearing earlier in the publication. However, this name is preoccupied by *Nodosaria variabilis* Neugeboren, 1852, and the specific name *demissa* thus is the next available name. Although there is slight trace of a coil in the early portion, the aperture is generally eccentric in position and the sutures are horizontal, hence the species is considered closer to *Marginulina* than to either *Nodosaria* or *Dentalina*. It is one of the many Jurassic borderline species, which could be placed in either of these genera.

Types and occurrence.—Unfigured hypotypes (USNM P420) from a core at 2,028–2,048 feet, unfigured hypotype (USNM P421) from a core at 2,048–2,068 feet, all from the Lower Toarcian; unfigured hypotype (USNM P422) from a core at 2,068–2,078 feet, unfigured hypotype (USNM P423) from a core at 2,099–2,109 feet, unfigured hypotypes (USNM P424) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P425) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P426) from a core at 2,150–2,170 feet, hypotypes of figs. 15–20 (USNM P427a–f) and unfigured hypotypes (USNM P428) from a core at 2,170–2,179 feet, and unfigured paratype (USNM P429) from a core at 2,179–2,199 feet, all of Late Pliensbachian age; from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Marginulina interrupta Terquem

Plate 20, figures 17–25

Marginulina interrupta Terquem, 1866, Cinquième Mém. Foram. Lias Moselle, p. 426, pl. 17, figs. 4a–c; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 79, pl. 8, fig. 9; Macfadyen, 1936, Jour. Roy. Micros. Soc. London, ser. 3, v. 56, p. 151, pl. 1, fig. 262b.

Test free, narrow, elongate, rectilinear; 3 to 6 chambers, subglobular and of somewhat greater breadth than height, proloculus with a basal spine, final chamber somewhat produced terminally; sutures straight, horizontal, constricted; wall calcareous, ornamented by numerous (about 18) low and rounded ribs, which are broken at the sutures, giving the basal margin of the chambers a serrate appearance; aperture terminal, rounded.

Length of hypotype of fig. 17, 0.49 mm, breadth 0.18 mm, length of hypotype of fig. 25, 0.81 mm, breadth 0.21 mm. Other specimens range from 0.26 to 1.22 mm in length.

Remarks.—This species was originally described from the lower and middle Lias of France, and is characterized by the interrupted costae, which end in spinose projections at the base of each chamber.

Types and occurrence.—Hypotypes (USNM P430) from a core (Lower Toarcian) at 2,028–2,048 feet; hypotype of fig. 20 (USNM P431) from a core at 2,068–2,078 feet, unfigured hypotypes (USNM P432) from a core at 2,099–2,109 feet, hypotypes of figs. 17–19, 21, 23–25 (USNM P433a–g) and unfigured hypotypes (USNM P434) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P435) from a core at 2,130–2,140 feet, hypotype of fig. 22 (USNM P436) and unfigured hypotypes (USNM P437) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P438) from a core at 2,150–2,170 feet, and unfigured hypotypes (USNM P439) from a core at 2,170–2,179 feet, all from the Upper Pliensbachian, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Marginulina pletha Tappan, n. sp.

Plate 18, figures 10–11

Test free, short and stout, early portion coiled, later uncoiling, periphery broadly rounded; 4 to 5 chambers, increasing rapidly in size as added, final chamber occupying nearly two-thirds the length of the test and somewhat inflated toward the ventral margin; sutures distinct, slightly depressed, very slightly curved, quite oblique in the uncoiled portion; wall calcareous, hyaline, surface smooth; aperture at the peripheral angle, radiate.

Length of holotype 0.44 mm, greatest breadth 0.26 mm, thickness 0.21 mm. Length of paratype of fig. 10, 0.42 mm, breadth 0.21 mm. Length of unfigured paratype 0.47 mm, breadth 0.23 mm.

Remarks.—This species is similar to *Cristellaria breviformis* Terquem and Berthelin, from the Middle Lias of France, but is about twice as large in both length and breadth, with tests of an equal number of chambers.

Types and occurrence.—Holotype (USNM P440) from a core at 2,099–2,109 feet, paratype of fig. 10 (USNM P441) from a core at 2,028–2,048 feet, unfigured paratypes (USNM P442) from a core at 2,109–2,119 feet, and unfigured paratype (USNM P443) from a core at 2,033–2,038 feet, all from the Upper Pliensbachian, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Marginulina prima d'Orbigny

Plate 20, figures 1–13

Marginulina prima d'Orbigny, 1850, Prodrome de paléon. stratig. universelle, v. 1, p. 242; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 76, pl. 8, figs. 1–7; Macfadyen, 1936, Jour. Roy. Micros. Soc. London, ser. 3, v. 56, p. 151, pl. 1, figs. 262a–b; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 161, pl. 2B, fig. 26, pl. 3, figs. 39–40, pl. 4, figs. 60a–b, pl. 5, figs. 46a–b; Wicher, 1938, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 193, pl. 16, fig. 4, pl. 19, fig. 6; Barnard, 1950, Quart. Jour. Geol. Soc. London, v. 105, pt. 3, p. 372, figs. 5a, b, g.

Marginulina rugosa Bornemann, 1854 (not Neugeboren, 1851), Über Liasformation Umgegend Göttingen, p. 39, pl. 3, fig. 26.

Marginulina prima d'Orbigny var. *gibbosa* Terquem, 1858, Mém. Acad. Imp. Metz, ann. 39, (ser. 2, ann. 6), p. 612, pl. 3, figs. 5a–d; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 77, pl. 8, fig. 2.

Marginulina prima d'Orbigny var. *recta* Terquem, 1858, Mém. Acad. Imp. Metz, ann. 39 (ser. 2, ann. 6), p. 613, pl. 3, fig. 6; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 77, pl. 8, fig. 4; Payard, 1947, Faune Foram. Lias Supérieur Détroit Poitevin, p. 152, pl. 2, fig. 31.

Marginulina prima d'Orbigny var. *acuta* Terquem, 1858, Mém. Acad. Imp. Metz, ann. 39 (ser. 2, ann. 6), p. 614, pl. 3, fig. 7; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 77, pl. 8, fig. 5.

Marginulina ornata Terquem, 1858, Mém. Acad. Imp. Metz, ann. 39 (ser. 2, ann. 6) p. 616, pl. 3, figs. 10a–c.

Marginulina prima var. *praelonga* Terquem and Berthelin, 1875, Mém. Soc. géol. France, ser. 2, v. 10, no. 3, p. 54, pl. 4, fig. 18; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 77, pl. 7, fig. 3; Payard, 1947, Faune Foram. Lias Supérieur Détroit Poitevin, p. 152, pl. 2, fig. 30.

Marginulina crassiuscula Terquem and Berthelin, 1875, Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 56, pl. 4, figs. 23a–c.

Dentalina insignis Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 36, pl. 3, figs. 11a–b.

Test free, of medium size, elongate, robust, early portion slightly coiled in the microspheric form (figs. 5, 11), gently curved in the megalospheric generation (figs. 2–4, 9), chambers numerous, inflated, increasing slightly in size as added, early coiled chambers low and broad, later ones about equal in height and breadth; sutures distinct, slightly constricted, horizontal in later portion; wall calcareous, hyaline, ornamented

with 8 to 11 narrow, elevated continuous ribs which cross chambers and sutures; aperture terminal, radiate, on a slight neck, varying from the dorsal margin in position to almost central, so that the species is gradational between true *Marginulina* and *Nodosaria*.

Length of hypotype of fig. 3, 1.30 mm, breadth 0.34 mm, length of hypotype of fig. 8, 0.47 mm, of fig. 9, 1.72 mm, and of fig. 11, 0.57 mm.

Remarks—Many species have been described that have apparently been based on variations of this species. Because many of these forms grade into each other, the writer does not consider them of sufficient importance to warrant even varietal distinction, and they are here placed in synonymy. Undoubtedly other "species" are also synonymous, but a study of the types is necessary to determine this definitely. The specimens here shown in figs. 2, 4 and 12 are similar to the type of *Marginulina prima* var. *recta* Terquem, fig. 3 is close to the type of *M. prima* d'Orbigny, fig. 5 resembles *M. rugosa* Bornemann, figs. 6 and 8 are like the type of *M. prima* var. *gibbosa* Terquem, or *M. crassiuscula* Terquem and Berthelin, fig. 9 resembles Franke's *Dentalina insignis* and fig. 11 resembles the type of *Marginulina rugosa* Bornemann.

Types and occurrence.—Unfigured hypotypes (USNM P444) from a core at 2,028–2,048 feet, hypotype of fig. 10 (USNM P445) from a core at 2,048–2,068 feet, from the Lower Toarcian; unfigured hypotype (USNM P446) from a core at 2,099–2,109 feet, hypotype of fig. 11 (USNM P447) and unfigured hypotypes (USNM P448) from a core at 2,109–2,119 feet, unfigured hypotypes (USNM P449) from a core at 2,130–2,140 feet, hypotypes of figs. 3, 12 (USNM P450a–b) and unfigured hypotypes (USNM P451) from a core at 2,140–2,150 feet, hypotypes of figs. 4–6, 8 and 13 (USNM P452a–e) and unfigured hypotypes (USNM P453) from a core at 2,150–2,170 feet, hypotype of fig. 2 (USNM P454) and unfigured hypotypes (USNM P455) from a core at 2,170–2,179 feet, unfigured hypotypes (USNM P456) from a core at 2,179–2,199 feet, all of Late Pliensbachian age; hypotypes of figs. 1 and 7 (USNM P457a–b) and unfigured hypotype (USNM P458) from a core at 2,199–2,218 feet, unfigured hypotype (USNM P459) from a core at 2,231–2,251 feet, unfigured hypotype (USNM P460) from a core at 2,251–2,271 feet, unfigured hypotypes (USNM P461) from a core at 2,300–2,320 feet, unfigured hypotypes (USNM P462) from a core at 2,320–2,323 feet, unfigured hypotypes (USNM P463) from a core at 2,468–2,478 feet, and unfigured hypotypes (USNM P464) from a core at 2,478–2,496 feet, all of Early Lias age from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Hypotype of fig. 9 (USNM P465) from a core at 2,341–2,356 feet, and unfigured hypotypes (USNM P466) from a core at 2,356 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Marginulina psila Tappan, n. sp.

Plate 19, figures 6–16

Test free, of medium size, narrow, elongate, rounded in section, early portion coiled, later uncoiling, periphery broadly rounded; chambers numerous, about 3 to 4 in the partial coil, followed by 2 to 6 uncoiled chambers, at first reaching backwards toward the coil, later becoming nearly cylindrical, degree of coiling and size of coil is variable; sutures distinct, slightly constricted, at first slightly curved, later becoming nearly straight; wall calcareous, hyaline, surface smooth and unornamented; aperture at the end of a slight neck, radiate.

Length of holotype in fig. 15, 0.70 mm, breadth of coil 0.26 mm, thickness of coil 0.18 mm. Length of paratype of fig. 8, 0.31 mm, breadth 0.13 mm; length of paratype of fig. 11, 0.75 mm, breadth 0.29 mm; length of paratype of fig. 14, 0.88 mm, breadth 0.31 mm.

Remarks.—This species differs from *Marginulina incurva* Terquem in having a more enrolled base, of a diameter approximately equal to that of the later portion of the test, a slightly more curved test, somewhat curved sutures and a more central aperture, rather than having the aperture at the dorsal margin.

Types and occurrence.—Unfigured paratype (USNM P467) from a core at 2,018–2,028 feet, paratype of fig. 9 (USNM P468) and unfigured paratype (USNM P469) from a core at 2,028–2,033 feet, all of Early Toarcian age; holotype of fig. 15 (USNM P470), paratypes of figs. 11 and 14 (USNM P471a–b) and unfigured paratypes (USNM P472) from a core at 2,109–2,119 feet, paratype of fig. 13 (USNM P473) and unfigured paratypes (USNM P474) from a core at 2,130–2,140 feet, paratypes of figs. 7 and 12 (USNM P475a–b) and unfigured paratypes (USNM P476) from a core at 2,140–2,150 feet, paratypes of figs. 6, 8, 10, and 16 (USNM P477a–d) and unfigured paratypes (USNM P478) from a core at 2,150–2,170 feet, and unfigured paratypes (USNM P479) from a core at 2,170–2,179 feet, all of Late Pliensbachian age, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Marginulina pinguicula Tappan, n. sp.

Plate 18, figure 4

Test free, short, broad, robust, periphery broadly rounded; chambers few in number, about four, early

chambers very low and broad, forming an incomplete coil, final chamber much higher and inflated, almost globular, though slightly produced at the dorsal angle; sutures distinct, nearly straight, slightly depressed; wall calcareous, surface smooth; aperture radiate, at the dorsal angle.

Length of holotype 0.29 mm, greatest breadth 0.23 mm, greatest thickness 0.21 mm. Paratype has a length of 0.26 mm.

Remarks.—This species resembles small specimens of *Saracenaria cypha* Loeblich and Tappan, from Upper Jurassic rocks of the western interior, in the short, fat test, but the present species has a less well defined coil and is rounded in section, lacking the typically triangular face of *Saracenaria*. The present species never reaches a length comparable to that of adult specimens of *S. cypha*, all specimens being short and fat like the holotype.

Types and occurrence.—Holotype (USNM P789) and unfigured paratype (USNM P790) from upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in northern Alaska.

Marginulina quadricostata Terquem

Plate 20, figure 14

Marginulina quadricostata Terquem, 1863, Mém. Acad. Imp. Metz, ann. 44 (ser. 2, ann. 11), pt. 2, p. 190, pl. 8, figs. 12a–b.

Cristellaria (*Astacolus*) *quadricosta* (Terquem) Franke (for *quadricostata*), 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 109, pl. 11, fig. 4.

Cristellaria (*Astacolus*) *quadricostata* (Terquem) Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 173, pl. 3, fig. 47, pl. 4, fig. 71, pl. 5, fig. 57; Wicher, 1938, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 193, pl. 16, fig. 6.

Test free, somewhat flattened, with an incompletely coiled base, followed by a later uncoiled portion; chambers of greater breadth than height, but increasing slightly in height as added; sutures obscured by the strongly elevated and continuous costae; wall calcareous, ornamented with 2 to 4 costae on each side, which die out at the terminal portion of the final chamber; aperture produced on a short neck at the dorsal angle.

Length of figured hypotype 0.57 mm, greatest breadth 0.18 mm, greatest thickness 0.13 mm. Other hypotypes range from 0.47 to 0.62 mm in length.

Remarks.—Terquem recorded this species from the Lower Lias of France, and Bartenstein and Brand and later Wicher also found it in the middle Lias. It is characterized by the partial coil, flattened test and few costae. It is somewhat gradational between *Marginulina* and *Astacolus*, but because the later chambers are somewhat rounded, it is here considered to belong in *Marginulina*, where it was originally placed by Terquem *M. quadricostata* differs from *M. radiata* Terquem in being more compressed, and in having fewer ribs, with these more narrow and elevated.

Types and occurrence.—Hypotype of fig. 14 (USNM P480) and unfigured hypotypes (USNM P481) all from a core (of Sinemurian age) at 2,478–2,496 feet, in the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Marginulina radiata Terquem

Plate 20, figures 15–16

Marginulina radiata Terquem, 1864, Mém. Acad. Imp. Metz, Ann. 44 (ser. 2, ann. 11), pt. 2, p. 410, pl. 9, figs. 10a, b; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 161, pl. 1a, fig. 15, pl. 1B, fig. 17, pl. 2A, figs. 12, 13, pl. 2B, fig. 25.

Cristellaria (*Astacolus*) *radiata* (Terquem) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 108, pl. 11, fig. 3.

not *Vaginulina radiata* (Terquem) Franke, 1936, Ibid., p. 84, pl. 8, figs. 33, 40.

not *Pseudocitharina radiata* (Terquem) Payard, 1947, Foram. Lias Supérieur, p. 143, pl. 3, fig. 22.

Test free, robust, elongate, early portion curved, later chambers rectilinear, rounded in section; chambers 6 to 7 in number, low at first, later ones higher, final one or two chambers of nearly equal height and breadth; sutures straight, somewhat obscured by the costae, radial in the early portion, nearly horizontal in the later portion, last one or two slightly constricted; wall calcareous, surface ornamented with numerous longitudinal costae that are continuous, but may be at a slight angle from the vertical; aperture at the dorsal angle, rounded.

Length of hypotype of fig. 15, 0.47 mm, breadth 0.16 mm, thickness 0.16 mm. Length of hypotype of fig. 16, 0.52 mm, breadth 0.47 mm.

Remarks.—Franke referred specimens with a slight coil to *Cristellaria* (*Astacolus*) *radiata* (Terquem) and also referred a flatter, broader and straighter species to *Vaginulina radiata* (Terquem), using the same specific name of Terquem for forms that he referred to two distinct genera. Payard (1947) further complicated the synonomy by placing Terquem's and Franke's references in the synonomy of *Pseudocitharina radiata* (Terquem), referring the species to his new genus. Payard's figured specimen is a flattened one, much like *Citharina fallax* (Payard), although more narrow, and Terquem's type was circular in section. Payard's form was also twice as long as the type, and is very close also to the form he referred to *Pseudocitharina proxima* (Terquem) and similar to *Marginulina proxima* Terquem, var. I Terquem, 1868. The specimen figured

by Franke as *Vaginulina radiata* may be conspecific with Payard's specimens, but these should either be placed in a different species (perhaps *Marginulina proxima* Terquem), or a new name should be proposed for them. Terquem's type of *Marginulina radiata* is a true *Marginulina*, and other species belonging to distinct genera cannot be assigned this specific name.

Types and occurrence.—Figured hypotypes (USNM P482a–b) from a core (of Sinemurian age) at 2,478–2,496 feet, in the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156° 34′45″ W., in northern Alaska.

Marginulina thuringica (Franke)

Plate 21, figures 12–22

Cristellaria (Astacolus) thuringica Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 103, pl. 10, figs. 7a–b.

Cristellaria (Astacolus) cf. *thuringica* Franke Wicher, 1938, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 193, pl. 19, fig. 8.

Test free, of medium size, early portion coiled, or with an inflated proloculus, later uncoiled, dorsal margin straight; early chambers low, increasing gradually in size as added, last chamber higher than the preceding ones; sutures distinct, curved in the early portion, later nearly straight and slightly depressed; wall calcareous, surface smooth; aperture terminal, radiate.

Length of hypotype of fig. 16, 0.55 mm, breadth 0.21 mm. Length of hypotype of fig. 21 0.86 mm, breadth 0.29 mm. Other specimens range from 0.42 to 1.72 mm in length, and from 0.23 to 0.47 mm in breadth.

Remarks.—The Alaskan specimens are very close to the type of Franke, from the middle Lias of Germany. It is distinguished from *Marginulina utricula* Terquem and Berthelin by the smooth and rounded base, and the absence of any basal spines.

Types and occurrence.—Unfigured hypotypes (USNM P488) from a core at 2,028–2,048 feet, hypotype of fig. 16 (USNM P489) from a core at 2,048–2,068 feet, all of Early Toarcian age; unfigured hypotypes (USNM P490) from a core at 2,068–2,078 feet, hypotypes of figs. 13 and 22 (USNM P491a–b) and unfigured hypotypes (USNM P492) from a core at 2,109–2,119 feet, hypotypes of figs. 18–19 (USNM P493) and unfigured hypotypes (USNM P494) from a core at 2,130–2,140 feet, hypotypes of figs. 12, 14–15, and 20 (USNM P495a–d) and unfigured hypotypes (USNM P496) from a core at 2,140–2,150 feet, hypotype of fig. 17 (USNM P497) and unfigured hypotypes (USNM P498) from a core at 2,150–2,170 feet, unfigured hypotypes (USNM P499) from a core at 2,170–2,179 feet, all of Late Pliensbachian age, hypotype of fig. 21 (USNM P500) and unfigured hypotypes (USNM P501) from a core at 2,468–2,478 feet, and unfigured hypotype (USNM P502) from a core at 2,478–2,496 feet, from the Lower Lias; all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, lat 71°09′40″ N., long 156°34′45″ W., northern Alaska.

Marginulina utricula Terquem and Berthelin

Plate 21, figures 1–10

Marginulina utricula Terquem and Berthelin, 1875, Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 55, pl. 4, fig. 20.

Cristellaria (Astacolus) basidentata Franke, 1936, Abh. Preuss. Geol. Landesanst. Neue Folge, no. 169, p. 100, pl. 9, figs. 34a–b.

Test free, elongate, slightly curved, subcylindrical with a rounded base and a short basal spine, and may have a few smaller accessory spines on the basal margin (figs. 1 and 3); chambers from 2 to 9, with 4 to 6 the most frequent, proloculus comparatively large and globular, later chambers slightly inflated, variable in size, some nearly globular throughout development, and in other specimens the chambers are low at first and later ones increase gradually in height, final chamber somewhat produced at the apertural end; sutures distinct, constricted, nearly straight, slightly oblique to horizontal; wall calcareous, surface smooth; aperture at the dorsal margin, radiate, on a short neck.

Length of hypotype of fig. 5, 1.51 mm, greatest breadth 0.42 mm; length of hypotype of fig. 8, 0.75 mm, breadth 0.26 mm; length of hypotype of fig. 10, 1.40 mm, breadth 0.34 mm. Other specimens range in length from 0.36 to 2.08 mm.

Remarks.—The type of this species (from the Middle Lias of France) had only two chambers and a single basal spine (like the specimen of fig. 4). *Cristellaria (Astacolus) basidentata* Franke is similar but had more than one spine, his types being close to the specimens here shown in figs. 3 and 8. Some specimens of *Marginulina reversa* Blake are similar, but the chambers are lower, there is a better defined coil and there are no basal spines. *Dentalina tortilis* Franke has smooth rounded chambers and a basal spine, as in the present species, but is smaller in length and diameter, more tapering, with a more elongate proloculus and somewhat higher chambers.

Types and occurrence.—Hypotype of fig. 9 (USNM P503) and unfigured hypotype (USNM P504) from a core (Lower Toarcian) at 1,979–1,999 feet; unfigured hypotype (USNM P505) from a core at 2,068–2,078 feet, hypotypes of figs. 5–7 and 10 (USNM P506a–d) and unfigured hypotypes (USNM P507) from a core at 2,099–2,109 feet, hypotypes of figs. 1–4 (USNM P508a–d) and unfigured hypotypes (USNM P509) from a core at 2,109–2,119 feet, hypotype of fig. 8 (USNM P510) and unfigured hypotypes (USNM P511 from a

core at 2,130–2,140 feet, all from the Upper Pliensbachian; and unfigured hypotype (USNM P512) from a core (Lower Lias) at 2,300–2,320 feet; all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured hypotype (USNM P513) from a core at 6,173–6,183 feet in the Kingak shale of Early Jurassic age in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson, in northern Alaska.

Genus MARGINULINOPSIS Silvestri, 1904

Marginulinopsis phragmites Loeblich and Tappan

Plate 17, figure 18

Marginulina cf. *lacunata* (Terquem) Sandidge, 1933 (not *Cristellaria lacunata* Terquem, 1870), Am. Midland Nat., v. 14, p. 180, pl. 1, figs. 6–8.

Marginulina cf. *lacunata* (Terquem and Berthelin) Wickenden, 1933 (not *Cristellaria lacunata* Terquem and Berthelin, 1875), Trans. Roy. Soc. Canada, 3rd ser., sec. 4, v. 27, p. 162, pl. 1, fig. 12.

Marginulina cf. *sparsa* (Terquem and Berthelin) Wickenden, 1933 (not *Cristellaria sparsa* Terquem and Berthelin, 1875), Ibid., p. 161, pl. 1, fig. 14.

Marginulinopsis phragmites Loeblich and Tappan, 1950, Jour. Wash. Acad. Sci., v. 40, no. 1, p. 9, pl. 1, figs. 22–23b, text fig. 1.

Test free, elongate, robust, early portion planispiral, later uncoiled, rounded to slightly flattened in section; chambers increasing in size as added, about twice as broad as high; sutures radiate and nearly straight in the coil, slightly curved in the later portion and becoming more nearly horizontal, obscured by the longitudinal costae; wall calcareous, surface ornamented with 10 to 12 strongly elevated and continuous costae; aperture radiate, produced on a short neck at the dorsal angle, although the dorsal angle is broken from the hypotype here figured.

Length of hypotype of fig. 18, 0.39 mm, breadth 0.21 mm. Other hypotypes range in length from 0.29 to 0.36 mm.

Remarks.—This species differs from the Lias species *Cristellaria sparsa* Terquem and Berthelin in being less elongate, with higher chambers and fewer ribs.

Marginulinopsis phragmites differs from *Cristellaria lacunata* Terquem and Berthelin, 1875, in being smaller, and in having higher chambers and more numerous ribs. Terquem and Berthelin's name was preoccupied by *Cristellaria lacunata* Terquem, 1870, which is a distinct form from the Middle Jurassic.

Types and occurrence.—Figured hypotype (USNM P787) and unfigured hypotypes (USNM P788) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in northern Alaska.

Genus SARACENARIA Defrance, 1824

Saracenaria oxfordiana Tappan, new name

Plate 26, figure 27

Cristellaria triquetra Gümbel, 1862 (not *Cristellaria triquetra* Gümbel, 1861), Jahrh. Württemberg Naturw., v. 18, p. 225, pl. 3, figs. 28a–c; Macfadyen, 1935, Geol. and Paleon. Brit. Somaliland, pt. 2, p. 16, pl. 1, figs. 19a–b.

Test free, early portion planispiral, later uncoiling and with a triangular cross section, peripheral keel and margins of the apertural face acute and elevated; about 7 chambers in the coil, followed by 4 to 5 uncoiled and triangular chambers, all showing a gradual increase in size as added, comparatively low and broad; sutures distinct, slightly depressed, gently curved; wall calcareous, surface smooth; apertural portion broken from the Alaskan hypotype, but the species was originally described as having a rounded aperture, somewhat produced at the dorsal angle.

Length of figured hypotype 0.49 mm, greatest breadth of coil 0.23 mm, greatest breadth of last chamber 0.31 mm, thickness of face 0.21 mm.

Remarks.—The Alaskan specimen is very similar to the type of *Cristellaria triquetra* Gümbel, 1862, from the German Lower Oxfordian, in general appearance, small coil and elevated margins, but is about one-half as large. The Alaskan specimen has one less uncoiled chamber, and the last one present is broken, so that it would have been more nearly equal in size if complete and at an equal stage of development. Macfadyen's specimen from British Somaliland is approximately the same size as that from Alaska. Gümbel preoccupied his specific name for this form by using it the previous year for an Eocene form. Hence, his Jurassic species requires a new name and *Saracenaria oxfordiana* Tappan, new name is here proposed.

Types and occurrence.—Figured hypotype (USNM P786) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in northern Alaska.

Saracenaria phaedra Tappan, n. sp.

Plate 26, figure 22

Test free, elongate, early portion faintly coiled, later becoming uniserial, with chambers highest at the dorsal margin and triangular in section, margins carinate; chambers low and broad, 10 in the holotype, increasing more rapidly in breadth than in height; sutures distinct, slightly curved, moderately depressed; wall calcareous, surface smooth; aperture at the dorsal angle, tiny and rounded.

Length of holotype 0.55 mm, greatest breadth 0.26 mm, breadth of apertural face 0.23 mm.

Remarks.—This species lacks the distinct coil of the associated species *Saracenaria topagorukensis* and *S. oxfordiana*, the chambers are lower and the sutures less curved. The test is more like a triangular *Astacolus* than a triangular *Lenticulina*. Only a single specimen has been found.

Type and occurrence.—Holotype (USNM P785) from Upper Jurassic rocks in a core at 7,042–7,052 feet in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in northern Alaska.

Saracenaria segmentata Tappan, n. sp.

Plate 26, figures 23–25

Test free, early portion coiled, later uncoiling and with a triangular cross section, margins strongly keeled; 8 to 9 chambers, increasing gradually in size as added from the rounded proloculus; sutures curved, strongly oblique in the uncoiled portion, thickened but not raised; wall calcareous, hyaline, surface smooth except for the strong flangelike keels at the angles of the test; aperture at the dorsal angle, but as all of the specimens observed have this angle broken, it is uncertain whether the aperture is rounded or radiate.

Length of holotype (fig. 25) 0.60 mm, breadth of side 0.26 mm, breadth of apertural face 0.23 mm; length of paratype of fig. 23, 0.75 mm, and length of paratype of fig. 24, 0.62 mm.

Remarks.—This species is similar to *S. alata-angularis* Franke, from the German Lias, in size, number of chambers and prominent keels, but has a less well-developed coil. The present species has a comparatively large and globular proloculus, and a more uncoiled later portion.

S. segmentata, n. sp. also resembles *Cristellaria cornucopiae* Schwager of Brückmann, 1904 and *Saracenaria cornucopiae* (Schwager) of Paalzow, 1932, but Schwager's type is smaller, more slender, more compressed and has less prominent keels.

Types and occurrence.—Holotype of fig. 25 (USNM P517) and paratypes of figs. 23–24 (USNM P518a–b) from a core (Sinemurian) at 2,478–2,496 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Saracenaria topagorukensis Tappan, n sp.

Plate 26, figure 26

Test free, planispiral and involute, early portion more closely coiled than later chambers, periphery with a slight keel; 8 to 9 chambers visible in the final whorl, triangular in section, inflated at the angles of the apertural face, and this inflation remains as a ridge just below each suture, giving a false impression of elevated and thickened sutures; sutures distinct, slightly depressed, gently curved, convex toward the aperture; wall calcareous, surface smooth, except for the ridge-like elevation of the chambers subjacent to the sutures; aperture radiate, at the dorsal angle, slightly produced.

Length of holotype 0.57 mm, breadth of coil 0.29 mm, breadth of final chamber 0.31 mm. Paratypes range in length from 0.29 to 0.68 mm.

Remarks.—This species resembles the type of *Cristellaria lithuanica* Brückmann, 1904, but differs in lacking the definitely incised sutures and in being only about one-half as large as the German species. *S. topagorukensis* differs from the associated *S. oxfordiana* in having a comparatively larger coil, and in the inflation of the chambers subjacent to the sutures.

Types and occurrence.—Holotype (USNM P782) and unfigured paratypes (USNM P783) from the Upper Jurassic rocks, in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in northern Alaska.

Genus DENTALINA d'Orbigny

Dentalina bartensteini Tappan, n. name

Plate 21, fig. 28

Dentalina sublinearis Franke, 1936 (not *Dentalina sublinearis* Schwager, 1865), Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 31, pl. 2, fig. 24; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 140.

Test free, elongate, rectilinear; with four to six inflated chambers increasing gradually in diameter from the rounded base, but increasing more rapidly in height; sutures distinct, depressed, oblique; wall calcareous, surface smooth; aperture at the end of a short neck, radiate.

Length of figured hypotype 0.70 mm, breadth 0.21 mm. Other specimens range in length from 0.42 to 1.30 mm.

Remarks.—This species differs from the associated *D. tortilis* Franke in the absence of a basal spine. Franke's type was from the middle Lias of Germany. However, his name was preoccupied by *D. sublinearis* Schwager, 1865, an Upper Jurassic (Oxfordian) species from Germany. The present species is here renamed in honor of Dr. Helmut Bartenstein, in recognition of his excellent work on the German Jurassic Foraminifera.

Types and occurrence.—Unfigured hypotype (USNM P616) from a core (Lower Toarcian) at 2,028–2,048 feet; unfigured hypotypes (USNM P617) from a core at 2,109–2,119 feet, hypotype of fig. 28 (USNM P618) and unfigured hypotypes (USNM P619) from a core

at 2,130–2,140 feet, unfigured hypotype (USNM P620) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P621) from a core at 2,150–2,170 feet, all of Late Pliensbachian age; and unfigured hypotypes (USNM P622) from a core (Sinemurian) at 2,478-2,496 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Dentalina clivosa (Franke)

Plate 23, figures 14–15

Vaginulina clivosa Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 86, pl. 8, fig. 42.

Test free, elongate, arcuate, sub-triangular in section and with keeled margins; chambers few, as many as 6, increasing slowly in size as added, final chamber somewhat produced apically; sutures distinct, oblique, slightly depressed; wall calcareous, hyaline, with about 5 or 6 longitudinal ribs, three of which form "keels" at the angles; aperture terminal, simple.

Length of hypotype of fig. 14, 0.47 mm, breadth 0.13 mm.

Remarks.—This species differs from the associated *Dentalina tenuistriata* Terquem in having fewer ribs and a narrower test.

Types and occurrence.—Hypotype of fig. 14 (USNM P597), from a core (Lower Toarcian) at 2,028–2,048 feet, and hypotype of fig. 15 (USNM P598) from a core (Upper Pliensbachian) at 2,099–2,109 feet, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Dentalina ectadia Loeblich and Tappan

Plate 21, figure 11

Dentalina ectadia Loeblich and Tappan, 1950, Jour. Paleontology, v. 24, no. 1, p. 47, pl. 13, figs. 3–5.

Test free, elongate, small; chambers few, of nearly equal breadth and height, with final chamber somewhat more elongate; sutures distinct, slightly constricted, oblique; wall calcareous, surface smooth; aperture terminal, but apertural extremity broken from the only Alaskan specimen.

Length of figured hypotype 0.70 mm, breadth 0.18 mm.

Remarks.—This specimen is close to the types from the Redwater shale member of the Sundance formation (Upper Jurassic) of South Dakota, although not as large, nor with as many chambers. As it is otherwise similar, and as only a single specimen was found, it is throught probable that it represents the same species, but a juvenile form.

Type and occurrence.—Hypotype (USNM P794) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30′ N., long 155°53′36″ W., in the Arctic Coastal Plain, in northern Alaska.

Dentalina exilis Franke

Plate 23, figures 5–7

Dentalina exilis Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 31, pl. 2, fig. 25; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 139, pl. 2B, fig. 24.

Test free, narrow, elongate, arcuate; five or more chambers which are subcylindrical or slightly inflated centrally, increasing very little in size as added, of approximately equal height and breadth, final chamber somewhat produced at the apertural end; sutures distinct, straight, horizontal, slightly constricted; wall calcareous, surface smooth; aperture terminal, radiate.

Length of hypotype of fig. 5, 0.55 mm, breadth 0.10 mm; length of hypotype of fig. 6, 0.99 mm, breadth 0.18 mm; length of hypotype of fig. 7, 0.52 mm, breadth 0.13 mm.

Remarks.—This species is similar in size to *Dentalina sinemuriensis* Terquem, 1866, from the French Lias, and in the subcylindrical to slightly inflated chambers which increase rapidly in height but very little in diameter. However, the specimens of *D. sinemuriensis* figured by Terquem and Berthelin, in 1875, are more tapered and the chambers more inflated and not as high, hence the two species are not considered synonymous.

Types and occurrence.—Hypotype of fig. 7 (USNM P599) from a core at 2,099–2,109 feet, and hypotypes of figs. 5–6 (USNM P600a–b) from a core at 2,130–2,140 feet, all of Late Pliensbachian age, in the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Dentalina pseudocommunis Franke

Plate 21, figures 29–33

Dentalina communis (d'Orbigny) Blake, 1876 (not *Nodosaria* (*Dentaline*) *communis* d'Orbigny, 1826), in Tate and Blake, The Yorkshire Lias, pt. 2, p. 457, pl. 18, fig. 19; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 136, pl. 1A, fig. 6, pl. 1B, figs. 14–15, pl. 2A, fig. 5, pl. 2B, figs. 9–10, pl. 3, fig. 8, pl. 4, figs. 23a–b, pl. 5, fig. 13, pl. 6, fig. 10; Macfadyen, 1941, Philos. Trans. Roy. Soc. London, ser. B, no. 576, v. 231, p. 39, pl. 2, fig. 34.

Dentalina pseudocommunis Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, v. 169, p. 30, pl. 2, figs. 20a–b; Barnard, 1950, Quart. Jour. Geol. Soc. London, v. 105, pt. 3, p. 364, fig. 5k; Barnard, 1950, Ibid., v. 106, pt. 1, p. 19, pl. 3, figs. 6, 7, text figs. 11a–b.

Dentalina subsiliqua Franke, Bartenstein and Brand, 1937 (not Franke, 1936), Abh. Senckenberg. Naturf. Gesell., v. 439, p. 136, pl. 1A, fig. 5, pl. 2A, fig. 6, pl. 3, fig. 7, pl. 4, fig. 22, pl. 5, fig. 11.

Dentalina vetustissima d'Orbigny, Bartenstein and Brand, 1937 (not d'Orbigny, 1849), Abh. Senckenberg. Naturf. Gesell., v. 439, p. 137, pl. 4, fig. 25, pl. 5, fig. 12.

Enantiodentalina pseudocommunis (Franke) Payard, 1947, Foram. Lias Supérieur, p. 178, pl. 2, fig. 38.

Test free, narrow, elongate, arcuate, rounded in cross section; chambers increasing gradually in size from the ovate apiculate proloculus, increasing most rapidly in height, so that early chambers are low and broad and later ones comparatively high and elongate; sutures distinct, slightly oblique, later ones more nearly horizontal; wall calcareous, hyaline, surface smoothb; aperture terminal, radiate.

Length of hypotype of fig. 30, 1.14 mm, breadth 0.18 mm; length of hypotype of fig. 31, 0.96 mm, breadth 0.16 mm; length of hypotype of fig. 33, 0.83 mm, breadth 0.21 mm. Other specimens range from 0.26 to 1.22 mm in length.

Remarks.—The Alaskan specimens are similar to Franke's types. Barnard (1950b) figured two typical specimens (text figs. 11a, b) and two atypical ones (pl. 3, figs. 6, 7). In the present writer's opinion the latter may belong to a distinct species, as Barnard's fig. 7 shows a specimen with more horizontal and much more constricted sutures than is characteristic of *D. pseudocommunis*. Specimens referred by Bartenstein and Brand to *D. subsiliqua* Franke and *D. vetustissima* d'Orbigny are very like the present species, and have more oblique sutures and a more apiculate base than the types of these species described by Franke and d'Orbigny, respectively.

Types and occurrence.—Unfigured hypotypes (USNM P601) from a core at 1,999–2,018 feet, hypotype of fig. 31 (USNM P602) and unfigured hypotypes (USNM P603) from a core at 2,028–2,048 feet, all of Lower Toarcian age; unfigured specimens (USNM P605) from a core at 2,068–2,078 feet, unfigured hypotypes (USNM P606) from a core at 2,099–2,109 feet, unfigured hypotypes (USNM P607) from a core at 2,109–2,119 feet, hypotype of fig. 33 (USNM P608) and unfigured hypotypes (USNM P609) from a core at 2,130–2,140 feet, hypotypes of figs. 29–30 (USNM P610a–b) and unfigured hypotypes (USNM P611) from a core at 2,140–2,150 feet, hypotype of fig. 32 (USNM P612) and unfigured hypotypes (USNM P613) from a core at 2,150–2,170 feet, unfigured hypotypes (USNM P614) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; and unfigured hypotypes (USNM P615) from a core (Lower Lias) at 2,231–2,251 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Dentalina subtenuicollis Franke

Plate 21, figures 26–27

Dentalina subtenuicollis Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 32, pl. 2, figs. 29a–b.

Test free, elongate, robust, enlarging very slightly from the rounded base; chambers 5 to 7 in number, increasing gradually in size as added, early chambers low, later ones of nearly equal height and breadth; sutures distinct, nearly horizontal, slightly constricted; wall calcareous, surface smooth; aperture terminal, radiate, somewhat produced at the outer margin.

Length of hypotype of fig. 26, 0.86 mm, breadth 0.23 mm.

Remarks.—Franke's types were somewhat better developed than the Alaskan specimens, but the latter are well within the size limits as given by Franke.

Types and occurrence.—Hypotype of fig. 27 (USNM P623) and unfigured hypotype (USNM P624) from a core (Lower Toarcian) at 1,979–1,999 feet, and hypotype of fig. 26 (USNM P625) from a core (Upper Pliensbachian) at 2,130–2,140 feet, all from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Dentalina tenuistriata Terquem

Plate 23, figures 8–13

Dentalina tenuistriata Terquem, 1866, Cinquième Mém. Foram. Lias Moselle, Metz, p. 405, pl. 15, figs. 5a–c; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 35, pl. 3, figs. 7a–c; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 141, pl. 4, figs. 29a–c, pl. 5, fig. 37; Wicher, 1938, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 193, pl. 18, figs. 11, 12.

Test free, elongate, tapering to the apiculate base; chambers increasing gradually in size as added, low and broad in the early portion, later chambers much higher, final chamber elongate-ovate; sutures distinct, depressed, slightly oblique; wall calcareous, hyaline, ornamented with numerous fine longitudinal ribs which may die out at the terminal portion of the final chamber; aperture at the end of a short neck on the ventral margin, radiate.

Length of hypotype of fig. 8, 0.83 mm, breadth 0.21 mm, thickness 0.18 mm; length of hypotype of fig. 10, 0.57 mm, breadth 0.13 mm; length of hypotype of fig. 11, 0.52 mm, breadth 0.16 mm; length of single chamber of fig. 13, 0.65 mm, breadth 0.29 mm.

Remarks.—Tests of this rather fragile species are often broken in the preparation of the material for study. Occasional very large chambers are found

(fig. 13) which probably represent the adult stage of the microspheric test, which flares more rapidly (fig. 8) than does the megalospheric form (fig. 10).

Types and occurrence.—Unfigured hypotype (USNM P626) from a core at 1,979–1,999 feet, specimen of fig. 8 (USNM P627) from a core at 1,999–2,018 feet, unfigured hypotypes (USNM P628) from a core at 2,028–2,033 feet, hypotype of fig. 9 (USNM P629) and unfigured hypotypes (USNM P630) from a core at 2,028–2,048 feet, all of Early Toarcian age; unfigured hypotypes (USNM P631) from a core at 2,068–2,078 feet, hypotypes of figs. 10–13 (USNM P632a–d) and unfigured hypotypes (USNM P633) from a core at 2,109–2,119 feet, all from the Upper Pliensbachian; in the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Dentalina terquemi d'Orbigny

Plate 23, figures 1–4

Dentalina terquiemi d'Orbigny, 1850, Prodrome Paléon. stratig. universelle, v. 1, p. 242.

Vaginulina hausmanni Bornemann, 1854, Über Liasformation Umgegend Göttingen, p. 38, pl. 3, fig. 25.

Dentalina terquemi d'Orbigny, Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 28, pl. 2, fig. 17; Macfadyen, 1936, Jour. Roy. Micros. Soc. London, ser. 3, v. 56, p. 149, pl. 1, fig. 257; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 138, pl. 2A, fig. 8, pl. 4, figs. 26a–c, pl. 5, fig. 64; Wicher, 1938, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 193, pl. 17, figs. 2, 4; Barnard, 1950, Quart. Jour. Geol. Soc. London, v. 106, pt. 1, p. 22, text fig. 14.

Dentalina hausmanni (Bornemann) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 29, pl. 2, figs. 15a–b.

Test free, elongate, arcuate, somewhat flattened; early chambers low and broad, oblique, later chambers higher and more rounded in section; sutures distinct, oblique, straight to slightly curved; wall calcareous, surface smooth; aperture at the dorsal angle, radiate.

Length of hypotype of fig. 1, 0.73 mm, breadth 0.18 mm; length of hypotype of fig. 2, 1.17 mm, breadth 0.21 mm; length of hypotype of fig. 3, 1.46 mm. Other specimens range from 0.39 to 1.17 mm in length.

Remarks.—This species is characterized by its robust form and by the low conical proloculus.

Types and occurrence.—Unfigured specimens (USNM P634) from a core at 2,028–2,048 feet, unfigured hypotype (USNM P635) from a core at 2,033–2,038 feet, all of Early Toarcian age; unfigured hypotype (USNM P636) from a core at 2,099–2,109 feet, hypotypes of figs. 2, 3 (USNM P637a–b) and unfigured hypotypes (USNM P638) from a core at 2,109–2,119 feet, hypotypes of figs. 1 and 4 (USNM P639a–b) and unfigured hypotypes (USNM P640) from a core at 2,130–2,140 feet, unfigured hypotypes (USNM P641) from a core at 2,140–2,150 feet, and unfigured hypotypes (USNM P642) from a core at 2,150–2,170 feet, all from the Upper Pliensbachian; in the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Dentalina tortilis Franke

Plate 21, figures 23–25

Dentalina tortilis Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge no. 169, p. 29, pl. 2, figs. 19a–b; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 138.

Test free, elongate, tapering; proloculus ovate, with a somewhat eccentric basal spine, which is nearest to the outer margin of the arcuate test, followed by 3 to 5 additional chambers of somewhat greater breadth than height, later chambers slightly inflated, especially at the dorsal margin, final chamber comparatively high and inflated; sutures distinct, flush or slightly constricted, straight and horizontal or a little oblique; wall calcareous, surface smooth; aperture radiate, on a short neck at the inner margin of the test.

Length of hypotype of fig. 24, 0.62 mm, greatest breadth 0.18 mm, length of hypotype of fig. 25, 0.78 mm, greatest breadth 0.23 mm. Other specimens range from 0.42 to 0.70 mm in length.

Remarks.—This small species has more elongate chambers than does *Marginulina utricula* Terquem and Berthelin, and an ovate rather than globular proloculus. Only a single apical spine is found on this species.

Types and occurrence.—Hypotypes of figs. 23 and 25 (USNM P643a–b) and unfigured hypotypes (USNM P644) from a core at 2,109–2,119 feet, and hypotype of fig. 24 (USNM P645), and unfigured hypotypes (USNM P646) from a core at 2,140–2,150 feet, all of Late Pliensbachian age; from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus NODOSARIA Lamarck, 1812

Nodosaria apheilolocula Tappan, new name

Plate 24, figures 6–7

Nodosaria incerta Terquem and Berthelin, 1875 (not *N. incerta* Neugeboren, 1856, and not *N. incerta* O. Silvestri, 1872), Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 18, pl. 1, fig. 15.

Nodosaria hirsuta d'Orbigny, Bartenstein and Brand, 1937 (not *Nodosaria* (*Nodosaire*) *hirsuta* d'Orbigny, 1826), Abh. Senckenberg. Naturf., no. 439, p. 145, pl. 4, figs. 39a–b, pl. 5, fig. 26.

Tests generally consisting of isolated globular chambers, with broken necks at each end, showing them to be only portions of a fragile, elongate, multilocular

species, composed of globular to ovate chambers with very slender connecting necks; wall calcareous, finely hispid; aperture at the end of a neck, rounded.

Length of chamber of hypotype shown in fig. 6, 0.39 mm, breadth 0.23 mm; length of hypotype of fig. 7, 0.21 mm, breadth 0.16 mm.

Remarks.—This species was described by Terquem and Berthelin as *Nodosaria incerta*, which was a double homonym, being preoccupied both by *N. incerta* Neugeboren, 1856 and *N. incerta* O. Silvestri, 1872. The species was referred to *N. hirsuta* d'Orbigny by Bartenstein and Brand, but differs from this Recent species in being more finely hispid, and in having more blunt spines and a thicker and smoother neck.

Types and occurrence.—Hypotype of fig. 6 (USNM P520) from a core at 2,130–2,140 feet, and hypotype of fig. 7 (USNM P519) from a core at 2,150–2,170 feet, both from the Upper Pliensbachian part of the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Nodosaria berthelini Tappan, n. sp.

Plate 25, figures 13–16

Dentalina paucicosta Terquem, Terquem and Berthelin, 1875 (not Terquem, 1866), Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 31, pl. 2, figs. 18a–f.

Glandulina paucicosta Römer, Blake, 1876 (part; not Römer, 1841), in Tate and Blake, The Yorkshire Lias, pt. 2, p. 455, pl. 19, fig. 1a (not pl. 18, fig. 13 and not pl. 19, fig. 1).

Test free, narrow, elongate, microspheric form tapering at the base, megalospheric form nearly cylindrical; early chambers low, very slightly inflated, final chamber higher, 4 to 8 in megalospheric tests, as many as 10 in the microspheric form, proloculus with an elongate basal spine (figs. 15, 16); sutures indistinct, obscured by the longitudinal ribs, but may be seen as dark lines on some specimens, and are discernible on others when dampened; sutures straight and horizontal, not depressed; wall calcareous, hyaline, surface ornamented by 5 to 7 low and thick longitudinal ribs, which are continuous across the sutures, but die out at the terminal portion of the final chamber; aperture terminal, rounded, at the end of a short protruberance on the final chamber.

Length of holotype in fig. 16, 0.60 mm, breadth 0.18 mm; length of paratype of fig. 13, 0.62 mm, breadth 0.21 mm. Other specimens range from 0.31 to 0.94 mm in length.

Remarks.—This species is apparently identical with that figured by Terquem and Berthelin in 1875 as *Dentalina paucicosta* Terquem, for it is regularly conical or cylindrical, with a central aperture and about 8 ribs. Terquem's species is a true *Dentalina*, however, arcuate, more slender, much larger and with only 6 ribs. The specimen Franke (1936) referred to *D. paucicosta* is distinct both from Terquem's species and the present one, being thicker, with as many as 14 ribs and may belong to *D. sculpta* Terquem.

Blake (1876) figured a specimen belonging to the present species, including it with "*Glandulina paucicosta* Römer", although he stated (p. 455), "Pl. XIX, fig. 1a, doubtfully belongs here. It may be *Dentalina cuneiformis* Terquem." However, it differs from *Dentalina cuneiformis* in the straight sides, fewer ribs, and in being smooth at the apertural end of the final chamber. Blake's specimen was from the *planorbis* zone of the Lower Lias, in England.

Types and occurrence.—Unfigured paratypes (USNM P521) from a core at 2,109–2,119 feet, unfigured paratypes (USNM P522) from a core at 2,130–2,140 feet, unfigured paratypes (USNM P523) from a core at 2,140–2,150 feet, holotype (fig. 16) (USNM P524) and paratypes of figs. 13–15 (USNM P525a–c) and unfigured paratypes (USNM P526) from a core at 2,150–2,170 feet, and unfigured paratypes (USNM P527) from a core at 2,170–2,179 feet, all of Late Pliensbachian age, from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Nodosaria candela Franke

Plate 26, figure 6

Nodosaria candela Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 42, pl. 4, fig. 1.

Test free, elongate, narrow; consisting of approximately 6 subcylindrical rectilinear chambers of nearly equal breadth and height, slightly lower in the early portion of the test, and final chamber about 1½ times as high as broad; sutures distinct, flush, horizontal; wall calcareous, surface smooth; aperture terminal, broken on the only hypotype found.

Length of figured hypotype 1.07 mm, breadth 0.23 mm.

Remarks.—This species is characterized by the slender, elongate and cylindrical test and produced final chamber.

Type and occurrence. Hypotype (USNM P528) from a core (Sinemurian) at 2,468–2,478 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Nodosaria detruncata Schwager

Plate 26, figures 19–20

Nodosaria detruncata Schwager, 1867, Geogn. -Paläont. Beiträge v. Bennecke, v. 1, no. 3, p. 656, pl. 34, fig. 7; Paalzow, 1932, Jahresheft. Ver. Vaterl. Naturk. Wurttemberg, Jahrg. 88, p. 120, pl. 8, fig. 18.

Test free, small, elongate, consisting of a rectilinear series of 2 to 6 rounded chambers; chambers increasing gradually in size from the rounded base, early chambers comparatively low, later ones more globular; sutures distinct, horizontal, straight and constricted; wall calcareous, surface smooth; aperture terminal, rounded.

Length of hypotype of fig. 19, 0.47 mm, breadth 0.21 mm; length of hypotype of fig. 20, 0.57 mm, breadth 0.18 mm. Length of unfigured hypotype 0.36 mm.

Remarks.—Schwager's type is 0.42 mm in length and is similar to the specimen shown here in fig. 20. It was from the Dogger (middle Jurassic) of Switzerland, in the *Ammonites sowerbyi* zone. Paalzow recorded a single specimen, about 1 mm in length, from the *transversarius* beds, which showed an early tapered stage like that of the specimen here shown in fig. 20, and the later chambers more globular, like those of the specimen of fig. 19.

This species is similar to the Lower Lias *Nodosaria primitiva* Kübler and Zwingli, but is about three times as large. It differs from *Nodosaria osynkiensis* Myatliuk, from the Russian Upper Jurassic series, in being shorter and broader, and in lacking a pointed, spine-like basal chamber.

Types and occurrence.—Figured hypotypes (USNM P586a–b) and unfigured hypotype (USNM P587) from Upper Jurassic rocks at approximately lat 68°24′ N., long 150°55′ W., on the west bank of Welcome Creek, about 6 miles upstream from its confluence with Kanayut River, in the foothills of the Brooks Range, in northern Alaska. Collected by William W. Patton, 1950.

Nodosaria mitis (Terquem and Berthelin)

Plate 24, figures 11–18

Dentalina mitis Terquem and Berthelin, 1875, Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 28, pl. 2, figs. 9a–c.

Dentalina oculina Terquem and Berthelin, 1875, Ibid., p. 31, pl. 2, figs. 20a–c.

Nodosaria mitis (Terquem and Berthelin) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 45, pl. 4, fig. 11a; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 145, pl. 2A, fig. 9, pl. 2B, fig. 13, pl. 3, fig. 18, pl. 4, fig. 36, pl. 5, fig. 24.

Nodosaria mitis (Terquem and Berthelin) f. *juvensis* Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 46, pl. 4, fig. 11b.

Nodosaria oculina (Terquem and Berthelin) Franke, 1936, Ibid., p. 49, pl. 4, fig. 21; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 147, pl. 3, fig. 19, pl. 5, fig. 25; Payard, 1947, Foram. Lias Supérieur Détroit Poitevin, p. 170, pl. 2, figs. 17–18.

Nodosaria oculina (Terquem and Berthelin) forma a. Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 147, pl. 8, fig. 14.

Test narrow and elongate, tapering slightly; consisting of a series of 2 to 8 chambers which increase very little in size as added, somewhat greater in breadth than height, and slightly inflated centrally, proloculus with a short basal spine; sutures distinct, represented by a dark line, horizontal; wall calcareous, hyaline, ornamented with 8 to 9 longitudinal, narrow, and flange-like ribs, which are continuous across chambers and sutures; aperture terminal, radiate, on a short neck.

Length of hypotype of fig. 11, 0.42 mm; length of hypotype of fig. 16, 1.20 mm, breadth 0.39 mm; length of hypotype of fig. 17, 1.14 mm. Other specimens are from 0.29 to 1.66 mm in length.

Remarks.—This species was originally described as belonging to *Dentalina* and a few specimens occur which have a slightly curved axis, but the species is placed in *Nodosaria* as the specimens are most frequently typically nodosarian in character.

This species well illustrates the great confusion in the nomenclature of the Jurassic Nodosariidae. The species *Dentalina mitis* and *Dentalina oculina* were described by Terquem and Berthelin from the same horizon, and were apparently separated on the degree of chamber inflation. Franke (1936) recognized both species, although placing them in the genus *Nodosaria*, and described *Nodosaria mitis* (Terquem and Berthelin) f. *juvensis* Franke, for a single young specimen of three chambers. He also placed *Dentalina vermicularis* Terquem as *Nodosaria oculina* (Terquem and Berthelin) f. *vermicularis* (Terquem).

Bartenstein and Brand (1937) recognized *Nodosaria mitis* and *N. oculina* but placed *Dentalina vermicularis* Terquem, and Franke's *N. oculina* f. *vermicularis* with *Dentalina oculina* Terquem and Berthelin (part, fig. 20b) in *N. oculina* (Terquem and Berthelin) forma *a* Bartenstein and Brand. They also erected *N. infraoolithica* as a new species, transitional with *N. oculina*, but with more numerous and very thin ribs, but gave no further description, illustrations nor measurements for this new form.

Macfadyen (1941, p. 43) placed *Dentalina mitis* (Terquem and Berthelin) (pl. 2, fig. 9b only) and *N. mitis* of Franke, and of Bartenstein and Brand in *Nodosaria fontanessi* (Berthelin), stating

> It seems impossible to be certain of the valid name for the Lias form. Berthelin states that a form similar to *N. fontanessi* occurs in the Lias, but he does not name it, and *N. fontanessi* is the first description and figure that seem satisfactory. Terquem and Berthelin's *Dentalina mitis* is not a satisfactory type for this form, though it has been accepted lately by German authors.

However, *N. fontanessi* (Berthelin) is an Albian (lower Cretaceous) species and has itself been placed in the synonomy of *Nodosaria obscura* Reuss by the present writer (Tappan, 1940, p. 104).

Payard (1947) placed *Dentalina mitis* Terquem and Berthelin (part) in the synonymy of *Nodosaria oculina*

(Terquem and Berthelin), citing the same Pl. II, fig. 9b of Berthelin, and the references of Franke and Bartenstein and Brand, which Macfadyen had placed in *N. fontanessi*. Payard apparently included the more flaring forms in this species, although he stated that *N. mitis* and *N. oculina* might represent only the microspheric and megalospheric generations of a single species.

The writer considers *Dentalina mitis* and *D. oculina* to be synonyms, and according to the rules of nomenclature, the first used name is the only possible one, regardless of its "suitability." Therefore, the species is known as *Nodosaria mitis* (Terquem and Berthelin). *Nodosaria vermicularis* (Terquem) is a distinct species, being a larger form, with straight ribs and without definite constrictions at the sutures. It also occurs in Alaska. *Nodosaria mitis* differs from the other associated species in the presence of the high flange-like ribs, which are few, and the slightly inflated chambers.

Types and occurrence.—Unfigured hypotypes (USNM P531) from a core (Lower Toarcian) at 2,048–2,068 feet; hypotype of fig. 12 (USNM P532) and unfigured hypotypes (USNM P533) from a core at 2,068–2,078 feet, unfigured hypotypes (USNM P534) from a core at 2,099–2,109 feet, unfigured hypotypes (USNM P535) from a core at 2,109–2,119 feet, hypotypes of figs. 11 and 13 (USNM P536a–b) and unfigured hypotypes (USNM P537) from a core at 2,130–2,140 feet, hypotypes of figs. 14 and 18 (USNM P538a–b) and unfigured hypotypes (USNM P539) from a core at 2,140–2,150 feet, hypotypes of figs. 16 and 17 (USNM P540a–b) and unfigured hypotypes (USNM P541) from a core at 2,150–2,160 feet, hypotype of fig. 15 (USNM P542) and unfigured hypotypes (USNM P543) from a core at 2,170–2,179 feet, and unfigured hypotypes (USNM P544) from a core at 2,179–2,199 feet, all from the Upper Pliensbachian; from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured hypotype (USNM P545) from a core at 5,677–5,692 feet, in the Kingak shale of Early Jurassic age, in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson, in northern Alaska.

Nodosaria pachistika Tappan, n. sp.

Plate 25, figures 10–12

Test free, small, stout, increasing very little in diameter from the rounded base; chambers low and broad, slightly inflated centrally; sutures distinct, slightly constricted, horizontal; wall calcareous, hyaline, surface ornamented with numerous, very low blunt costae, 13 to 24 in number, the increase in number occurring with increase in diameter of the test, as costae are approximately equidistant throughout; aperture terminal, rounded.

Length of holotype (fig. 12) 0.62 mm, breadth 0.23 mm; length of paratype of fig. 10, 0.73 mm, breadth 0.29 mm. Other specimens range from 0.34 to 0.68 mm in length.

Remarks.—This species is closest to *Nodosaria bambergensis* Franke, from the German Lias, but differs in being much broader and more robust, less tapering, and with lower and more numerous chambers. It may also have more ribs.

Types and occurrence.—Unfigured paratypes (USNM P546) from a core (Lower Toarcian) at 2,048–2,068 feet, holotype of fig. 12 (USNM P547), paratype of fig. 11 (USNM P548) and unfigured paratypes (USNM P549) from a core at 2,068–2,078 feet, unfigured paratype (USNM P550) from a core at 2,109–2,119 feet, all from the Upper Pliensbachian; paratype of fig. 10 (USNM P551) and unfigured paratypes (USNM P552) from a core at 2,468–2,478 feet, and unfigured paratype (USNM P553) from a core at 2,478–2,496 feet, from the Sinemurian; all from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Nodosaria phobytica Tappan, n. sp.

Plate 24, figures 8–10

Test free, small, elongate, sides nearly parallel; 4 to 6 broad low chambers, increasing very little in size from the somewhat conical proloculus, chambers very slightly inflated, final chamber somewhat higher and produced at the aperture; sutures flush or a little depressed, straight and horizontal; wall calcareous, hyaline, ornamented with 8 to 14 low and rounded narrow ribs; aperture terminal, radiate, on a very short broad neck.

Length of holotype of fig. 9, 0.44 mm, breadth 0.16 mm; length of paratype of fig. 8, 0.47 mm; length of paratype of fig. 10, 0.70 mm, breadth 0.18 mm. Other specimens range from 0.26 to 0.55 mm in length.

Remarks.—This species differs from *Nodosaria bambergensis* Franke in having lower and more numerous chambers, in being more slender and in having more continuous ribs.

Types and occurrence.—Unfigured paratypes (USNM P554) from a core at 2,109–2,119 feet, holotype of fig. 9 (USNM P555), and paratype of fig. 10 (USNM P556) and unfigured paratypes (USNM P557) from a core at 2,130–2,140 feet, paratype of fig. 8 (USNM P558) and unfigured paratypes (USNM P559) from a core at 2,170–2,179 feet, all of Late Pliensbachian age, all from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Nodosaria prima d'Orbigny

Plate 25, figures 8–9

Nodosaria prima d'Orbigny, 1850, Prodrome de paléon. stratig. universelle, v. 1, p. 241; Terquem, 1858, Mém. Acad. Imp. Metz, ann. 39, (2nd ser., 6th ann.), p. 589, pl. 1, figs. 6a–d; Paalzow, 1932, Jahreshefte Vereins Vaterl. Naturkunde in Württemberg, p. 122, pl. 9, fig. 2; Macfadyen, 1936, Jour. Roy. Micr. Soc. London, ser. 3, v. 56, p. 148, pl. 1, figs. 253a–b; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 45, pl. 4, fig. 9; Bartenstein and Brand, 1937, Abh. Senckenberg Naturf. Gesell., no. 439, p. 145, pl. 5, fig. 36, pl. 14B, fig. 2, pl. 15A, fig. 11, pl. 15C, fig. 3; Payard, 1947, Foram. Lias Supérieur du Détroit Poitevin, p. 164, pl. 2, fig. 9; Barnard, 1950, Quart. Jour. Geol. Soc. London, v. 105, pt. 3, p. 357, text fig. 1h.

Test free, large, robust, elongate, sides nearly parallel; chambers increasing slightly in size as added from the base, later portion nearly cylindrical with chambers slightly inflated centrally; sutures horizontal, reflected in slight constrictions between the chambers; wall calcareous, hyaline, ornamented with about 14 longitudinal costae (fig. 9) to a maximum of 20 ribs (fig. 8), ribs continuous across chambers and sutures, continuing up the neck of the final chamber and forming projections around the aperture; aperture radiate, at the end of a short thick neck.

Length of hypotype of fig. 8, a broken specimen, 2.60 mm, breadth 0.75 mm.

Remarks.—This species is distinguished from all associated forms by its massive appearance, as it is by far the largest species of *Nodosaria* in the Jurassic of Alaska.

Types and occurrence.—Unfigured hypotypes (USNM P560) from a core at 2,099–2,109 feet, unfigured hypotypes (USNM P561) from a core at 2,109–2,119 feet, hypotype of fig. 8 (USNM P562) and unfigured hypotype (USNM P563) from a core at 2,140–2,150 feet, all of Late Pliensbachian age; from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Hypotype of fig. 9 (USNM P564) from cuttings at 5,860–5,870 feet, in the Kingak shale of Early Jurassic age, in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson, in northern Alaska.

Nodosaria radiata (Terquem)

Plate 25, figures 1–5

Dentalina radiata Terquem, 1866, Sixième Mém. Foram. Lias, p. 490, pl. 20, figs. 5a–b.

Nodosaria radiata (Terquem) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 49, pl. 4, fig. 20.

Test free, of medium size, narrow, elongate, tapering; chambers low, increasing in diameter as added, more rapidly in the microspheric form (figs. 1, 3, 5) than in the megalospheric form (fig. 2); sutures distinct, horizontal, visible as a clear dark line across the test, not much constricted; wall calcareous, hyaline, ornamented by thin and flangelike longitudinal ribs, widely spaced, from 5 to 7 in number, and continuous across chambers and sutures, but becoming less prominent near the aperture on the final chamber; aperture terminal, radiate, on a slight neck.

Length of hypotype of fig. 1, 0.70 mm, breadth 0.21 mm; length of hypotype of fig. 2, 1.33 mm, breadth 0.34 mm; length of hypotype of fig. 3, 1.69 mm, breadth 0.42 mm. Other specimens range from 0.70 to 1.22 mm in length.

Remarks.—This species differs from other Alaskan Jurassic species in the low number of high, flangelike ribs. Terquem and Franke distinguished various species and varieties on the basis of the number of ribs, but as this varies in a single specimen (fig. 1), all specimens with a small number of ribs (from 5 to 7) are included here, providing they are alike in other features. It is very probable that *Marginulina excavata* Terquem, *Dentalina paucicosta* Terquem, *D. quadricosta* Terquem *D. quadrilatera* Terquem and *D. quadrilatera* Terquem var. *quinquelatera* Franke, are all synonymous. If a study of the type specimens should show this to be true, *D. quadrilatera* Terquem would have priority. As the writer has seen no specimens possessing only four ribs, the name *radiata* is here used, as it is the earliest similar species having more than four ribs.

Types and occurrence.—Hypotype of fig. 3 (USNM P565) and unfigured hypotypes (USNM P566) from a core at 2,099–2,109 feet, unfigured hypotypes (USNM P567) from a core at 2,109–2,119 feet, hypotypes of figs. 2, 4, and 5 (USNM P568a–c) and unfigured hypotypes (USNM P569) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P570) from a core at 2,150 -2,170 feet, hypotype of fig. 1 (USNM P571) and unfigured hypotype (USNM P572) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Nodosaria regularis Terquem

Plate 26, figures 7–9

Nodosaria regularis Terquem, 1862, Mém. Acad. Imp. Metz, ann. 42 (ser. 2, ann. 9), p. 436, pl. 5, fig. 12; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 41, pl. 3, figs. 19a–b; Bartenstein and Brand, 1937, Abh. Senckenberg Naturf. Gesell., no. 439, p. 144, pl. 11A, figs. 6a–b, pl. 15A, fig. 10; Payard, 1947, Foram. Lias Supérieur Détroit Poitevin, p. 159, pl. 2, figs. 2–3.

Nodosaria germanica Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 41, pl. 3, figs. 18a–b; Bartenstein and Brand, 1937, Abh. Senckenberg Naturf. Gesell., no. 439, p. 143, pl. 5, fig. 66.

Nodosaria crispata Terquem, Franke, 1936 (not Terquem, 1866), Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 41, pl. 3, fig. 20c (not figs. 20a–b).

Test free, elongate, straight or slightly arcuate; chambers elongate, ovate, increasing rapidly in size from the subglobular proloculus which has a long basal spine; sutures distinct, much constricted, so that tests are extremely fragile; wall calcareous, hyaline, surface smooth; aperture terminal, radiate.

Length of hypotype of fig. 7, 0.96 mm, greatest breadth 0.31 mm; length of hypotype of fig. 8, 0.60 mm, breadth 0.18 mm; length of hypotype of fig. 9, 0.55 mm, greatest breadth 0.13 mm.

Remarks.—*Nodosaria regularis* Terquem and *N. germanica* Franke are apparently identical. Franke distinguished them by the degree of constriction between the chambers, but this varies even in a single specimen, and both forms occur together and are the same size, with the typically inflated chambers and apiculate base. The Alaskan specimen of fig. 9 is similar to Franke's *N. germanica*. Part of Franke's *N. crispata* Terquem seems also to belong to *N. regularis*. The specimen he figured on pl. 3, fig. 20c, seems like this species, and differs from those of figs. 20a–b and the typical *N. crispata* in being smooth and in lacking the bulbous neck. *N. crispata* Terquem is probably a *Reophax*, according to Payard, who erected a new species *Nodosaria frankei* Payard, for the hispid calcareous forms referred to *N. crispata* by Franke and by Bartenstein and Brand.

Nodosaria subcalomorpha Franke differs from the present species only in lacking the apical spine, and may belong to the same species.

Nodosaria simplex Terquem and Berthelin, 1875, also from the Middle Lias of France, is similar in the inflated ovate chambers, apiculate proloculus, and much constricted sutures, but apparently has more deeply constricted sutures, with tubular connections between the chambers.

Types and occurrence.—Hypotype of fig. 7 (USNM P573) from a core at 2,140–2,150 feet, hypotypes of figs. 8–9 (USNM P574a–b) and unfigured hypotypes (USNM P575) from a core at 2,150–2,170 feet, and unfigured hypotypes (USNM P576) from a core at 2,170–2,179 feet, all of Late Pliensbachian age, from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Nodosaria setulosa Tappan, n. sp.

Plate 24, figures 1–5

Test free, elongate, straight or arcuate, tapering; 4 to 7 rounded chambers, increasing gradually in size as added, somewhat greater in breadth than height in the early portion, later chambers of greater proportional height; sutures distinct, constricted, horizontal; wall calcareous, surface finely hispid; aperture terminal, rounded.

Length of holotype of fig. 1, 0.81 mm, greatest breadth 0.31 mm; length of paratype of fig. 3, 1.17 mm, breadth 0.29 mm; length of paratype of fig. 4, 0.55 mm, breadth 0.29 mm; length of paratype of fig. 5, 0.57 mm, breadth 0.21 mm.

Remarks.—This species differs from *Nodosaria aspera* Terquem and Berthelin from the middle Lias of France, in the more flared test, low and broad early chambers and rapid increase in chamber height, and is about 2 to 4 times as large as the French species. It resembles *Glandulina hybrida* Terquem and Berthelin in general form, but is slightly larger and has a hispid surface. *Glandulina vulgata* Bornemann is also similar in general appearance, but is not hispid.

Types and occurrence.—Unfigured paratype (USNM P577) from a core at 2,068–2,078 feet, unfigured paratype (USNM P578) from a core at 2,099–2,109 feet, paratypes of figs. 2–5 (USNM P579a–d) and unfigured paratypes (USNM P580) from a core at 2,109–2,119 feet, unfigured paratypes (USNM P581) from a core at 2,130–2,140 feet, holotype of fig. 1 (USNM P582) and unfigured paratypes (USNM P583) from a core at 2,140–2,150 feet, unfigured paratypes (USNM P584) from a core at 2,150–2,170 feet, and unfigured paratypes (USNM P585) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Nodosaria vermicularis (Terquem)

Plate 25, figures 6–7

Dentalina vermicularis Terquem, 1866, Sixième Mém. Foram. Lias, p. 483, pl. 19, fig. 21.

not *Nodosaria oculina* (Terquem and Berthelin) f. *vermicularis* (Terquem) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 49, pl. 4, figs. 22a–b.

Test free, large, elongate, robust, sides nearly parallel, somewhat tapered at the base, and sloping sharply to the aperture at the opposite extremity; chambers indistinct, about 5 to 7 in number; sutures indistinct, not depressed, horizontal; wall calcareous, surface ornamented with 7 to 9 high and flangelike continuous ribs, which cross sutures and chambers alike, extending to the border of the aperture and commonly somewhat ragged along the edges because of their fragile nature; aperture terminal, central.

Length of hypotype of fig. 6, 2.44 mm, breadth 0.55 mm.

Remarks.—Terquem's type of this species was 1.36 mm in length and had continuous flangelike ribs with

irregular margins (probably due to breakage, as in the present specimens), and the chambers were not inflated nor the sutures depressed. Franke referred to this species a form only about one-half to one-third as large, with lower ribs, judging from the illustration, and depressed sutures. It is undoubtedly a distinct species.

Types and occurrence.—Hypotype of fig. 6 (USNM P529) from a core at 2,099–2,109 feet, and hypotype of fig. 7 (USNM P530) from a core at 2,109–2,119 feet, both of Late Pliensbachian age, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus RECTOGLANDULINA Loeblich and Tappan, 1955

Loeblich and Tappan (1955) have recently shown that the genus *Pseudoglandulina* Cushman, 1929, is a synonym of *Nodosaria* Lamarck, 1812. The species *Nautilus comatus* Batsch, 1791, selected by Cushman as type species for his genus, was shown by Parker, Jones, and Brady to be a *Nodosaria*, and possibly even conspecific with *Nodosaria raphanus*. Thus *Pseudoglandulina* must be suppressed as a junior synonym of *Nodosaria*. Loeblich and Tappan defined *Rectoglandulina* (type species, *Rectoglandulina appressa* Loeblich and Tappan) to include the uniserial *Glandulina*-like forms, with strongly overlapping chambers, some of which have been known previously as *Pseudoglandulina*.

Rectoglandulina brandi Tappan, n. sp.

Plate 26, figure 12

Test of medium size, robust, enlarging gradually from the broad rounded base; chambers averaging about four, overlapping so that only a narrow portion remains visible of the early chambers, final chamber extending over two-fifths the length of the test; sutures distinct, flush, nearly horizontal; wall calcareous, surface smooth; aperture terminal, radiate.

Length of holotype 0.55 mm, greatest breadth 0.31 mm. Length of unfigured paratypes 0.34 mm and 0.39 mm.

Remarks.—This species is closest to *Glandulina pigmaea* Schwager, 1865, in general proportions, but is much larger (Schwager's specimen is 0.1 mm in length) and has a radiate, rather than elliptical aperture. This species is named in honor of Dr. Erich Brand, in recognition of his work on the German Jurassic Foraminifera.

Types and occurrence.—Holotype (USNM P792) and unfigured paratypes (USNM P793) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, in northern Alaska.

Rectoglandulina multicostata (Bornemann)

Plate 26, figures 14–16

Orthocerina multicostata Bornemann, 1854, Über Liasformation Umgegend Göttingen, p. 35, pl. 3, figs. 14–15.

Glandulina multicostata (Bornemann) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 59, pl. 5, fig. 20.

Nodosaria (Glandulina) multicostata (Bornemann) Wicher, 1938, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 193, pl. 23, figs. 1, 2, 6.

Pseudoglandulina multicostata (Bornemann) Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 151, pl. 3, fig. 42, pl. 4, fig. 28; Barnard, 1950, Quart. Jour. Geol. Soc. London, v. 105, pt. 3, p. 364, fig. 4a.

Test free, short, stout, uniserial; chambers enlarging rapidly from the pointed base to about the mid portion, later chambers of decreasing diameter in the Alaskan specimens, about 5 to 6 chambers present; sutures horizontal, slightly constricted; wall calcareous, surface ornamented by 11 to 12 continuous longitudinal costae which cross the sutures and extend from the base nearly to the aperture, occasionally increasing in number by intercalation; aperture terminal, rounded.

Length of hypotype of fig. 14, 0.62 mm, breadth 0.26 mm; length of hypotype of fig. 15, 0.73 mm, breadth 0.34 mm; length of hypotype of fig. 16, 0.62 mm, breadth 0.31 mm.

Remarks.—*Rectoglandulina multicostata* differs from *R. quinquecostata* (Bornemann) in having more costae and somewhat higher chambers.

Types and occurrence.—Hypotypes of figs. 14–16 (USNM P588a–c) and unfigured hypotypes (USNM P589) from a core (Upper Pliensbachian) at 2,109–2,119 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Rectoglandulina oviformis (Terquem)

Plate 26, figure 13

Glandulina oviformis Terquem, 1864, Mém. Acad. Imp. Metz, ann. 44 (ser. 2, ann. 11) pt. 2, p. 378, pl. 7, figs. 4a–b; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 55, pl. 5, fig. 11.

Pseudoglandulina oviformis (Terquem) Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 149, pl. 4, fig. 40; Barnard, 1950a, Quart. Jour. Geol. Soc. London, vol. 105, pt. 3, p. 365, fig. 6h; Barnard, 1950b, Ibid., v. 106, pt. 1, p. 24, pl. 1, fig. 6.

Test free, short, stout; chambers low, about 5, increasing rapidly in breadth from the conical proloculus, final chamber occupying over one-third the length of the test; sutures distinct, horizontal, flush; wall calcareous, surface smooth; aperture terminal, rounded.

Length of hypotype of fig. 13, 0.44 mm, breadth 0.21 mm. Other specimens range from 0.36 to 0.68 mm in length.

Remarks.—This smooth species is pupiform in outline, with the final chamber of approximately equal height and breadth. Described originally from France, it has also been recorded from England and Germany.

Types and occurrence.—Figured hypotype (USNM P590) and unfigured hypotypes (USNM P591) from a core (Sinemurian) at 2,468–2,478 feet in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Rectoglandulina quinquecostata (Bornemann)

Plate 26, figures 17, 18

Glandulina abbreviata Bornemann, 1854 (not *Glandulina abbreviata* Neugeboren, 1850), Über Liasformation Umgegend Göttingen, p. 33, pl. 2, figs. 10a–b; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 59, pl. 5, figs. 24a–b.

Glandulina quinquecostata Bornemann, 1854, Über Liasformation Umgegend Göttingen, p. 32, pl. 2, fig. 6; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 58, pl. 5, figs. 25–26.

Glandulina sexcostata Bornemann, 1854, Über Liasformation Umgegend Göttingen, p. 32, pl. 2, figs. 7a–b; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 58, pl. 6, figs. 1a–2b.

Glandulina septangularis Bornemann, 1854, Über Liasformation Umgegend Göttingen, p. 33, pl. 2, figs. 8a–b; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 58, pl. 5, figs. 22, 23.

Pseudoglandulina abbreviata (Bornemann) Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 151, pl. 4, fig. 44, pl. 5, fig. 31.

Test free, small, short and broad; composed of 3 to 5 uniserial chambers, final chamber about twice as high as the preceding, proloculus apiculate; sutures obscure, not depressed, straight to slightly arched between the costae; wall calcareous, surface ornamented with 5 to 9 sharp longitudinal costae, which may increase by intercalation after the second chamber, or may extend to the basal spine; aperture terminal, somewhat produced.

Length of hypotype of fig. 17, 0.42 mm, breadth 0.29 mm; length of hypotype of fig. 18, 0.47 mm, breadth 0.34 mm.

Remarks.—*Glandulina abbreviata* Bornemann, 1854, was preoccupied by *Glandulina abbreviata* Neugeboren, 1850. The species was described as having 3 to 4 chambers and 8 to 9 costae, was from 0.5 to 0.6 mm in length, and resembles the specimen here shown in fig. 18. *Glandulina quinquecostata* Bornemann had 5 costae, 3 to 4 chambers and was 0.5 mm in length. *G. sexcostata* Bornemann had 6 costae, 3 to 4 chambers and was 0.5 mm in length. *G. septangularis* Bornemann had 7 costae, 3 to 4 chambers and was 0.5 mm in length, resembling the specimen here shown in fig. 17. Inasmuch as all of these "species" are of about the same size, number of chambers and general outline, and as the number of costae is variable, increasing by intercalation in the development of a single specimen, as shown in fig. 17, the four species of Bornemann are here considered synonymous. *G. quinquecostata* is the first specific name used, and hence must be used for this species, although the number of costae may range between 5 and 9. The specimen here shown in fig. 17 has 9 ribs, that of fig. 18 has 7 ribs. Franke also figured a specimen, referred to *G. septangularis*, which showed an intercalation of costae, like that mentioned above.

Types and occurrence.—Hypotype of fig. 17 (USNM P592) and unfigured hypotype (USNM P593) from a core at 2,109–2,119 feet, hypotype of fig. 18 (USNM P594) from a core at 2,170–2,179 feet, all of Late Pliensbachian age from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Rectoglandulina turbinata (Terquem and Berthelin)

Plate 26, figures 10–11

Glandulina turbinata Terquem and Berthelin, 1875, Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 22, pl. 1, fig. 24; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 56, pl. 5, fig. 18.

Test free, small, rectilinear; early chambers low and cylindrical, increasing very gradually in size as added, final chamber occupying two-fifths to one-half the length of the test, and more inflated than earlier chambers, somewhat produced at the apertural end; sutures distinct, straight, horizontal and flush; wall calcareous, surface smooth; aperture terminal, rounded.

Length of hypotype of fig. 10, 0.31 mm, breadth 0.16 mm; length of hypotype of fig. 11, 0.62 mm, breadth 0.31 mm.

Remarks.—This species is characterized by the low early chambers and high and much inflated final chamber. The types were from the Lias of France and it has also been recorded from Germany.

Types and occurrence.—Hypotype of fig. 10 (USNM P595) from a core (Upper Pliensbachian) at 2,130–2,140 feet, and hypotype of fig. 11 (USNM P596) from a core (Sinemurian) at 2,468–2,478 feet, both from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus LINGULINA d'Orbigny, 1826

Lingulina lanceolata (Haüsler)

Plate 27, figures 5–6

Frondicularia lanceolata Haüsler, 1881, Untersuch. micr. Struct. Aarg. Jurakalke Berück. Foram., p. 18, pl. 2, fig. 3.

Lingulina lanceolata (Haüsler) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, v. 169, p. 62, pl. 6, fig. 10; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 151, pl. 2B, fig. 17.

Test free, narrow, elongate, rectilinear, compressed, ovate in section, lateral margins lobulate, due to constrictions of the sutures; proloculus globular, later chambers equitant, narrow and high; sutures distinct, depressed, strongly arched centrally; wall calcareous, surface smooth and unornamented; aperture terminal, elongate.

Length of hypotype of fig. 5, 0.57 mm, breadth 0.16 mm, thickness 0.10 mm; length of hypotype of fig. 6, 0.62 mm, breadth 0.16 mm, thickness 0.10 mm.

Remarks.—This species differs from *Lingulina micida* Loeblich and Tappan, from the Redwater shale member of the Sundance formation (Oxfordian) of South Dakota, in being larger, somewhat more compressed, and in having relatively higher chambers and more arched sutures. It resembles *Lingulina nodosaria* (Terquem) (not *Frondicularia nodosaria* Ehrenberg, 1854 and not *Frondicularia nodosaria* Kübler and Zwingli, 1866) in the narrow test and high chambers, but lacks the numerous striae of Terquem's species.

Types and occurrence.—Hypotype of fig. 6 (USNM P692) and unfigured hypotypes (USNM P693) from a core at 2,109–2,119 feet, hypotype of fig. 5 (USNM P694) from a core at 2,140–2,150 feet, and unfigured hypotypes (USNM P695) from a core at 2,150–2,170 feet, all of Late Pliensbachian age, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Lingulina polita Tappan, n. sp.

Plate 27, figures 1–2

Test free, narrow, elongate, rectilinear, tapering slightly, somewhat compressed, ovate in section; proloculus ovate, pointed at the base, followed by comparatively narrow equitant chambers, which increase gradually in size as added; sutures distinct, highly arched, thickened; wall calcareous, surface smooth; aperture terminal, elongate.

Length of paratype of fig. 1, 0.86 mm, breadth 0.18 mm, thickness 0.16 mm; length of holotype of fig. 2, 0.68 mm, breadth 0.16 mm, thickness 0.10 mm. Length of unfigured paratype 0.31 mm.

Remarks.—This species is closest to *Lingulina saccula* (Terquem) from the Middle-Lias of France, but differs in being narrower and more tapering but less compressed, and in having a much more lanceolate proloculus and higher later chambers.

Types and occurrence.—Holotype (fig. 2) (USNM P696), paratype of fig. 1 (USNM P697) and unfigured paratype (USNM P698) all from a core (Upper Pliensbachian) at 2,130–2,140 feet, in the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus VAGINULINA d'Orbigny, 1826

Vaginulina anomala Blake

Plate 26, figure 1

Vaginulina anomala Blake, 1876, in Tate and Blake, The Yorkshire Lias, pt. 2, p. 464, pl. 17, figs. 23–23a.

Test free, robust, short and broad, fusiform in outline, thickest at the inner margin; chambers few, proloculus pointed at the base, forming a low cone, later chambers very low and broad, with final chamber higher and occupying about one-half of the test, narrowing toward the aperture; sutures flush, strongly oblique; wall calcareous, surface smooth; aperture radiate, at the dorsal angle.

Length of figured hypotype 0.47 mm, breadth 0.21 mm.

Remarks.—This species was originally described from the middle-Lias of England, where it was also rare, only 5 specimens having been found by Blake. The Alaskan specimen is typical in having a large final chamber, low, oblique early chambers, and triangular section. It differs from the Upper Jurassic species *Marginulina brevis* Paalzow in being larger, with a more pointed base and more triangular section, and the sutures are not depressed.

Types and occurrence.—Figured hypotype (USNM P647) from a core (Upper Pliensbachian) at 2,140–2,150 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Vaginulina curva Franke

Plate 22, figures 9–19

Cristellaria costata d'Orbigny, Crick and Sherborn, 1891 (not *Cristellaria* (*Cristellaire*) *costata* d'Orbigny, 1826), Jour. Northamptonshire Nat. Hist. Soc., v. 6, no. 46, p. 213, plate fig. 20.

Vaginulina curva Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 85, pl. 8, fig. 39; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 165, pl. 1B, fig. 18.

Test free, of medium size, robust, early portion coiled, later uncoiling, periphery broadly rounded; chambers at first low and broad, later ones higher, early chambers in an incomplete coil in the microspheric form (figs. 14, 17), the coil less evident in the megalospheric forms (figs. 9, 11); sutures distinct, depressed; wall calcareous, surface ornamented with longitudinal costae, increasing both by intercalation and bifurcation from about 4 on each side in the early portion to from 7 to 13 on the side in the later portion, costae continuous across sutures and chambers; aperture at the peripheral angle, radiate, on a slightly produced neck.

Length of hypotype of fig. 9, 0.55 mm, breadth 0.31 mm, thickness 0.26 mm; length of hypotype of fig. 13,

1.04 mm, breadth 0.39 mm; length of hypotype of fig. 14, 0.60 mm, breadth 0.26 mm; length of hypotype of fig. 15, 1.40 mm, breadth 0.44 mm and length of hypotype of fig. 16, 1.14 mm, and breadth 0.49 mm.

Remarks.—This species is closest to *Cristellaria nexa* Terquem and Berthelin, in the compressed test, marginuline coil and longitudinal costae, but differs in having a less pronounced peripheral keel, more numerous ribs and higher chambers. The French form is also two to 4 times as large as the present species.

Vaginulina curva is like many of the Jurassic Nodosariidae in being somewhat gradational between genera. The specimen in fig. 9 is almost a *Marginulina*, that of fig. 15 is a typical *Vaginulina* and those of figs. 14, 17 and 19 are tending toward *Astacolus* in character. However, as it was placed in *Vaginulina* by Franke, and as many of the Alaskan specimens are slightly compressed, it is kept in that genus, although its gradational character is recognized. Some of the specimens from Alaska attain a size greater than those from the German Lias, Franke's type being about the size of the specimen here shown in fig. 11.

Crick and Sherborn figured a specimen which is apparently the same species. They referred it to the Recent *Cristellaria costata* d'Orbigny, but the Jurassic form is less compressed, and is narrower than the Recent species, and does not possess the distinct keel of d'Orbigny's form.

Types and occurrence.—Hypotype of fig. 15 (USNM P648) from a core at 2,109–2,119 feet, unfigured hypotype (USNM P649) from a core at 2,130–2,140 feet, hypotype of fig. 19 (USNM P650) and unfigured hypotypes (USNM P651) from a core at 2,140–2,150 feet, hypotypes of figs. 9–11, 13–14 and 16 (USNM P652a–f) and unfigured hypotypes (USNM P653) from a core at 2,150–2,170 feet, hypotypes of figs. 12, 17–18 (USNM P654a-c) and unfigured hypotypes (USNM P655) from a core at 2,170–2,179 feet, unfigured hypotypes (USNM P656) from a core at 2,179–2,199 feet, all of Late Pliensbachian age; and unfigured hypotypes (USNM P657) from a core (Lower Lias) at 2,300–2,320 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Vaginulina sherborni (Franke)

Plate 23, figures 16–22

Dentalina multicostata Terquem var. *laevigata* Crick and Sherborn, 1891 (not *Vaginula* (*Vaginulina*) *laevigata* Roemer, 1838 and not *Marginulina laevigata* d'Orbigny, 1826), Jour. Northamptonshire Nat. Hist. Soc., v. 6, p. 4, fig. 16.

Marginulina sherborni Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 74, pl. 7, figs. 18a–b; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturforsch. Gesell., no. 439, p. 160, pl. 4, fig. 56, pl. 5, fig. 44.

Test free, elongate, fairly straight or slightly arcuate, tapering, rounded to ovate in section; chambers increasing gradually in size from the apiculate proloculus, at first low and broad, later chambers comparatively higher, in a few specimens very slightly inflated; sutures distinct, thickened, oblique in the early portion, later nearly horizontal; wall calcareous, surface smooth; aperture terminal, radiate.

Length of hypotype of fig. 18, 0.68 mm, breadth 0.26 mm; length of hypotype of fig. 19, 0.75 mm, breadth 0.23 mm; length of hypotype of fig. 20, 1.20 mm, breadth 0.39 mm; length of hypotype of fig. 21, 1.43 mm, breadth 0.36 mm; and length of hypotype of fig. 22, 1.95 mm, breadth 0.47 mm. Other specimens range from 0.55 to 2.0 mm in length.

Remarks.—The synonymy of this species is somewhat complicated. It was first described as *Dentalina multicostata* Terquem var. *laevigata* Crick and Sherborn, 1891. In 1936, Franke placed the species in the genus *Marginulina* and as it would then be preoccupied by *Marginulina laevigata* d'Orbigny, 1826, he proposed the new specific name *Marginulina sherborni*. It seems to the present writer that the species would be better placed in the genus *Vaginulina* as it has neither the round cross section and early coil of *Marginulina*, nor the oblique sutures and rounded section characteristic of *Dentalina*. If placed in *Vaginulina*, Crick and Sherborn's specific name would be preoccupied by *Vaginula* (*Vaginulina*) *laevigata* Roemer, 1838, and the species is therefore referred to *Vaginulina sherborni* (Franke).

This species is characterized by the low chambers, flush sutures, pointed base and produced final chamber.

Types and occurrence.—Unfigured hypotype (USNM P658) from a core at 2,028–2,048 feet, unfigured hypotype (USNM P659) from a core at 2,048–2,068 feet, both of Early Toarcian age, hypotypes of figs. 16–17, 21–22 (USNM P660a–d) and unfigured hypotypes (USNM P661) from a core at 2,109–2,119 feet, hypotype of fig. 18 (USNM P662) and unfigured hypotype (USNM P663) from a core at 2,130–2,140 feet, hypotype of fig. 19 (USNM P664) and unfigured hypotypes (USNM P665) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P666) from a core at 2,150–2,170 feet, all of Late Pliensbachian age; and unfigured hypotype (USNM P667) from a core (Sinemurian) at 2,468–2,478 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Hypotype of fig. 20 (USNM P668) from a core at 5,866–5,874 feet in the Kingak shale of Early Jurassic age, in Simpson Test Well 1, at lat 70°57′05″ N., long 155°21′45″ W., west of Cape Simpson, in northern Alaska.

Vaginulina sp.

Plate 26, figures 2–3

Test free, broad and flattened, subtriangular in side view; chambers low and broad, increasing gradually in size as added; sutures distinct, thickened, slightly raised, oblique, highest dorsally; wall calcareous, surface smooth; aperture at the dorsal angle, rounded.

Length of specimen in fig. 2, 0.75 mm, breadth 0.42 mm, thickness 0.29 mm. Length of specimen in fig. 3, 0.73 mm, breadth 0.65 mm, thickness 0.23 mm.

Remarks.—This species differs from *Vaginulina sherborni* (Franke) in being more rapidly flared, shorter and much broader, and in having somewhat more oblique sutures. Only two specimens have been found, and as these are both broken at the base and the final chamber of each is incomplete, the species is not specifically identified.

Types and occurrence.—Figured specimens (USNM P669a–b) from a core (Upper Pliensbachian) at 2,109–2,119 feet, in the Kingak shale of early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus VAGINULINOPSIS Silvestri, 1904

Vaginulinopsis matutina (d'Orbigny)

Plate 26, figures 4–5

Cristellaria matutina d'Orbigny, 1850, Prodrome Palëon. stratig. universelle, v. 1, p. 242; Dreyer, 1888 (in Burbach), Zeitschr. Naturwiss., v. 61, (ser. 4, v. 7), p. 509, pl. 11, figs. 35–38; Macfadyen, 1936, Jour. Roy. Micr. Soc. London, ser. 3, v. 56, p. 151, pl. 1, fig. 264.

Cristellaria spirolina Bornemann, 1854, Über Liasformation Umgegend Göttingen, p. 40, pl. 4, figs. 30a–c.

Cristellaria (*Astacolus*) *spirolina* Bornemann, Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 102, pl. 10, fig. 10.

Cristellaria (*Astacolus*) *matutina* d'Orbigny, Franke, 1936, Ibid., p. 106, pl. 10, figs. 11–12; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 172, pl. 2B, fig. 33, pl. 3, fig. 45, pl. 4, fig. 79, pl. 5, fig. 53, pl. 6, fig. 33.

Lenticulina matutina (d'Orbigny) Barnard, 1950b, Quart. Jour. Geol. Soc. London, v. 106, pt. 1, p. 7, pl. 2, fig. 2.

Test free, large, early portion coiled, later uncoiled and rectilinear, periphery broadly rounded, somewhat ovate in cross-section; 5 to 9 chambers, more commonly about 7, with the early coiled ones increasing rather rapidly in size as added, uniserial chambers of nearly uniform size; sutures distinct, flush to very slightly constricted in the later portion of the test, nearly straight but somewhat oblique; wall calcareous, surface smooth; aperture at the dorsal angle, radiate.

Length of hypotype of fig. 5, 1.17 mm, breadth 0.49 mm, thickness 0.39 mm. Other hypotypes range from 0.39 to 0.78 mm in length.

Remarks.—According to Bartenstein and Brand, *Cristellaria spirolina* Bornemann is synonymous with *C. matutina* d'Orbigny.

Types and occurrence.—Hypotype of fig. 4 (USNM P670) from a core at 2,099–2,109 feet, hypotype of fig. 5 (USNM P671) from a core at 2,150–2,170 feet, both of Late Pliensbachian age; unfigured hypotypes (USNM P672) from a core at 2,468–2,478 feet and unfigured hypotypes (USNM P673) from a core at 2,478–2,496 feet, both of Sinemurian age, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus PLANULARIA Defrance, 1824

Planularia striata (Issler)

Plate 26, figure 21

Cristellaria crepidula (Fichtel and Moll) var. *striata* Issler, 1908, Palaeontogr., v. 55, no. 1, p. 82, pl. 5, fig. 265, pl. 6, figs. 266–268.

Test free, small, early portion slightly coiled, later uncoiling, with the chambers reaching far back toward the base on the inner margin; chambers few in number in the Alaskan specimen, about 7, low and broad, increasing very slowly in height but more rapidly in breadth, so that test is subtriangular in side view; sutures distinct, slightly depressed, strongly oblique; wall calcareous, surface ornamented by very faint longitudinal ribs near the dorsal margin; aperture at the somewhat produced dorsal angle.

Length of hypotype of fig. 21, 0.52 mm, breadth 0.23 mm, thickness 0.10 mm.

Remarks.—This species is represented by a single specimen in Alaskan material, but it is very close to the specimen figured by Issler in his fig. 265. Franke (1936) placed this species in the synonomy of *Cristellaria eugenii* Terquem, 1864, with *C. pikettyi* Terquem, 1866, but both of Terquem's species are larger, with more parallel sides, and the former has a much more enrolled base and more compressed test. Franke's specimen is similar to Terquem's species and is not the same as the present species.

Types and occurrence.—Hypotype of fig. 21 (USNM P674) from a core at 2,340–2,350 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 4, at lat 71°15′55.24″ N., long 156°37′44.89″ W., 447 feet N. 28° E. of South Barrow Test Well 2, in northern Alaska.

Genus CITHARINA d'Orbigny, 1839

In describing this genus d'Orbigny designated no species, and according to the International Rules of Zoological Nomenclature, the first species published in connection with the generic name becomes the type, when it has not been designated by the author of the genus.

Marie (1938, p. 93) designated *Vaginulina striatula* Roemer, 1842 as genotype, but this species was not in the first list of species belonging to *Citharina*, and hence is not available as a type.

Vaginulina (*Citharina*) *strigillata* Reuss, 1846 was cited as the genotype by Loeblich and Tappan, (1949, p. 259), but this was also erroneous, as *Vaginulina costulata* Roemer, 1842 was also referred to *Citharina* in Reuss' publication (1846, p. 106), in a list of species, and as it appeared in the list before *Citharina strigillata*, it thus takes precedence. The genotype thus is *Vaginulina costulata* Roemer, 1842 (see Ellis and Messina, Catalogue of Foraminifera, under *Citharina*).

Payard (1947, p. 118) defined *Pseudocitharina* (genotype: *Marginulina colliezi* Terquem), as differing from *Citharina* in having a spherical proloculus and a coiled or arcuate early portion, but resembling *Citharina* in the strongly compressed test, generally rectangular cross-section and oblique chambers. The writer examined and refigured Terquem's specimen, and the lectotype shows an arcuate early portion, but the "globular proloculus" is less evident, the lectotype having a distinctly ovate proloculus. The specimens referred to *Pseudocitharina colliezi* (Terquem) by Payard also show considerable variation in shape, some with no appreciable curvature (pl. 3, figs. 6, 7), and also have a somewhat ovate proloculus. Payard's specimen of *Pseudocitharina cornucopia* (Terquem) also has an elongate, ovate proloculus and a straight dorsal margin, although Terquem's type of this species had a globular proloculus.

Many Lower Cretaceous species also show a considerable degree of variation in the amount of curvature as well as in the shape of the proloculus. Thus the two major distinctions between *Pseudocitharina* and *Citharina* seem to be extremely variable, even within a single species, and the writer does not consider them sufficiently distinct to warrant separation. Therefore, although described as *Pseudocitharina* by the author of the species, the following species is here referred to *Citharina*, and the two genera are considered synonymous.

Citharina fallax (Payard)

Plate 28, figures 1–10

Pseudocitharina fallax Payard, 1947, Foram. Lias Supérieur, p. 129, pl. 5, figs. 1–4.

Test free, large, robust, flattened, dorsal margin straight or slightly curved; chambers low and broad, increasing very slowly in height from the rounded proloculus, but increasing more rapidly in breadth, so that the test is subtriangular in side view; sutures oblique, nearly obscured by the numerous longitudinal ribs; wall calcareous, ornamented by the longitudinal ribs which increase by intercalation and bifurcation from 2 to 3 in the earliest portion to as many as 13 on the broader adult tests; aperture at the dorsal angle, radiate.

Length of hypotype of fig. 2, 1.69 mm, breadth 0.49 mm; length of hypotype of fig. 6, 0.62 mm, breadth 0.26 mm; length of hypotype of fig. 7, 2.68 mm, breadth 0.81 mm; length of fragment in fig. 8, 1.92 mm, breadth 0.78 mm, and length of hypotype of fig. 9, 1.01 mm, breadth 0.31 mm.

Remarks.—Because of their size and comparatively fragile nature, and the relatively consolidated sediments of the well sections, the larger specimens of this species are invariably broken. Some of these fragments can be matched, as was done with the specimens of figs. 2 and 7, and the color, including a distinctive iron stain, suggest strongly that figs. 7 and 10 are from the same specimen, although unfortunately a segment between these is missing. This specimen probably reached a total length of nearly 4 mm when complete. The species was originally described from the upper Lias of France.

Types and occurrence.—Hypotype of fig. 5 (USNM P675) and unfigured hypotypes (USNM P676) from a core at 2,028–2,048 feet, hypotype of fig. 1 (USNM P677) and unfigured hypotypes (USNM P678) from a core at 2,048–2,068 feet, all of Lower Toarcian age; hypotypes of figs. 7 and 10 (USNM P679a–b) from a core at 2,068–2,078 feet, unfigured hyptotypes (USNM P680) from a core at 2,099–2,109 feet, hypotypes of figs. 3–4, and 8 (USNM P681a–c) and unfigured hypotypes (USNM P682) from a core at 2,109–2,119 feet, hypotype of fig. 9 (USNM P683) and unfigured hypotypes (USNM P684) from a core at 2,130–2,140 feet, hypotype of fig. 2 (USNM P685) and unfigured hypotypes (USNM P686) from a core at 2,140–2,150 feet, unfigured hypotypes (USNM P687) from a core at 2,150–2,170 feet, hypotype of fig. 6 (USNM P688) and unfigured hypotypes (USNM P689) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; and unfigured hypotypes (USNM P690) from a core (Lower Lias) at 2,300–2,320 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Citharina frankei Tappan, new name

Plate 28, figure 11

Cristellaria triquetra Terquem, 1870 (not *Cristellaria triquetra* Gümbel, 1861 and not *Cristellaria triquetra* Gümbel, 1862), Mém. Acad. Imp. Metz, ann. 50 (ser. 2, ann. 17), p. 430, pl. 9, figs. 25a–26b; Terquem, 1886, Mém. Soc. Géol. France, ser. 3, v. 4, no. 2, p. 30, pl. 3, figs. 13–14.

Vaginulina triquetra (Terquem) Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 84, pl. 8, fig. 28 (29?).

Test free, small, compressed, early portion somewhat curved, later portion uncoiled and subtriangular in side view; chambers few, increasing rapidly in breadth from the ovate proloculus, but of nearly equal height throughout; sutures strongly oblique, slightly arched and somewhat depressed; wall calcareous, surface smooth; aperture produced on a short neck.

Length of figured hypotype 0.26 mm, breadth 0.10 mm, thickness 0.05 mm.

Remarks.—Only a single specimen has been found in Alaska, and this is slightly smaller and has fewer chambers than the type, but is probably a juvenile specimen. Terquem's name was preoccupied by Gümbel, who used it in 1861 for an Eocene species, and again in 1862 for a middle Jurassic species, the latter being renamed in this paper as *Saracenaria oxfordiana* Tappan, new name. Franke placed *Marginulina depressa* Blake in the synonomy of this species, but Blakes' species is distinct, being a less compressed form.

Type and occurrence.—Figured hypotype (USNM P691) from a core (Upper Pliensbachian) at 2,028–2,048 feet, in the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Genus FRONDICULARIA Defrance, 1824

Frondicularia baueri Burbach

Plate 27, figure 7.

Frondicularia baueri Burbach, 1886, Zeitschr. Naturw. Halle, v. 59 (ser. 4, v. 5), p. 52, pl. 2, figs. 48–52; Schick, 1903, Jahresh. Ver. Vaterl. Naturk. Württemb., v. 59, p. 153, pl. 6, figs. 16–17; Issler, 1908, Palaeontogr., v. 55, no. 1, p. 60, pl. 3, fig. 137; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 70, pl. 7, fig. 10; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 158, pl. 3, fig. 36, pl. 4, fig. 49.

Test free, narrow, elongate, tapering slightly, sides parallel, margins carinate; chambers numerous, about 10 to 13, highly arched; sutures acutely angled, not depressed, and largely obscured by the surface ribs; wall calcareous, surface ornamented with 4 to 6 longitudinal costae on each of the flat sides, no marked central sulcus; aperture at the end of a slight neck, radiate.

Length of figured hypotype 1.25 mm, breadth 0.34 mm, thickness 0.18 mm. Other specimens range from 0.42 to 1.33 mm in length and from 0.16 to 0.39 mm in breadth.

Remarks.—Burbach's types were from the *Amaltheus* zone of the German Lias. The species differs from *F. lustrata* Tappan in lacking the central furrow. All costae are of approximately equal strength in *F. baueri* and the sides are flat. The specimens referred to this species by Wicher (1938, pl. 25, figs. 6, 7) were placed in *F. dubia* Bornemann by Barnard (1950a).

Types and occurrence.—Unfigured hypotype (USNM P699) from a core at 2,140–2,150 feet, hypotype of fig. 7 (USNM P700) and unfigured hypotypes (USNM P701) from a core at 2,150–2,160 feet, unfigured hypotypes (USNM P702) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; and unfigured hypotypes (USNM P703) from a core (Sinemurian) at 2,478–2,496 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Frondicularia lustrata Tappan

Plate 27, figures 11–19

Frondicularia lustrata Tappan, 1951, Contr. Cushman Found. Foram. Research, v. 2, pt. 1, p. 2, pl. 1, figs. 3–4.

Test free, narrow, elongate, compressed, rectilinear, periphery carinate; chambers numerous, proloculus with an apical spine which is usually broken, but may be present on perfectly preserved specimens, equitant chambers increasing gradually in size from the proloculus in the megalospheric form, flaring more rapidly in the microspheric form; sutures distinct, sharply angled at the center of the test; wall calcareous, hyaline, surface smooth, ornamented by strong longitudinal costae, with two prominent and parallel ribs at either side of the deep central longitudinal furrow, and two to three less prominent ribs at either side of these, tending to parallel the margins of the test; aperture terminal, radiate, on a distinct neck.

Length of holotype 1.43 mm, breadth 0.34 mm, thickness 0.21 mm. Other complete specimens range in length from 0.39 to 1.43 mm, and in breadth from 0.18 to 0.42 mm.

Remarks.—This species somewhat resembles *Frondicularia terquemi* var. *bicostata* d'Orbigny, which occurs in the Lias of England, France and Germany, but differs in having much more prominent ribs and an apical spine, and in having the central longitudinal depression.

F. lustrata is very similar to *F. venusta* Terquem and Berthelin, from the middle Lias of France, but is about three times as long, and as much as four times as wide. The sutures of the Alaskan species are also much more strongly arched.

Types and occurrence.—Unfigured hypotype (USNM P704) from a core at 1,979–1,999 feet, hypotype of fig. 18 (USNM P705) and unfigured hypotype (USNM P706) from a core at 1,999–2,018 feet, unfigured hypotypes (USNM P707) from a core at 2,028–2,033 feet, hypotypes of figs. 12, 16 (USNM P708a–b) and unfigured hypotypes (USNM P709) from a core at 2,028–2,048 feet, unfigured hypotypes (USNM P710) from a core at 2,033–2,038 feet, unfigured hypotype (USNM P711) from a core at 2,048–2,068 feet, all of Lower Toarcian age; unfigured hypotypes (USNM P712) from

a core at 2,099–2,109 feet, hypotype of fig. 15 (USNM P713), unfigured paratypes (USNM 106484) and unfigured hypotypes (USNM P714) from a core at 2,109–2,119 feet, paratype of fig. 13 (USNM 106483), hypotype of fig. 19 (USNM P715) and unfigured hypotypes (USNM P716) from a core at 2,130–2,140 feet, hypotype of fig. 14 (USNM P717) and unfigured hypotypes (USNM P718) from a core at 2,140–2,150 feet, holotype of fig. 11 (USNM 106481), paratype of fig. 17 (USNM 106482a) and unfigured paratypes (USNM 106482b–k) from a core at 2,150–2,160 feet, unfigured paratypes (USNM 106485) from a core at 2,170–2,179 feet, all of Late Pliensbachian age; and unfigured hypotype (USNM P719) from a core (Sinemurian) at 2,478–2,496 feet, all from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Frondicularia squamosa Terquem and Berthelin

Plate 27, figures 8–9

Frondicularia squamosa Terquem and Berthelin, 1875, Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 37, pl. 3, figs. 3a–b.
Frondicularia hauffi Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 66, pl. 6, fig. 22; Payard, 1947, Foram. Lias Supérieur, p. 116, pl. 6, fig. 30.

Test free, narrow, elongate, compressed, flaring slightly from the rounded base; as many as nine chambers, low and arched centrally, becoming wider and higher as added; sutures obscure unless specimen is dampened, strongly arched centrally; wall calcareous, hyaline, ornamented by numerous low ribs of equal size, which cross the sutures in the early portion, but may be broken at the sutures in the later portion, ribs sometimes curving slightly, fading out at the terminal portion of the final chamber; aperture terminal, simple, not produced on a neck.

Length of hypotype of fig. 8, 0.60 mm, breadth 0.13 mm, thickness 0.08 mm; length of hypotype of fig. 9, 0.52 mm, breadth 0.16 mm, thickness 0.08 mm. The type of *Frondicularia squamosa* was 0.62 mm in length and 0.14 mm in breadth, and the type of *Frondicularia hauffi* was 0.75 mm in length and 0.15 mm in breadth. This somewhat larger specimen also had more chambers than the others for which measurements are given.

Remarks.—The hypotypes agree closely with the original types of both Terquem and Berthelin, from the Middle Lias of France (*A. margaritatus* zone) and of Franke from the Upper Lias of Germany. *Frondicularia procera* Burbach, from the *Amaltheus* beds of the German Lias, is also very similar, but has somewhat lower chambers, and is about twice the size of *F. squamosa*.

Types and occurrence—Unfigured hypotype (USNM P720) from a core at 2,109–2,119 feet, unfigured hypotype (USNM P721) from a core at 2,140–2,150 feet, hypotypes of figs. 8 and 9 (USNM P722a–b) and unfigured hypotype (USNM P723) from a core at 2,150–2,170 feet, and unfigured hypotype (USNM P724) from a core at 2,170–2,179 feet, all of Late Pliensbachian age, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Frondicularia terquemi d'Orbigny

Plate 27, figures 3–4

Frondicularia terquiemi d'Orbigny, 1850, Prodr. paléon. strat. univ. anim. moll. rayonnés, v. 1, p. 241; Schick, 1903, Ver. Vaterl. Naturk. Württemberg Jahresh., v. 59, p. 125, 152, pl. 6, fig. 12; Issler, 1908, Palaeontogr., v. 55, no. 1, p. 57, pl. 3, figs. 115–118.
Frondicularia terquemi d'Orbigny, Terquem, 1858, Acad. Imp. Metz. Mém., ann. 39, (ser. 2, ann. 6), p. 594, pl. 1, figs. 12a–d; Terquem, 1866, Sixième mém. Foram. Lias, Metz., p. 469, 482–483; Terquem and Berthelin, 1875, Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 38, pl. 3, figs. 7a–b; Burbach, 1886, Zeitschr. Naturw., Halle, v. 59 (ser. 4, v. 5), p. 45, pl. 1, figs. 1–6; Crick and Sherborn, 1891, Northamptonshire Nat. Hist. Soc. Jour., v. 6, p. 213, plate fig. 36; Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, v. 169, p. 69, pl. 7, figs. 11a–b; Macfadyen, 1936, Jour. Roy. Micros. Soc., London, ser. 3, v. 56, p. 149, pl. 1, fig. 255; Bartenstein and Brand, 1937, Abh. Senckenberg. Naturf. Gesell., no. 439, p. 155, pl. 4, fig. 54, pl. 5, fig. 38; Payard, 1947, Foram. Lias Supérieur, p. 113, pl. 6, figs. 27, 29.

Test free, small, tapering, compressed, lateral margins carinate; chambers increasing gradually in size as added, very highly arched centrally; sutures fairly distinct, flush or slightly depressed, acutely angled; wall calcareous, hyaline, smooth or with two very obscure longitudinal ribs on each side; aperture terminal, on a distinct neck, rounded.

Length of hypotype of fig. 3, 0.52 mm, breadth 0.16 mm, thickness 0.08 mm; length of hypotype of fig. 4, 0.96 mm, breadth 0.31 mm, thickness 0.16 mm. Other specimens range from 0.42 to 0.57 mm in length.

Remarks.—The Alaskan specimens strongly resemble the French Liassic type specimen of *Frondicularia terquemi* d'Orbigny, in the smooth to faintly costate test, and although d'Orbigny's specimen was 1.86 mm in length, about 2 to 3 times as large as the Alaskan specimens, it also had one-third more chambers, so that the same number of chambers of the type specimen occupy a length about equal to that of the Alaskan specimens. Possibly because of the nature of the enclosing beds in Alaska, and the fragile nature of the species, any of the larger specimens may have been broken or destroyed in preparation of the samples.

Types and occurrence.—Unfigured hypotype (USNM P725) from a core at 2,109–2,119 feet, hypotype of fig. 4 (USNM P726) from a core at 2,140–2,150 feet,

hypotype of fig. 3 (USNM P727) and unfigured hypotype (USNM P728) from a core at 2,150–2,170 feet, all of Late Pliensbachian age, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Unfigured hypotypes (USNM P729) from a core at 2,356 feet in the Kingak shale of Early Jurassic age in South Barrow Test Well 2, at lat 71°15′51.34″ N., long 156°37′55.25″ W., in northern Alaska.

Frondicularia sp.

Plate 27, figure 10

Test free, short, only a juvenile specimen of three chambers having been obtained; proloculus comparatively large and globular, later chambers low and broad, chevron-shaped and with concave sides, increasing in breadth as added; sutures arched centrally, forming an obtuse angle at the midpoint of each side, not depressed; wall calcareous, smooth except for two longitudinal ribs on each side, beginning near the outer margin of the second chamber and roughly paralleling the margins of the test, with a broad low sulcus between the ribs on each side; aperture terminal, on a short and narrow neck.

Length of figured specimen 0.23 mm, breadth 0.16 mm, thickness 0.10 mm.

Remarks.—Only a single juvenile specimen was found but it is here figured and described as it is the only representative of the genus in the Upper Jurassic portion of the Kingak shale.

Type and occurrence.—Figured specimen (USNM P795) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain of northern Alaska.

Genus LAGENA Walker and Jacob, 1798

Lagena aphela Tappan, n. sp.

Plate 28, figures 13–14

Lagena globosa (Montagu) Bartenstein and Brand, 1937, (not *"Serpula (Lagena) globosa"* Walker and Boys, 1784, and not *Vermiculum globosum* Montagu, 1803), Abh. Senckenber. Naturf. Gesell., no. 439, p. 165, pl. 4, fig. 68, pl. 5, fig. 48, pl. 11A, fig. 8, pl. 12A, fig. 8, pl. 12B, figs 10a-b, pl. 15A, fig. 26.

Test free, small, unilocular; spherical to ovate in shape, somewhat produced at the aperture; wall calcareous, smooth; aperture radiate, sometimes slightly eccentric.

Height of paratype in fig. 13, 0.23 mm, breadth 0.18 mm; height of holotype of fig. 14, 0.34 mm, breadth 0.23 mm. Other paratypes range from 0.23 to 0.44 mm in height.

Remarks.—This species is similar in outline to *Lagena parkinsoni* Kübler and Zwingli, from the mid-Jurassic of Switzerland, but is from 2 to 3 times as large and has a distinctly radiate aperture. It is similar to the Upper Cretaceous *Oolina simplex* Reuss in form, but is more produced at the aperture and only about one-half as large. It differs from Montagu's Recent species in being much smaller, more globular, and in having a radiate aperture.

Types and occurrence.—Unfigured paratypes (USNM P730) from a core at 2,099–2,109 feet, holotype of fig. 14 (USNM P731) from a core at 2,130–2,140 feet, unfigured paratypes (USNM P732) from a core at 2,140–2,150 feet, paratype of fig. 13 (USNM P733) and unfigured paratypes (USNM P734) from a core at 2,150–2,160 feet, all of Late Pliensbachian age, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Lagena liasica (Kübler and Zwingli)

Plate 28, figure 12

Oolina liasica Kübler and Zwingli, 1866, Mikroskop. Bild. aus der Urwelt Schweiz, v. 2, p. 7, pl. 1, fig. 15.

Lagena mucronata Terquem and Berthelin, 1875, Mém. Soc. Géol. France, ser. 2, v. 10, no. 3, p. 14, pl. 1, figs. 8a, 8c (not 8b); Franke, 1936, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 90, pl. 9, fig. 7.

Test free, consisting of an ovate chamber with an apiculate base, and produced into a short and narrow neck at the opposite extremity; aperture rounded, at the end of the neck.

Length of figured specimen 0.44 mm, greatest breadth 0.26 mm; length of unfigured hypotype, 0.36 mm.

Remarks.—Kübler and Zwingli figured a specimen from the lower Lias of Switzerland similar to the Alaskan figured hypotype. Their specimen was 0.25 mm in length. Terquem and Berthelin described *Lagena mucronata* from the middle-Lias of France. Their specimen of fig. 8b is a rugose form, and probably should be referred to a distinct species. Their other figured specimens were 0.28 mm and 0.18 mm in length, and similar in appearance to the Swiss form.

Lagena liasica differs from the species of the Lower Kingak age *Lagena aphela* Tappan, in being somewhat larger, in having an apiculate base, a more elongate chamber and a narrower neck, which carries a rounded rather than a radiate aperture.

Types and occurrence.—Figured hypotype (USNM P796) and unfigured hypotype (USNM P797) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, in northern Alaska.

Family POLYMORPHINIDAE

Genus EOGUTTULINA Cushman and Ozawa, 1930

Eoguttulina liassica (Strickland)

Plate 28, figures 17–19

Polymorphina liassica Strickland, 1846, Quart. Jour. Geol. Soc. London, v. 2, p. 31, textfig. p. 30, fig b.

Polymorphina liasica Strickland Franke, Abh. Preuss. Geol. Landesanst., Neue Folge, no. 169, p. 120, pl. 12, figs. 8–10.

Polymorphina (*Eoguttulina*) *liassica* (Strickland) Macfadyen, 1941, Phil. Trans. Roy. Soc. London, ser. B, no. 576, v. 231, p. 65, pl. 4, fig. 66.

Eoguttulina liassica (Strickland) Cushman and Ozawa, 1930, Proc. U. S. Nat. Mus., v. 77, art. 6, p. 17, pl. 1, figs. 2a–c; Bartenstein and Brand, 1937, Abh. Senckenberg Naturforsch. Gesell., no. 439, p. 178, pl. 1A, figs. 24a–b, pl. 2A, fig. 23, pl. 2B, fig. 35, pl. 3, fig. 49, pl. 4, figs. 74a–b, pl. 5, figs. 69a–b; Barnard, 1950a, Quart. Jour. Geol. Soc. London, v. 105, pt. 3, no. 419, p. 376, figs. 6b, f; Barnard, 1950b, Ibid., v. 106, pt. 1, p. 421, p. 31.

Test free, elongate, fusiform; chambers biserial, increasing rapidly in size as added, final chamber extending four-fifths the length of the test; sutures obscure, flush, strongly oblique; wall calcareous, surface smooth; aperture terminal, radiate.

Length of hypotype of fig. 17, 0.49 mm, breadth 0.26 mm; length of hypotype of fig. 18, 0.52 mm, breadth 0.23 mm; length of hypotype of fig. 19, 0.65 mm, breadth 0.26 mm. Other hypotypes range from 0.23 to 0.62 mm in length.

Remarks.—The Alaskan specimens are similar in appearance to Strickland's type from the English Lower Lias. Various other forms have also been referred to this species, some of which are much more slender and with inflated chambers and depressed sutures. The Alaskan specimens have been compared with one from the *angulatum* zone of the Lower Lias of the Dorset Coast of England, sent through the courtesy of Dr. Tom Barnard, University College, London, and seem to be the same in all respects.

Types and occurrence.—Unfigured hypotype (USNM P735) from a core at 2,018–2,028 feet, unfigured hypotype (USNM P736) from a core at 2,048–2,068 feet, both from the Lower Toarcian; unfigured hypotypes (USNM P737) from a core at 2,109–2,119 feet, hypotypes of figs. 17–18 (USNM P738a–b) and unfigured hypotypes (USNM P739) from a core at 2,140–2,150 feet, hypotype of fig. 19 (USNM P740) and unfigured hypotypes (USNM P741) from a core at 2,150–2,160 feet, all from the Upper Pliensbachian, from the Kingak shale of Early Jurassic age in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ W., in northern Alaska.

Eoguttulina metensis (Terquem)

Plate 28, figures 15–16

Polymorphina metensis Terquem, 1864, Quatrième Mém. Foram. Lias, Polymorphines, p. 301, pl. 13, figs. 38a–b; Terquem and Berthelin, 1875, Mém. Soc. Géol. France, Mém. 3, ser. 2, v. 10, p. 68, pl. 16, figs. 1a–j.

Polymorphina oolithica Terquem, 1874 (part), Quatrième Mém. Foram. Oolithique, *Polymorphina, Guttulina*, etc., p. 299, pl. 32, fig. 6 (not figs. 1–5, 7–10).

Polymorphina disjuncta Terquem, 1874, Ibid., p. 303, pl. 33, fig. 3.

Polymorphina lactea (Walker and Jacob) Crick and Sherborn, 1892 (not *Serpula lactea* Walker and Jacob, 1798), Jour. Northamptonshire Nat. Hist. Soc., no. 50, p. 71, pl. 2, fig. 25.

Test free, small, fusiform; chambers narrow, elongate, about 5 in the adult specimen, increasing very rapidly in size as added, final pair extending two-thirds or more of the length of the test; sutures distinct, strongly oblique; wall calcareous, but most Alaskan specimens are represented only by pyritic casts, ornamentation lacking; aperture terminal, but due to the poor preservation it cannot be determined whether it was originally rounded or radiate.

Length of hypotype of fig. 15, 0.26 mm, breadth 0.10 mm; length of hypotype of fig. 16, 0.34 mm, breadth 0.10 mm, thickness 0.08 mm.

Remarks.—This is an elongate, fusiform and flattened species, originally described from the middle Lias of France. Although placed in the synonomy of *Eoguttulina liassica* (Strickland) by Cushman and Ozawa, it differs in having more depressed sutures, and a more fusiform and flattened test. It is also somewhat smaller.

Types and occurrence.—Unfigured hypotypes (USNM P742) from the black Kingak shale (Lower Jurassic), from 1,650 feet above the base, and hypotypes of figs. 15–16 (USNM P743a–b) and unfigured hypotypes (USNM P744) from the upper 60 feet of section exposed, 2,580–2,640 feet above the basal contact with the Upper Triassic Shublik formation, at lat 69°35′ N., long 145°04′ W., in the banks of a south-flowing tributary which enters the Sadlerochit River at about lat 69°34′30″ N., long 145°03′ W., on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Genus PALEOPOLYMORPHINA Cushman and Ozawa, 1930

Paleopolymorphina vagina (Terquem)

Plate 28, figures 20–21

Polymorphina irregularis Terquem, 1864 (not d'Orbigny, 1839), Quatrième Mém. Foram. Lias, Polymorphines, p. 297, pl. 12, fig. 36.

Polymorphina vagina Terquem, 1864, Ibid., p. 298, pl. 12, figs. 44–47; Terquem, 1874, Quatrième Mém. Foram. Oolithique, p. 302, pl. 33, fig. 1.

Polymorphina pupiformis Terquem, 1864, Quatrième Mém. Foram. Lias, Polymorphines, p. 300, pl. 13, figs. 22–37; Terquem, 1874, Quatrième Mém. Foram. Oolithique, p. 303, pl. 33, fig. 4.

Test free, elongate, narrow, biserial in the early portion, later chambers becoming more widely spaced and tending to become uniserial, although still alternating; sutures distinct, strongly oblique in the early portion, less oblique later in the development; aperture terminal and central, radiate.

Length of hypotype of fig. 20, 1.51 mm, breadth 0.42 mm; length of hypotype of fig. 21, 1.04 mm, breadth 0.34 mm. Length of unfigured hypotype 0.99 mm, breadth 0.31 mm.

Remarks.—Terquem described three species, all very similar in size, shape and chamber arrangement, and all from the same locality and stratigraphic zone of the Lower Lias of France. Of these, *P. irregularis* is preoccupied by *P. irregularis* d'Orbigny, 1839, a Recent species. *Polymorphina vagina* has page priority over *P. pupiformis*, hence the present species is referred to *Paleopolymorphina vagina* (Terquem).

Types and occurrence.—Hypotype of fig. 20 (USNM P745) from a core at 2,130–2,140 feet, hypotype of fig. 21 (USNM P746) and unfigured hypotype (USNM P747) from a core at 2,140–2,150 feet, all from the Upper Pliensbachian, from the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, at lat 71°09′40″ N., long 156°34′45″ N., in northern Alaska.

Genus GLOBULINA d'Orbigny, 1839

Globulina topagorukensis Tappan, n. sp.

Plate 28, figure 22

Test free, small, ovate; chambers globuline in arrangement, but only three chambers present, the last two overlapping the first so that only a small portion is visible, final chamber occupying about seven-eighths of the test; sutures distinct, oblique, very slightly depressed; wall calcareous, surface smooth; aperture radiate, terminal.

Length of holotype 0.34 mm, breadth 0.23 mm. Paratypes range in length from 0.18 to 0.47 mm.

Remarks.—This species somewhat resembles *Polymorphina bucculenta* Berthelin from the Lower Cretaceous of France, but is about one-half as large and has a comparatively greater overlap of chambers and a more globular shape.

Types and occurrence.—Holotype (USNM P798) and unfigured paratypes (USNM P799) from Upper Jurassic rocks in a core at 7,042–7,052 feet, in Topagoruk Test Well 1, west of Topagoruk River, at lat 70°37′30″ N., long 155°53′36″ W., in the Arctic Coastal Plain, in northern Alaska.

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Italic numbers indicate descriptions

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PLATE 7

FIGURES 1–3. *Bathysiphon anomalocoelia* Tappan, n. sp. 1, Side view of paratype (USNM P69). 2, Side view of holotype (USNM P68). 3, Side view of paratype (USNM P70). All from the Lower Jurassic in South Barrow Test Well 3. × 41. (p. 35).

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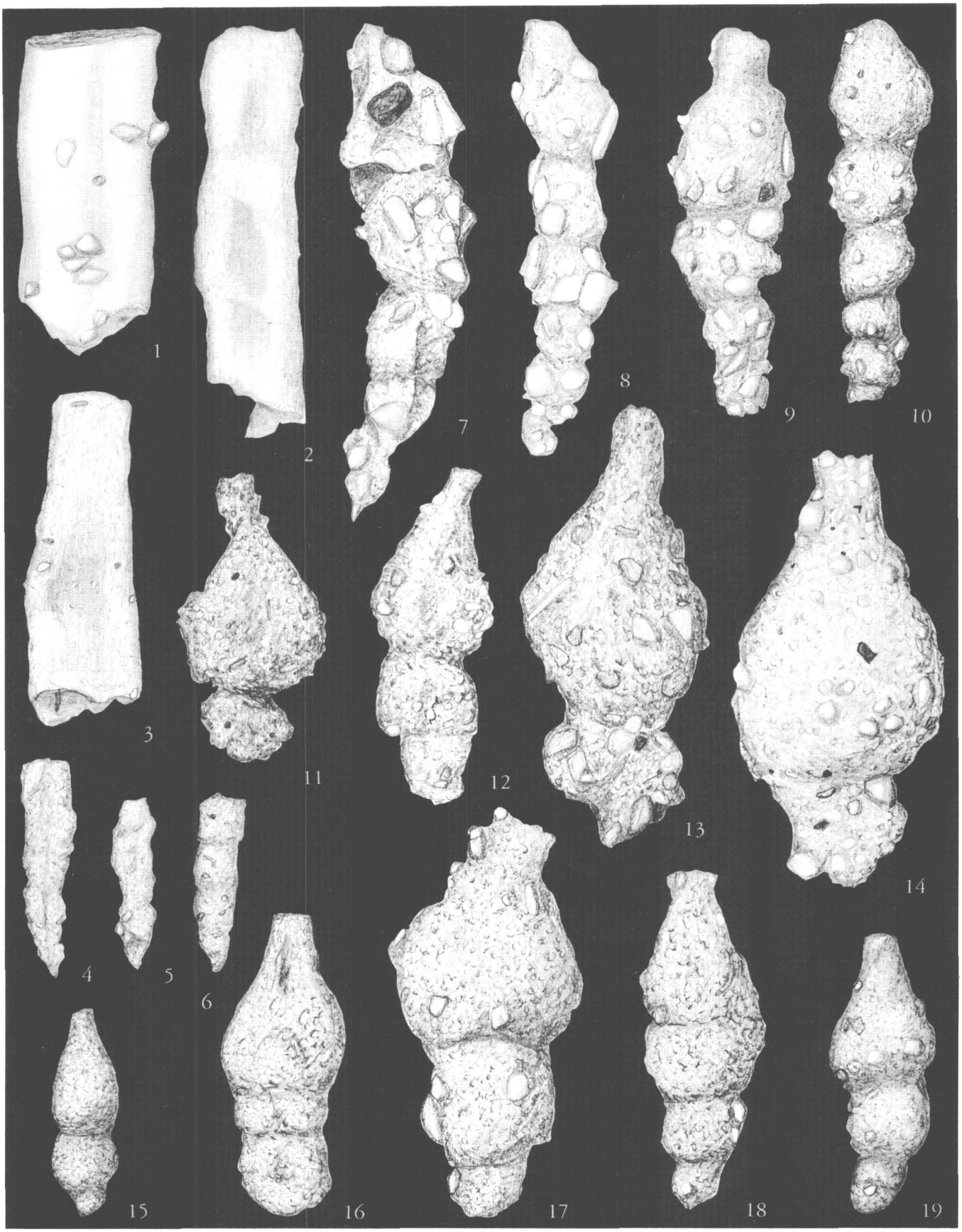
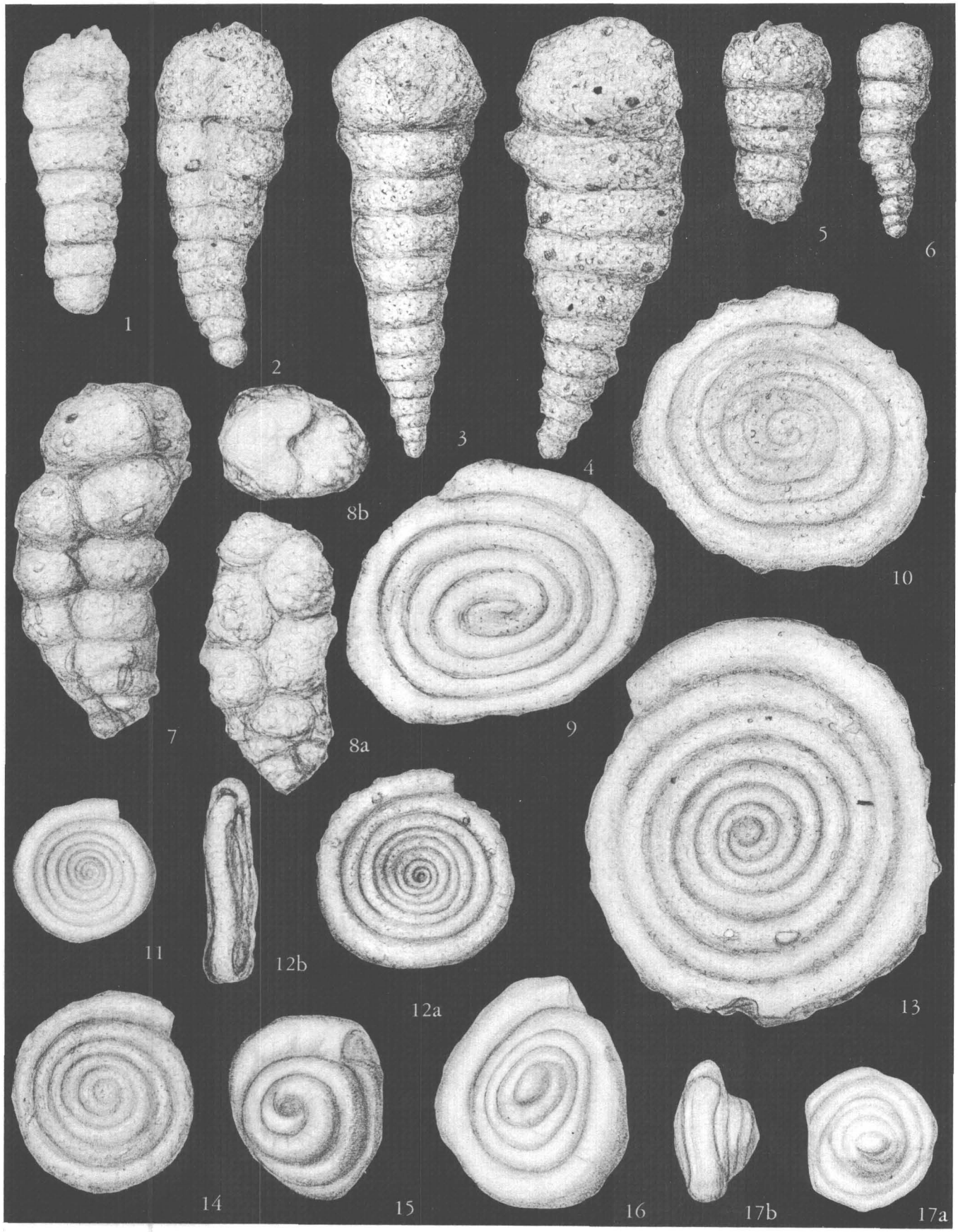


BATHYSIPHON, JACULELLA, REOPHAX



REOPHAX, INVOLUTINA, GLOMOSPIRA, GAUDRYINA

PLATE 8

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PLATE 9

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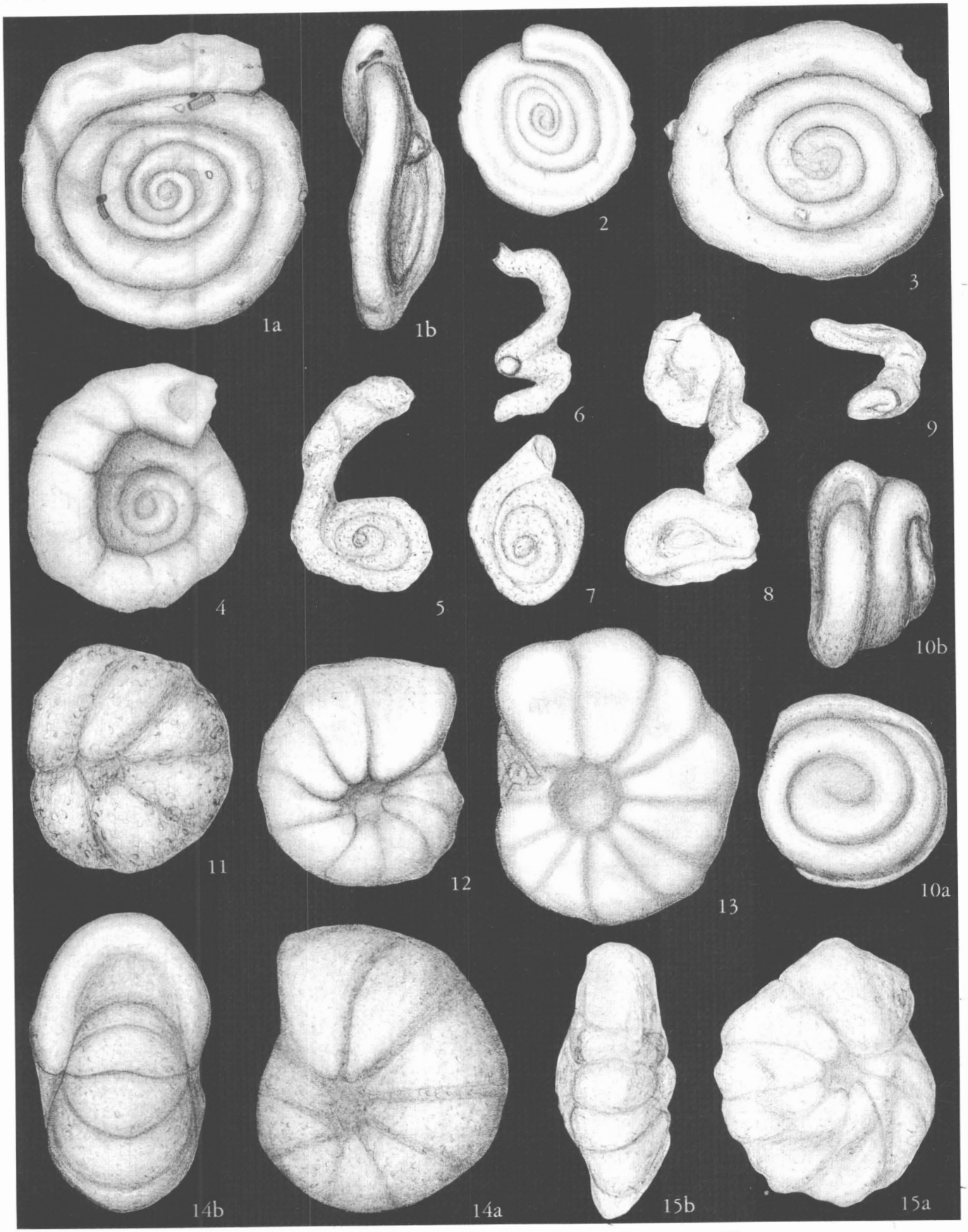
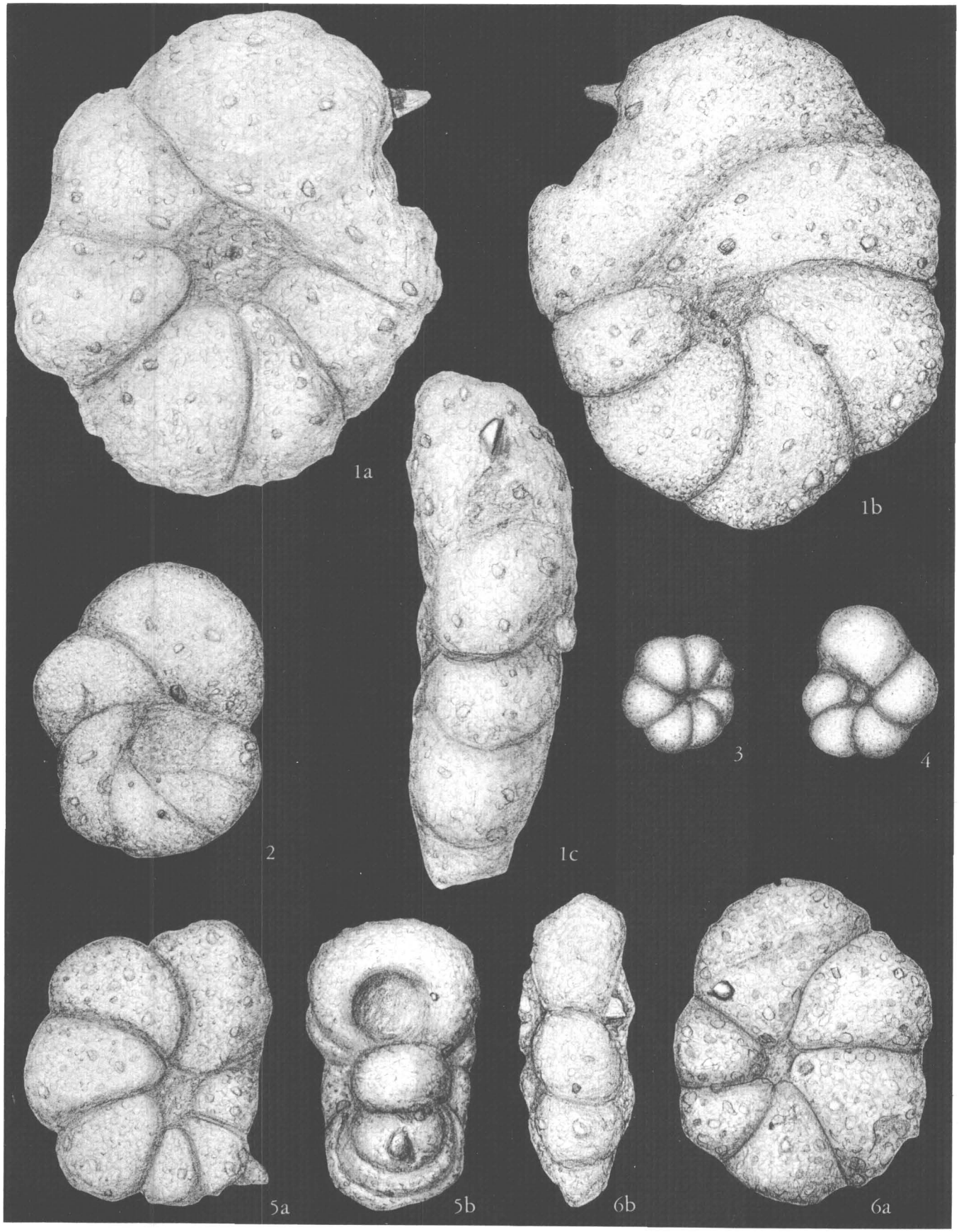
5–9. *Lituotuba irregularis* Tappan, n. sp. 5, Holotype (USNM P180), showing planispiral coil and later uncoiled portion, × 72. 6, 9, Two extremely irregularly formed paratypes (USNM P183a–b), × 41. 7, Paratype (USNM P181), ×72. 8, Paratype (USNM P185), showing early coil, uncoiled portion and final tendency to coil again, ×72. All from Lower Jurassic rocks in South Barrow Test Well 3. (p. 41).

10. *Glomospira perplexa* Franke. Hypotype (USNM P179). 10a, side view, 10b, edge view, showing irregular coiling. Lower Jurassic rocks of South Barrow Test Well 3. × 41. (p. 41).

11–15. *Haplophragmoides canui* Cushman. 11, 15a, Side views of hypotypes (USNM P202a–b); 15b, edge view of a compressed specimen. Both from Upper Jurassic rocks on Welcome Creek, in the Siksikpuk-Nanushuk region. 12, 14, Hypotypes (USNM P204a–b), 12, 14a, side views, 14b, edge view of uncompressed specimen, both from Upper Jurassic rocks of the Canning River region. 13, Hypotype (USNM P205) from Upper Jurassic rocks of the Canning River region. 11–13, × 72. 14–15, × 95. (p. 42).



INVOLUTINA, GLOMOSPIRA, LITUOTUBA, HAPLOPHRAGMOIDES



HAPLOPHRAGMOIDES

PLATE 10

FIGURES 1–6. *Haplophragmoides kingakensis* Tappan, n. sp. 1–2, Paratypes (USNM P213a–b); 1a, 1b, opposite sides, 1c, edge view of larger compressed specimen. 3, small paratype (USNM P210). 4, small paratype (USNM P211). 5, holotype (USNM P208), 5a, side view, 5b, edge view of this uncompressed form. 1–5, all from Lower Jurassic rocks in South Barrow Test Well 3. 6, Paratype (USNM P217), 6a, side view, 6b, edge view showing compression. From Lower Jurassic rocks in South Barrow Test Well 2. Figs. 1–2, × 95, 3–6, × 72. (p. 43).

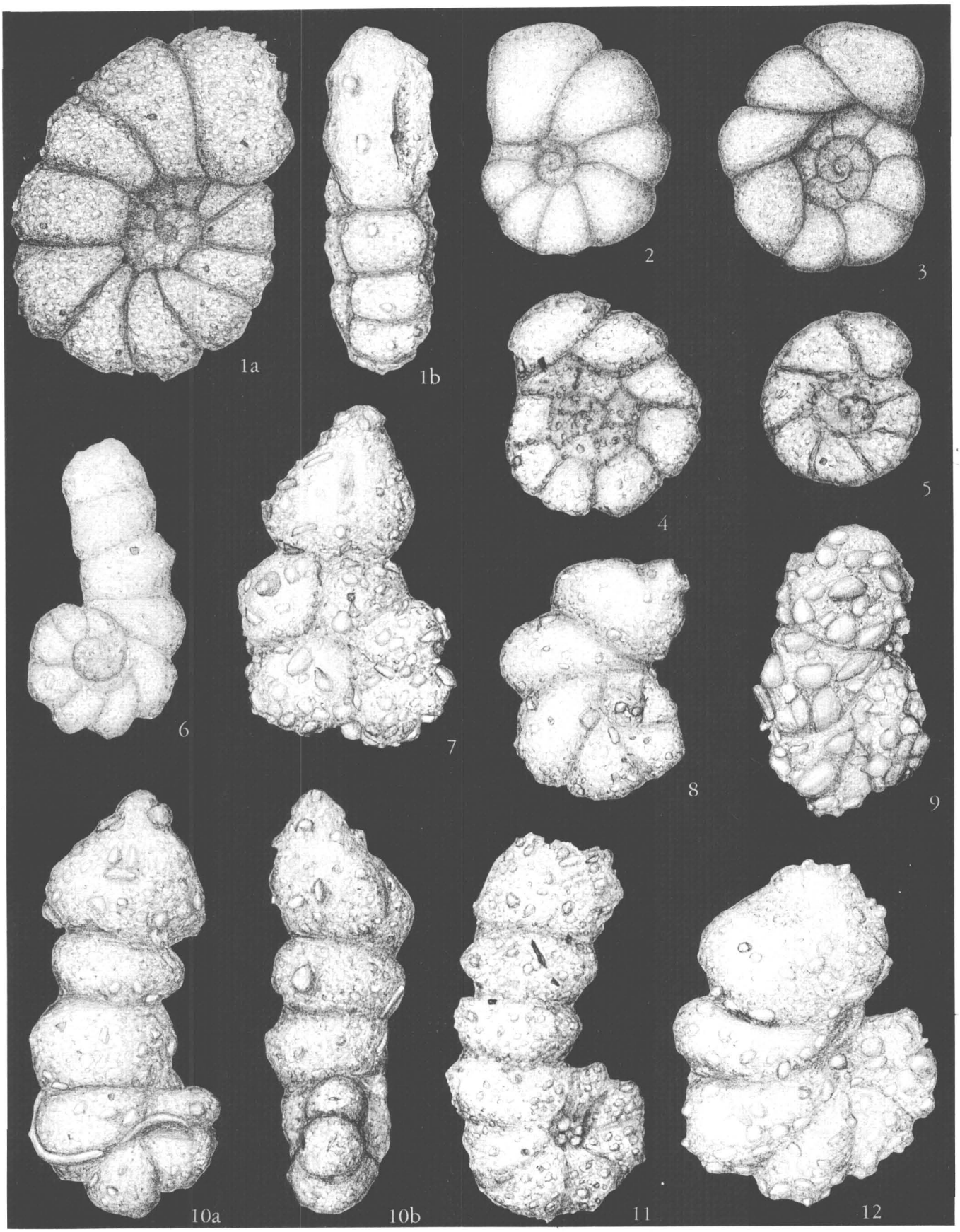
320475—55——8

PLATE 11

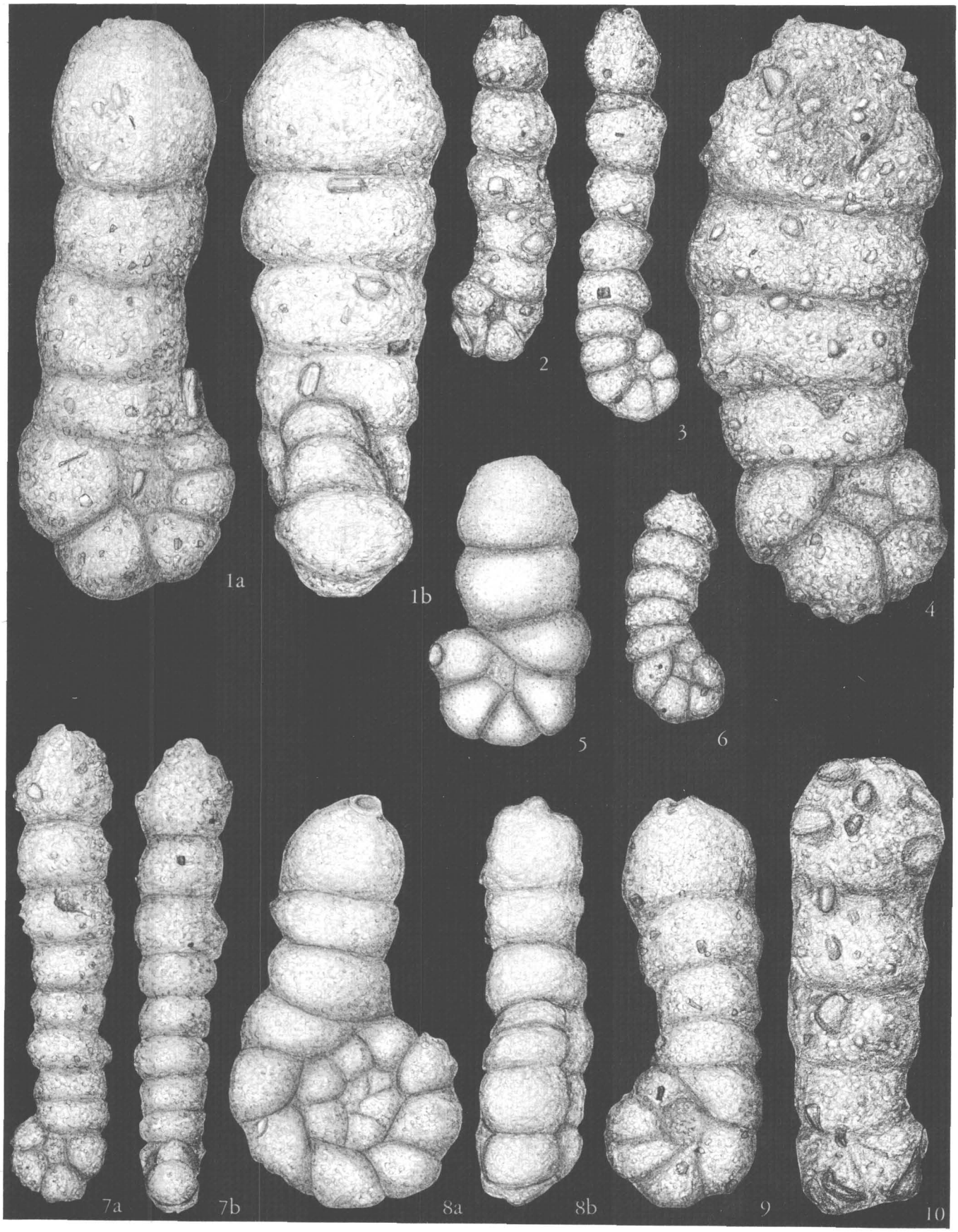
FIGURES 1–5. *Haplophragmoides barrowensis* Tappan. 1, Holotype (USNM 106477), 1a, side view, 1b, edge view. 2–3, Hypotypes (USNM P199a–b). 4–5, Hypotypes (USNM P193a–b). Figs. 1, 4–5, all from Lower Jurassic rocks in South Barrow Test Well 3, × 72. Figs. 2, 3, from Lower Jurassic rocks in the Sadlerochit River area, × 95. (p. 42).

6. *Ammobaculites fontinensis* (Terquem) Hypotype (USNM P253), from Lower Jurassic rocks of South Barrow Test Well 3. × 72. (p. 45).

7–12. *Ammobaculites barrowensis* Tappan, n. sp. 7, 8, 12, Paratypes (USNM P245a–c), showing large coil, short uniserial portion, constricted sutures and pyriform final chamber. 9, Paratype (USNM P249), an unusually coarsely grained specimen. 10a, Side view of holotype (USNM P244), 10b, edge view. 11, Paratype (USNM P247). All from Lower Jurassic rocks in South Barrow Test Well 3. × 41. (p. 45).



HAPLOPHRAGMOIDES, AMMOBACULITES



AMMOBACULITES

PLATE 12

FIGURES 1–10. *Ammobaculites alaskensis* Tappan, n. sp. 1a, Side view of holotype (USNM P219), a form with large coil and small uniserial portion, 1b, edge view. 2, 10, Paratypes (USNM P 768a–b). 3, 6, 8, 9, Paratypes (USNM P223a–d), showing variation from the small coil and narrow elongate test of fig. 3, to the wider form with fewer chambers as in fig. 9, and occasional evolutely coiled form of considerable width as in fig. 8. 4, Extremely wide paratype (USNM P221). 5, Small paratype (USNM P241). 7a, Side view of narrow, elongate paratype (USNM P225), showing unusually large number of uniserial chambers, 7b, edge view. Figures 1, 3–4, 6–9, all from Lower Jurassic rocks in South Barrow Test Well 3. Figures 2, 10, from Upper Jurassic rocks in Topagoruk Test Well 1. Fig. 5 from Upper Jurassic rocks of the Canning River area. All figures × 72. (p. 43).

320475—55——9

PLATE 13

FIGURES 1–3. *Ammobaculites vetusta* (Terquem and Berthelin) 1a, Side view of hypotype (USNM P255), 1b, edge view. 2, 3, Side views of hypotypes (USNM P257a–b), showing small size, tiny coil and somewhat irregular later chambers. Lower Jurassic rocks of South Barrow Test Well 3. All × 72. (p. 45).

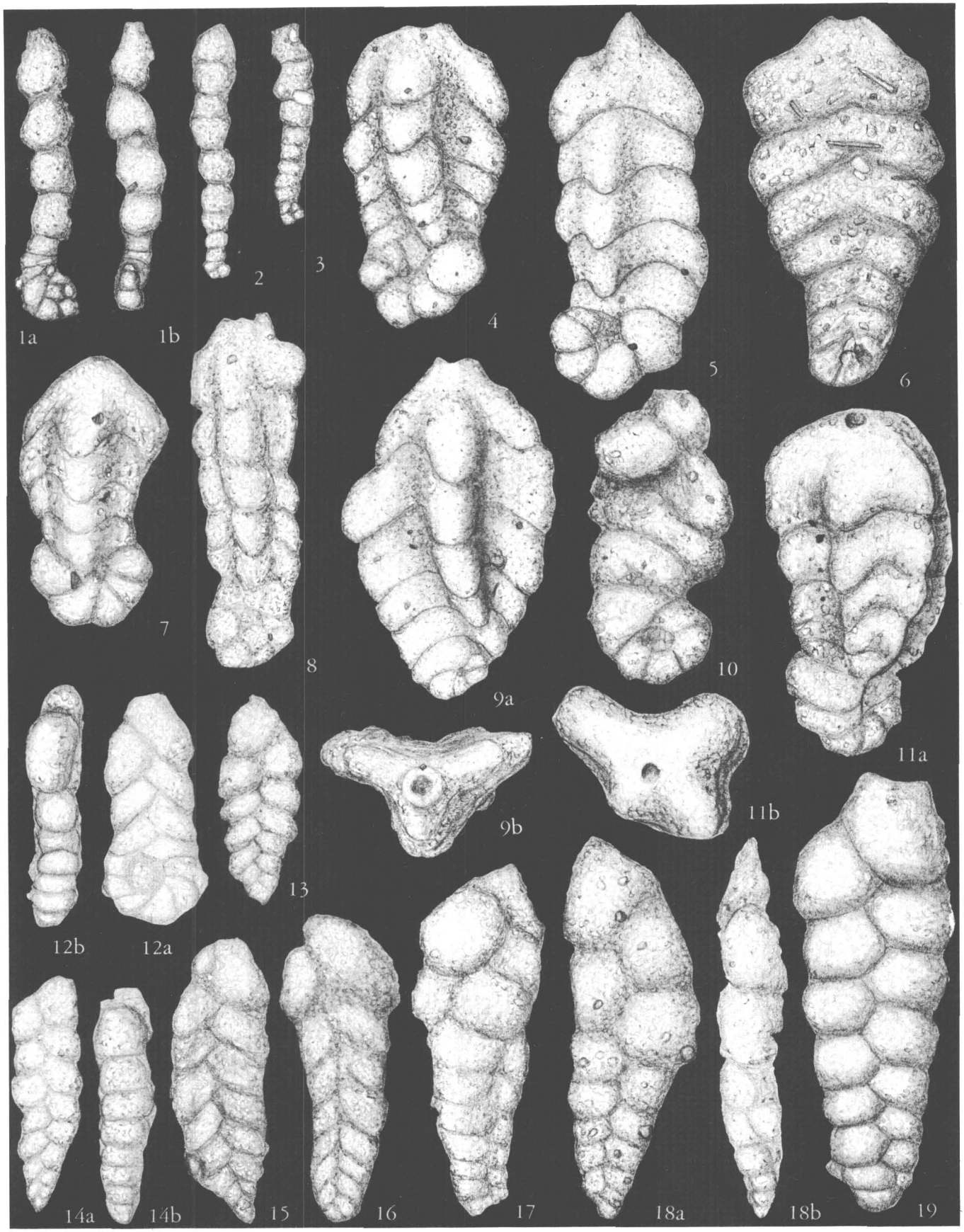
4–11. *Triplasia kingakensis* Loeblich and Tappan. 4, 5, Megalospheric paratypes, showing large coil and triangular later chambers. 6, Paratype lacking the third angle and remaining in a *Flabellammina*-stage. 7, Megalospheric paratype. 8, Elongate paratype with narrow test and parallel margins. 9a, Holotype, a microspheric form which flares more rapidly than the megalospheric generation; 9b, top view of holotype. 10, Paratype remaining in a *Flabellammina*-stage, although the final chamber shows a slight inflation which might have resulted in a third angle in succeeding chambers. 11a, Side view of paratype which has developed a fourth angle, although somewhat weaker than the three major angles; 11b, top view of the quadrate form. 9, Holotype (USNM P266), and paratypes of figs. 4–8, 10–11 (USNM P267a–g), all from Lower Jurassic rocks in South Barrow Test Well 3. All × 41. (p. 46)

12. *Spiroplectammina* sp. 12a, Side view of specimen (USNM P269), showing large coil, and narrower biserial portion, 12b, edge view. Upper Jurassic rocks of Welcome Creek, in the Siksikpuk-Nanushuk area. × 95. (p. 46).

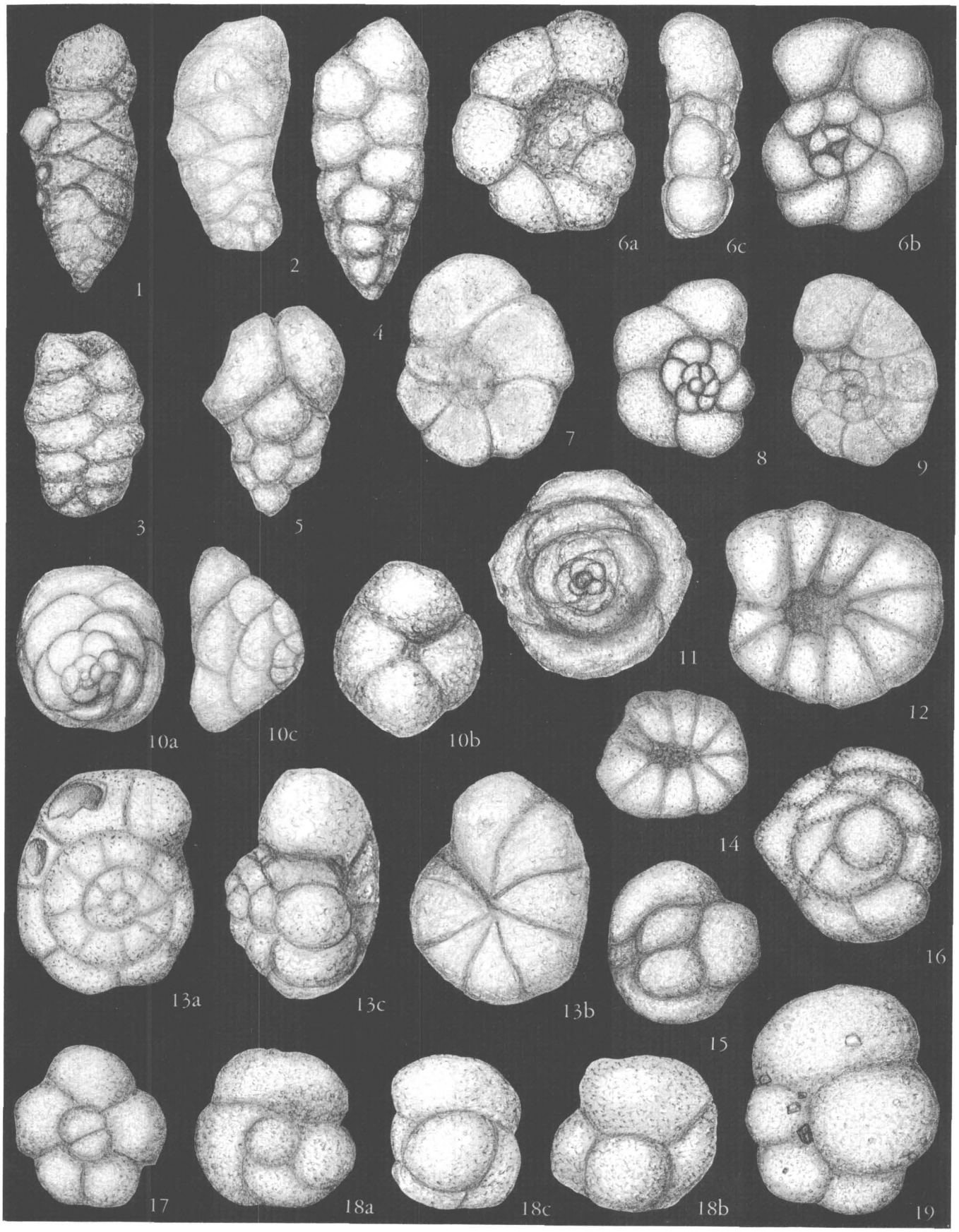
13–16. *Textularia areoplecta* Tappan, n. sp. 13, Small paratype (USNM P272). 14a, Side view of holotype (USNM P270), 14b, edge view. 15, Paratype (USNM P274). 16, Paratype (USNM P276). All from Lower Jurassic rocks in South Barrow Test Well 3. × 158. (p. 47).

17–18. *Gaudryina dyscrita* Tappan, n. sp. 17, Paratype (USNM P281) showing somewhat elongate triserial stage. 18a, Holotype (USNM P280), showing tapered base, 18b, edge view, showing amount of compression usual to this species, with triserial stage occupying about one-half the length of the test. Lower Jurassic rocks of South Barrow Test Well 3. × 158. (p. 47).

19. *Gaudryina kelleri* Tappan, n. sp. Holotype (USNM P761), showing rounded and inflated chambers, comparatively broad base and short triserial stage. Lower Jurassic rocks in South Barrow Test Well 3. × 158. (p. 47).



AMMOBACULITES, TRIPLASIA, SPIROPLECTAMMINA, TEXTULARIA, GAUDRYINA



GAUDRYINA, DOROTHIA, TROCHAMMINA

PLATE 14

FIGURES 1–3. *Dorothia*(?) *squamosa* (Terquem and Berthelin). Hypotypes (USNM P284a–c), showing rounded base, and almost cylindrical later portion. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 49).

4. *Gaudryina topagorukensis* Tappan, n. sp. Holotype (USNM P774) showing rounded chambers, and subparallel sides. Upper Jurassic rocks of Topagoruk Test Well 1. × 158. (p. 48).

5. *Gaudryina leffingwelli* Tappan, n. sp. Holotype (USNM P772), showing short and flaring test, short biserial portion and relatively large size. Upper Jurassic rocks of Topagoruk Test Well 1. × 95. (p. 48).

6–9. *Trochammina sablei* Tappan, n. sp. 6a, b, Opposite sides of holotype (USNM P304), showing flat spire, 6c, edge view. 7, 9, Ventral views of paratypes (USNM P305a–b). 8, Dorsal view of paratype (USNM P307). All from Lower Jurassic rocks in South Barrow Test Well 3. Figs. 6–8, × 95. Fig. 9, × 72. (p. 50).

10–11. *Trochammina topagorukensis* Tappan, n. sp. 10a, Dorsal view of holotype (USNM P777), showing numerous chambers and strongly curved sutures, 10b, ventral view, showing nearly radiate sutures, 10c, edge view, showing high spire, and plano-convex test. 11, Paratype (USNM P778), showing a crushed and compressed specimen, which still shows the numerous chambers and curved dorsal sutures. Upper Jurassic rocks of Topagoruk Test Well 1. × 95. (p. 51).

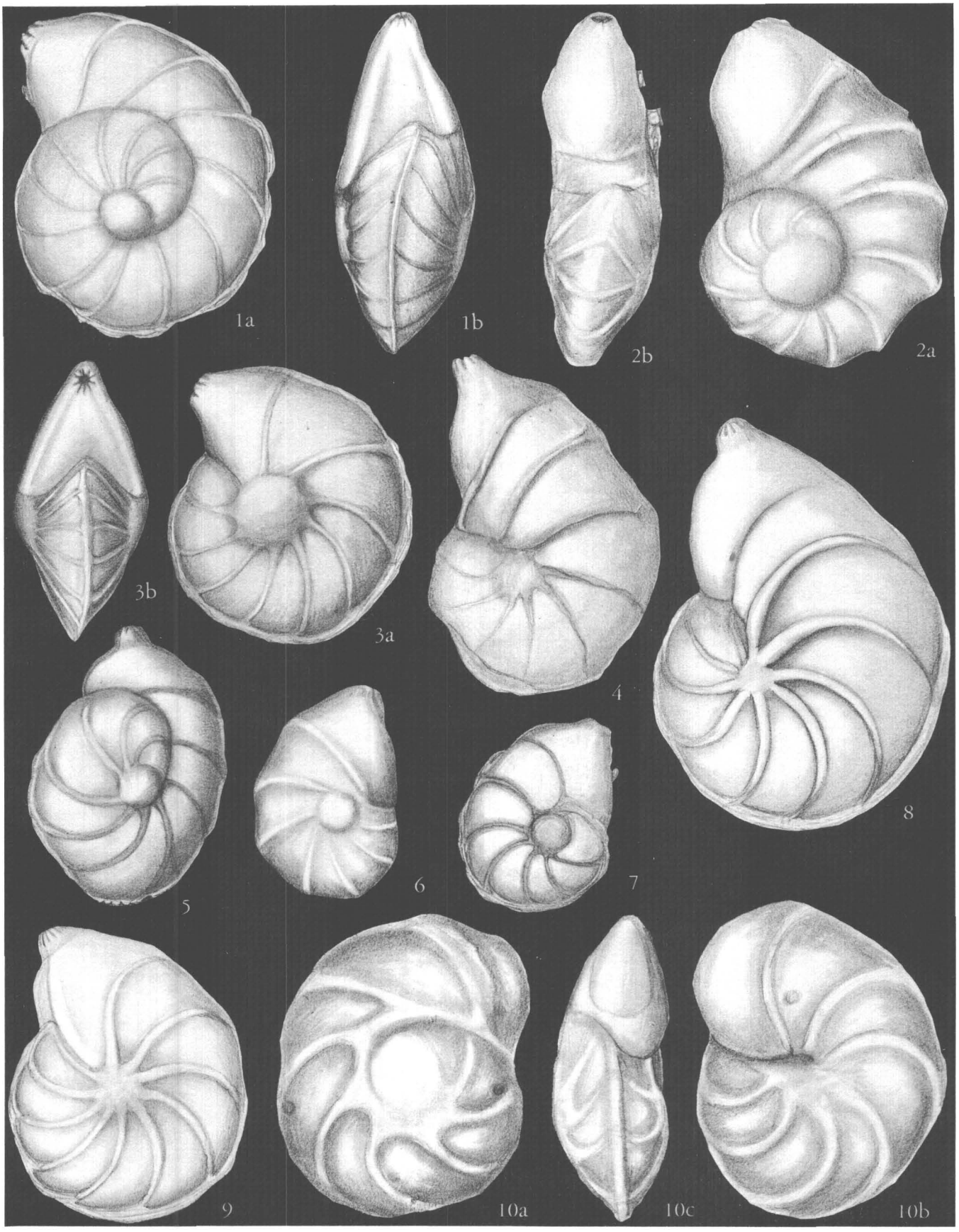
12–14. *Trochammina gryci* Tappan, n. sp. 12, 14, Ventral views of paratypes (USNM P302a–b), showing numerous chambers and central umbilicus. 13a, Dorsal view of holotype (USNM P301), showing radial and straight sutures; 13b, ventral view, showing numerous chambers in the final whorl, and radial sutures; 13c, edge view, showing bi-convex test, broadly rounded periphery and inflated chambers. Upper Jurassic rocks of the Canning River. × 95. (p. 50).

15–19. *Trochammina canningensis* Tappan, n. sp. 15, Dorsal view of small paratype (USNM P287), from Upper Jurassic rocks of the Canning River. 16, Larger paratype (USNM P289), showing more numerous chambers than is normal for this species, from the Lower Jurassic rocks of the Sadlerochit region. 17, Small paratype (USNM P293) and 19, larger specimen (USNM P291) from the Lower Jurassic of South Barrow Test Well 3. 18a, Dorsal view of holotype (USNM P286); 18b, ventral view, showing small number of much inflated chambers; 18c, edge view, showing very broadly rounded periphery. Upper Jurassic rocks of the Canning River. All × 95. (p. 49).

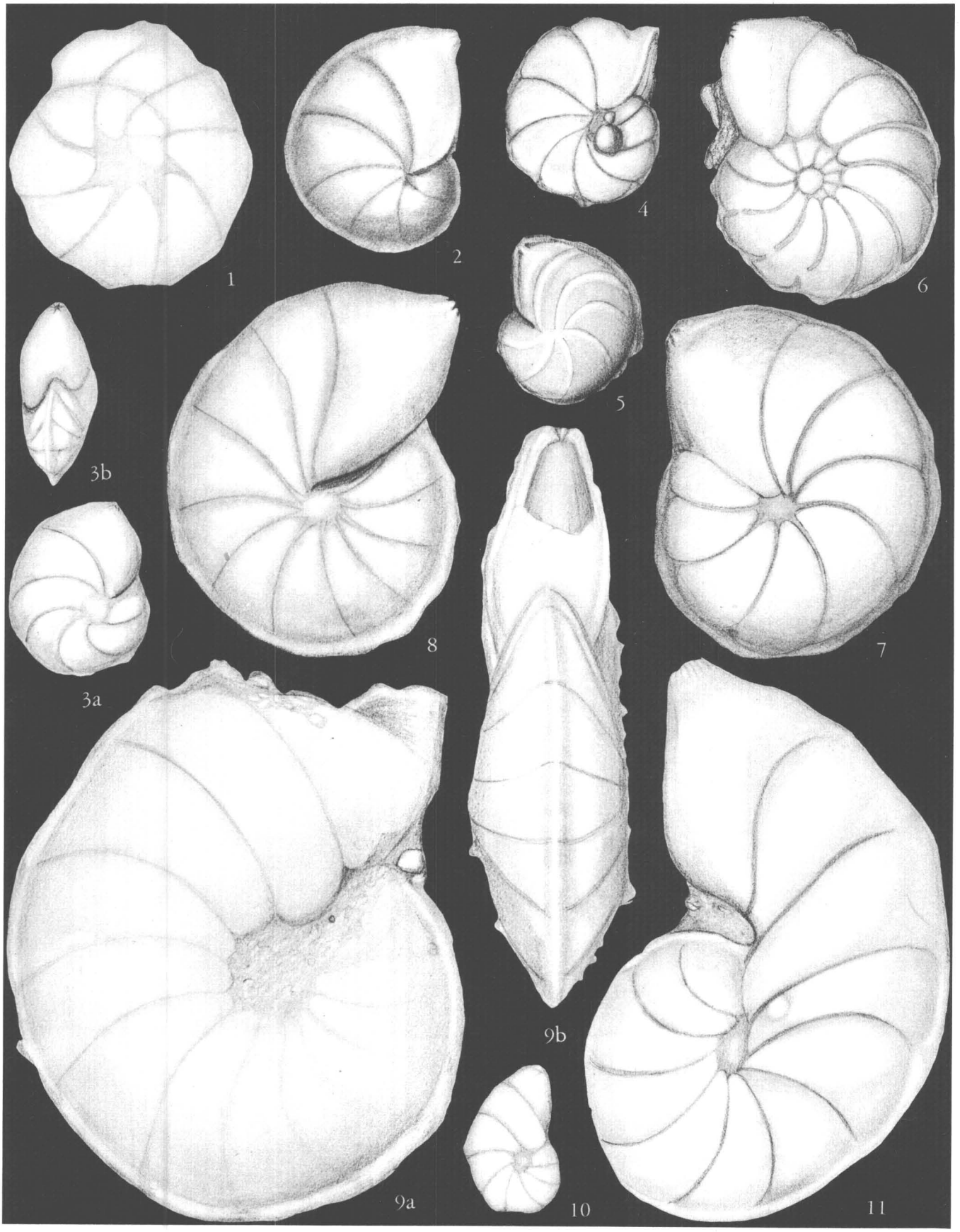
PLATE 15

FIGURE 1–9. *Lenticulina toarcense* Payard. 1a, Hypotype (USNM P356a), showing somewhat trochoid coil; lb, edge view. 2a, Hypotype (USNM P352a) showing trochoid character and final chamber which does not reach the coil, but tends to uncoil; 2b, edge view. 3a, Hypotype (USNM P356b), showing the most typical form, large umbonal boss, and elevated sutures; 3b, edge view, showing biconvex character, keeled periphery, and radiate aperture. 4, Hypotype (USNM P354a), showing planispiral test with smaller final chamber showing the tendency to uncoil. 5, Hypotype (USNM P354b), showing slightly irregular trochoid test. 6, Small hypotype (USNM P352b). 7, Small hypotype (USNM P359). 8, 9, Larger hypotypes (USNM P349a–b), showing strongly elevated sutures and peripheral keel. All from the lower Jurassic rocks in South Barrow Test Well 3. × 72. (p. 53).

10. *Darbyella volgensis* Tappan, new name. Hypotype (USNM P800). 10a, 10b, Opposite sides, showing the trochoid character, limbate sutures, which are strongly curved backwards at the periphery, and large umbilical boss on one side only; 10c, edge view. Upper Jurassic rocks of Topagoruk Test Well 1. × 95. (p. 51).



LENTICULINA, DARBYELLA



LENTICULINA

PLATE 16

FIGURES 1–3. *Lenticulina wisniowskii* (Myatliuk) 1, 3a, Side views of slightly trochoid hypotypes (USNM P360a–b); 3b, edge view; Upper Jurassic of Welcome Creek, in the Siksikpuk-Nanushuk area, × 72. 2, Side view of hypotype (USNM P780), a symmetrical form from upper Jurassic rocks in Topagoruk Test Well 1, × 95. (p. 54).

4–7. *Lenticulina excavata* (Terquem). 4, Hypotype (USNM P331). 5, Small hypotype (USNM P323). 6, Slightly evolute hypotype (USNM P333). 7, Typical involute lenticular hypotype (USNM P325). All from Lower Jurassic rocks in South Barrow Test Well 3. Figs. 4–6, × 72, fig. 7, × 95. (p. 52).

8–11. *Lenticulina prima* (d'Orbigny) 8, Hypotype (USNM P342). 9a, side view of large hypotype (USNM P337), showing numerous chambers, central depression and peripheral keel; 9b, edge view. 10, Small hypotype (USNM P345). 11, Large hypotype (USNM P339), which shows a tendency for the final chamber to uncoil, as did d'Orbigny's type specimens. All from Lower Jurassic rocks in South Barrow Test Well 3, and all × 72. (p. 52)

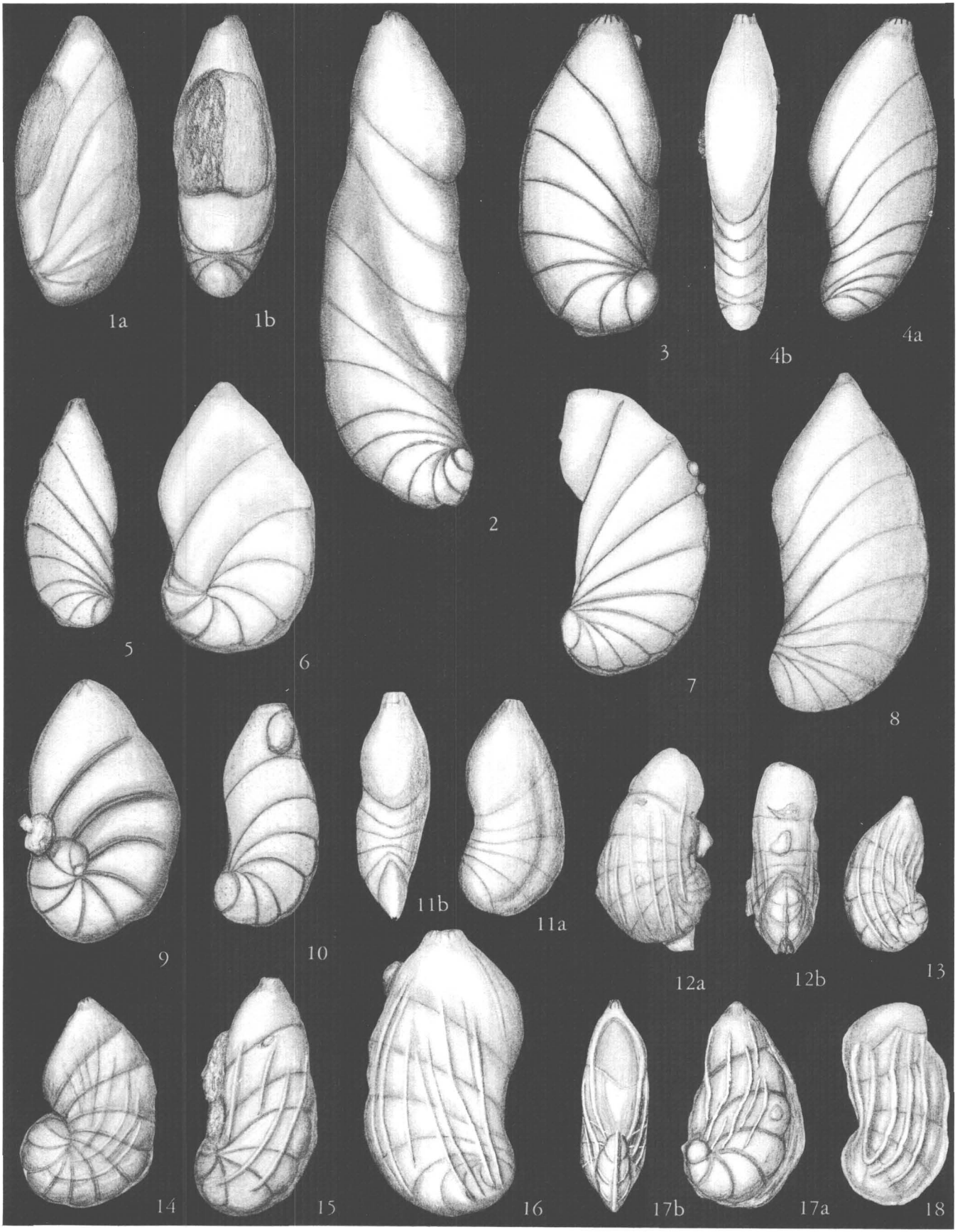
PLATE 17

FIGURES 1–10. *Astacolus pediacus* Tappan, n. sp. 1a, Side view of paratype (USNM P389); 1b, edge view, from Lower Jurassic rocks of Simpson Test Well 1. 2, 3, Side views of paratypes (USNM P395a–b), showing variation in size of this species. 4a, Side view of holotype (USNM P394); 3b, edge view. 5, 6, Side views of paratypes (USNM P397a–b), showing variation in breadth and amount of coiling of the early portion. 7, Paratype (USNM P399), with smaller final chamber, which does not reach backwards as much as is normal for this species. 8–10, Additional paratypes (USNM P395c–e), showing other variations in shape. Figs. 2–10 from Lower Jurassic rocks of South Barrow Test Well 3. All figs. × 95. (p. 56).

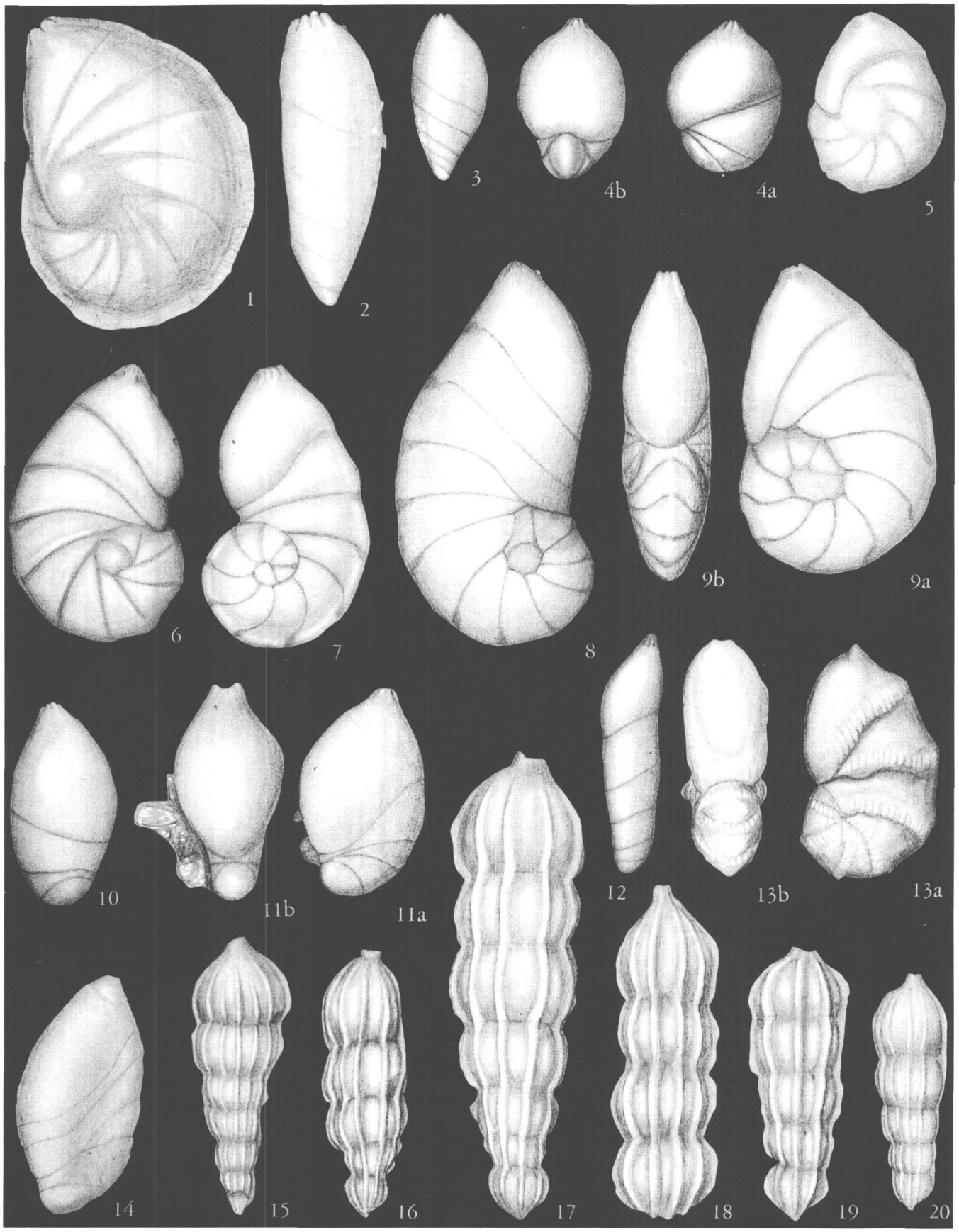
11. *Astacolus* sp. 11a, Side view of specimen (USNM P403) from Upper Jurassic rocks of Welcome Creek, in the Siksikpuk–Nanushuk region; 11b, edge view. × 72. (p. 57).

12–17. *Astacolus calliopsis* Tappan, n. sp. 12a, Side view of microspheric paratype (USNM P379); 12b, edge view. 13, 14, Side views of paratypes (USNM P375a–b). 15, Side view of paratype (USNM P373). 16, Side view of large paratype (USNM P377), showing the less pronounced coil of the megalospheric form. 17a, Side view of holotype (USNM P372); 17b, edge view. All from Lower Jurassic rocks of South Barrow Test Well 3. × 72. (p. 55).

18. *Marginulinopsis phragmites* Loeblich and Tappan. Hypotype (USNM P787) from Upper Jurassic rocks of Topagoruk Test Well 1. × 95. (p. 64).



ASTACOLUS, MARGINULINOPSIS



LENTICULINA, ASTACOLUS, MARGINULINA

PLATE 18

FIGURES 1. *Lenticulina varians* (Bornemann). Hypotype (USNM P346) from Lower Jurassic rocks of South Barrow Test Well 3 × 72. (p. 53).

2–3. *Marginulina breviformis* (Terquem and Berthelin). 2, Elongate hypotype (USNM P485a). 3, Short and broad hypotype (USNM P485b). Lower Jurassic rocks of South Barrow Test Well 3. × 72. (p. 58).

4. *Marginulina pinguicula* Tappan, n. sp. 4a, Side view of holotype (USNM P789). showing very few low and broad chambers, higher and inflated final chamber, and radiate aperture; 4b, face view. Upper Jurassic rocks of Topagoruk Test Well 1. × 95. (p. 61).

5–9. *Astacolus dubius* (Franke) 5, 6, Hypotypes (USNM P387a–b). 7–9, Hypotypes (USNM P384a–c), showing variation in size, and number of uncoiling chambers; 9b, edge view, showing degree of compression of this species. Lower Jurassic rocks of South Barrow Test Well 3. × 72. (p. 56).

10–11. *Marginulina pletha* Tappan, n. sp. 10, Paratype (USNM P441) showing very slight coil, and thick test. 11a, Side view of holotype (USNM P440); 11b, edge view. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 60).

12. *Marginulina calva* Tappan, n. sp. Holotype (USNM P515). showing narrow, elongate test. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 58).

13. *Astacolus daintreei* (Chapman) 13a, Side view of hypotype (USNM P381), showing striate and raised lower border of the chambers; 13b, edge view. Lower Jurassic rocks of South Barrow Test Well 3. × 72. (p. 55).

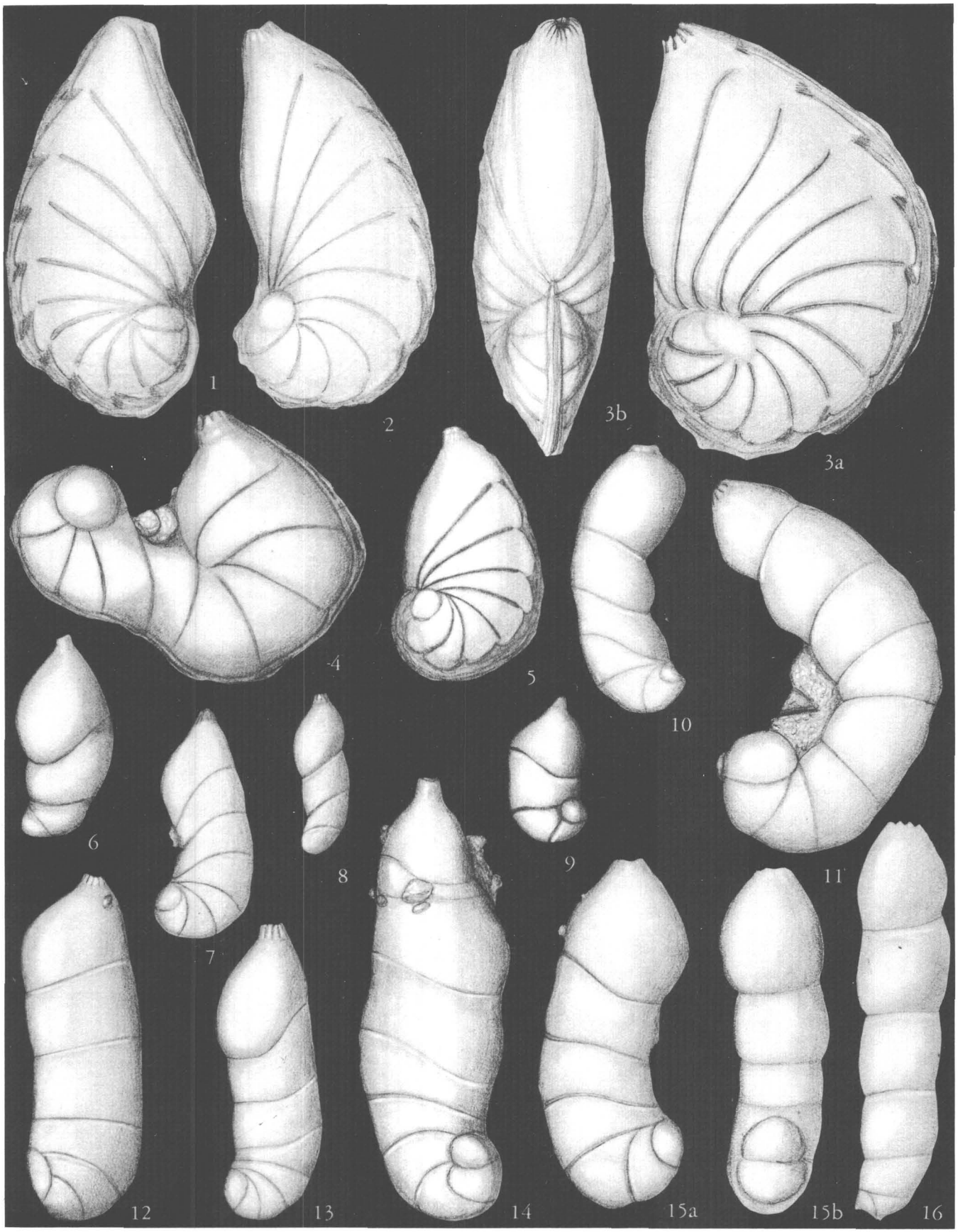
14. *Marginulina brevis* Paalzow. Hypotype (USNM P791), from Upper Jurassic rocks of Topagoruk Test Well 1, showing low, broad chambers, and ventral inflation. × 158. (p. 58).

15–20. *Marginulina demissa* (Terquem and Berthelin) Hypotypes (USNM P427a–f), showing low and narrow ribs, and variation in size and amount of tapering. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 59).

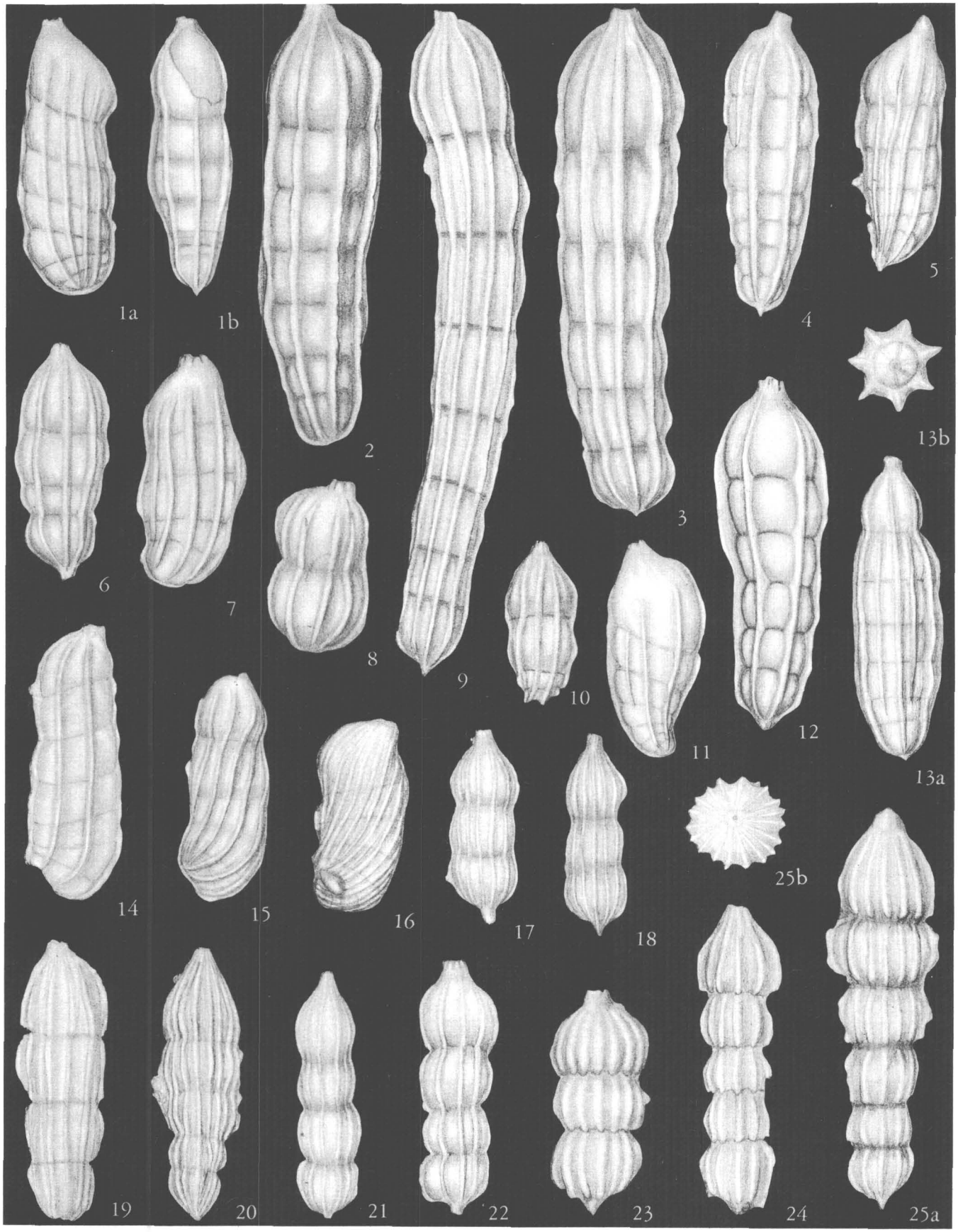
PLATE 19

FIGURES 1–5. *Astacolus arietis* (Terquem). 1–3, Hypotypes (USNM P362a–c) showing typical forms with wide, flange-like keel, and numerous chambers; 3b, edge view, showing lenticular character. 4, Malformed hyptoype (USNM P368), showing peculiar development caused by an injury during growth. 5, Smaller hypotype (USNM P364). Lower Jurassic rocks of South Barrow Test Well 3. Figs. 1–3, 5, × 72; fig. 4, × 95. (p. 55).

6–16. *Marginulina psila* Tappan, n. sp. 6, Paratype (USNM P477a), showing short form with inflated chambers. 7, 12, Paratypes (USNM P475a–b), showing slight coil and nearly cylindrical later portion. 8, Small paratype (USNM P477b). 9, Paratype (USNM P468) showing a thicker form. 10, 16, Elongate paratypes (USNM P477c–d), with slightly constricted sutures in the later portion. 11, Megalospheric paratype (USNM P471a), showing curved test, with numerous chambers. 13, Paratype (USNM P473). 14, Paratype (USNM P471b), showing thicker test than normal, and smaller final chamber with short distinct neck. 15a, Side view of holotype (USNM P470), showing most typical appearance; 15b, edge view. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 61).



ASTACOLUS, MARGINULINA



MARGINULINA

PLATE 20

FIGURES 1–13. *Marginulina prima* d'Orbigny. 1, 7, Hypotypes (USNM P457a–b), showing slight coil at the base, continuous ribs and eccentric aperture. 1b, edge view. 2, megalospheric hypotype (USNM P454). 3, 12, Megalospheric hypotypes (USNM P450a–b), with large bulbous proloculus. 4–6, 8, 13, Hypotypes (USNM P452a–e), showing gradation from almost nodosarian forms (figs. 4, 13) to definitely marginuline ones like fig. 5; 13b, top view. 10, Hypotype (USNM P445), a small, microspheric form. 11, Microspheric hypotype (USNM P447). All from Lower Jurassic rocks of South Barrow Test Well 3. 9, Very elongate megalospheric hypotype (USNM P465) from the Lower Jurassic rocks of South Barrow Test Well 2. Figs. 1, 3, 6, 7, 10, all × 95. Figs. 2, 4, 5, 8, 9, 11–13, all × 72. (p. 60).

14. *Marginulina quadricostata* Terquem. Side view of flattened hypotype (USNM P480), showing few ribs. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 62).

15–16. *Marginulina radiata* Terquem. Hypotypes (USNM P482a–b), showing somewhat oblique ribs. Lower Jurassic rocks of South Barrow Test Well 3. Fig. 15, × 95; fig. 16, × 72. (p. 62).

17–25. *Marginulina interrupta* Terquem. 17–19, 21, Small hypotypes (USNM P433a–d), showing inflated chambers, and basal spine. 20, Hypotype (USNM P431) which is nearly nodosarian. 22, Hypotype (USNM P436). 23–25, Hypotypes (USNM P433e–g), showing the interrupted costae typical of the species, and the almost symmetrical appearance of the tests; 25b, top view. All from the Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 59).

PLATE 21

FIGURES 1–10. *Marginulina utricula* Terquem and Berthelin. 1–4, Hypotypes (USNM P508a–d), showing small specimens similar to the type from France (fig. 4), and with accessory basal spines (figs. 1 and 3). 5–7, 10, Larger hypotypes (USNM P506a–d), showing nearly cylindrical test and basal spine. 8, Hypotype (USNM P510) showing slight curvature. 9, Hypotype (USNM P503), showing cylindrical test, with final chamber of smaller diameter. Lower Jurassic rocks of South Barrow Test Well 3. × 41. (p. 63).

11. *Dentalina ectadia* Loeblich and Tappan. Hypotype (USNM P794). Upper Jurassic of Topagoruk Test Well 1. × 95. (p. 66).

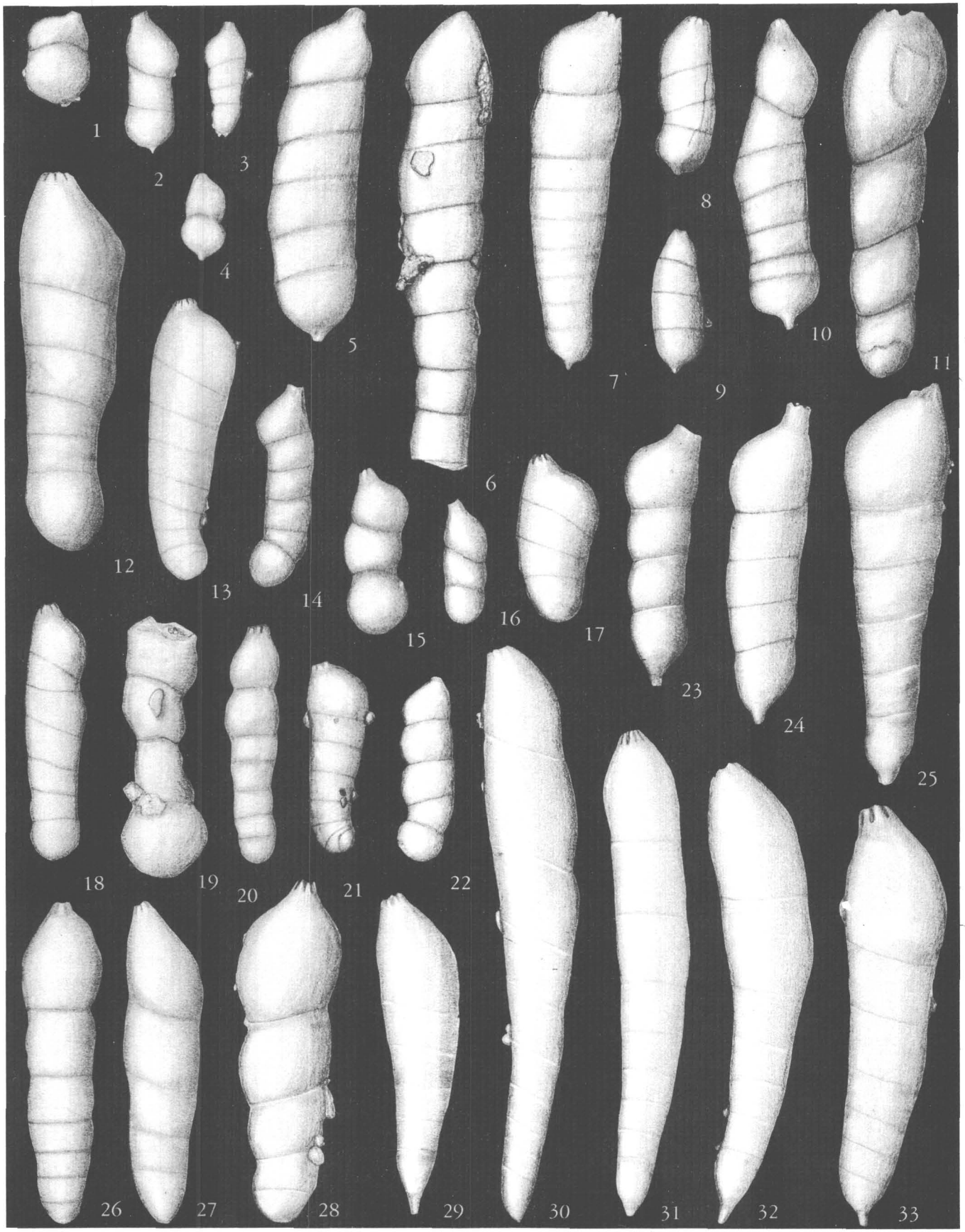
12–22. *Marginulina thuringica* (Franke). 12, Megalospheric hypotype (USNM P495a), showing large bulbous proloculus and nearly straight test. 13, Hypotype (USNM P491a), a microspheric specimen with slight coil at the base. 14, 15, Hypotypes (USNM P495b–c), showing two small forms. 16, Hypotype (USNM P489). 17, Hypotype (USNM P497). 18, 19, Hypotypes (USNM P493), showing variation in size of basal chamber and in height of later chambers. 20, Hypotype (USNM P495d). 21, Microspheric hypotype (USNM P500). 22, Hypotype (USNM P491b). All from Lower Jurassic rocks of South Barrow Test Well 3. × 41. (p. 63).

23–25. *Dentalina tortilis* Franke. 23, 25, Hypotypes (USNM P643a–b) showing elongate proloculus and single large basal spine. 24, Hypotype (USNM P645). Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 68).

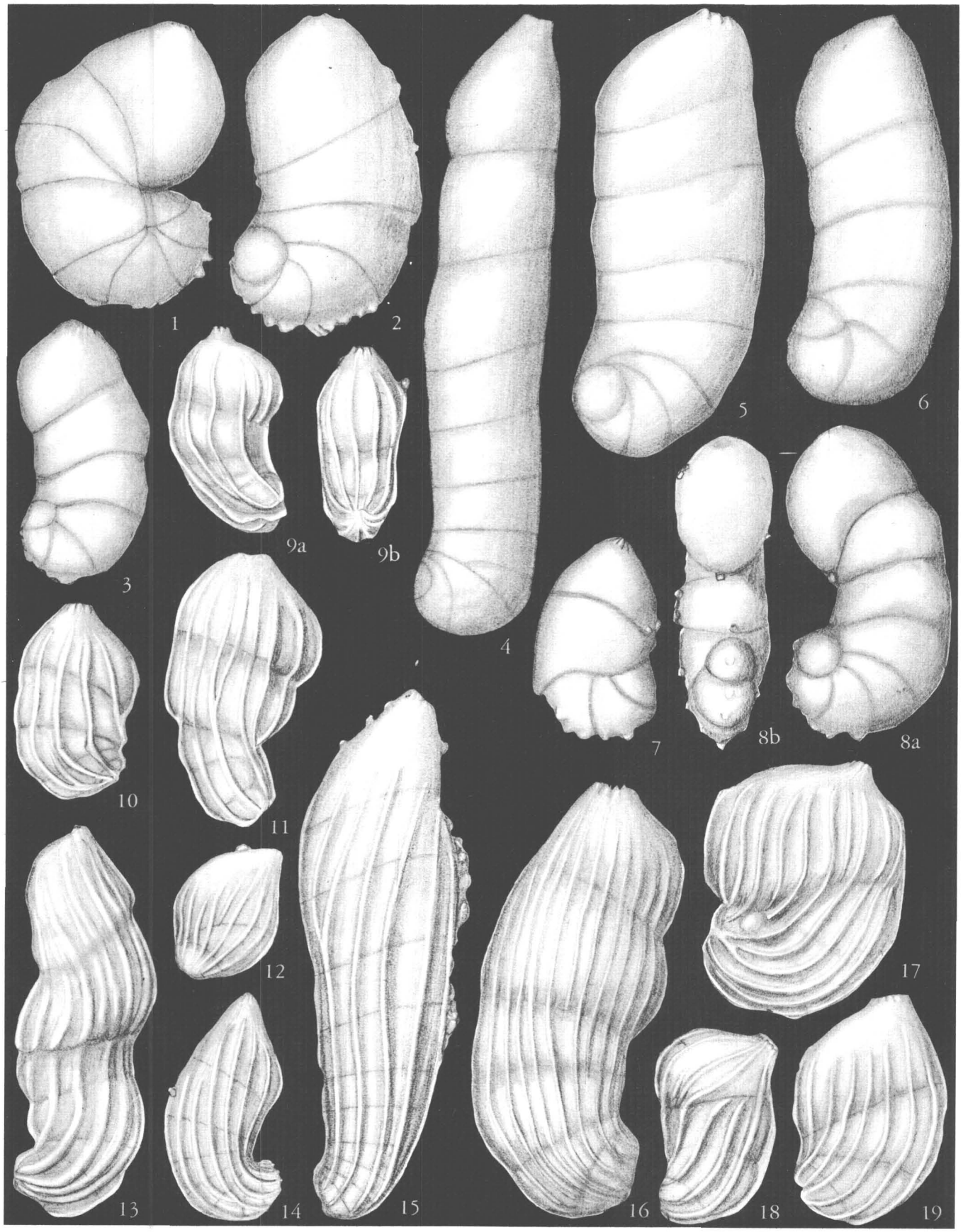
26–27. *Dentalina subtenuicollis* Franke. 26, Hypotype (USNM P625), × 72. 27, Hypotype (USNM P623), × 95. Lower Jurassic rocks of South Barrow Test Well 3. (p. 67).

28. *Dentalina bartensteini* Tappan, new name. Hypotype (USNM P618). Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 65).

29–33. *Dentalina pseudocommunis* Franke. 29–30, Hypotypes (USNM P610a–b) showing tapered test, oblique sutures, and basal spine. 31, Hypotype (USNM P602), showing a more cylindrical specimen. 32, Hypotype (USNM P612), showing curved test. 33, Hypotype (USNM P608). Lower Jurassic rocks of South Barrow Test Well 3. All × 95. (p. 66).



MARGINULINA, DENTALINA



MARGINULINA, VAGINULINA

PLATE 22

FIGURES 1–8. *Marginulina bergquisti* Tappan, n. sp. 1, Microspheric paratype (USNM P407a), showing closely coiled base, and denticulate lower margin. 2, Megalospheric paratype (USNM P405a), showing large proloculus, slight uncoiled portion, and well-developed denticulate lower margin. 3, Small paratype (USNM P407b). 4, Unusually long paratype (USNM P409), which lacks the basal denticulations. 5, 6, Two additional paratypes (USNM P405b–c) with smooth lower margin. 7, Small paratype (USNM P405d) showing well developed basal nodes. 8a, Side view of holotype (USNM P404), with slight coil, well developed nodes, and a few uncoiled chambers; 8b, edge view. All from Lower Jurassic rocks of South Barrow Test Well 3. Fig. 6, × 95; all others × 72. (p. 57).

9–19. *Vaginulina curva* Franke. 9, Hypotype (USNM P652a), a megalospheric form which has many of the characters of *Marginulina;* 9a, side view; 9b, edge view. 10, Hypotype (USNM P652b), a somewhat more flattened form. 11, Megalospheric hypotype (USNM P652c), of a size nearly equal to that of Franke's type from the German Lias. 12, Juvenile hypotype (USNM P654a). 13, Megalospheric hypotype (USNM P652d) showing *Marginulina*-like characters. 14, Microspheric hypotype (USNM P652e), tending toward the characters of *Astacolus*. 15, Elongate hypotype (USNM P648), showing typical *Vaginulina* development, slight curve at the base, and flattened uncoiled portion. 16, Broad hypotype (USNM P652f), with numerous costae, and inflated chambers. 17, Broad, flattened microspheric hypotype (USNM P654b). 18, Megalospheric hypotype (USNM P654c). 19, *Astacolus*-like hypotype (USNM P650). All from Lower Jurassic rocks of South Barrow Test Well 3. × 72. (p. 76).

PLATE 23

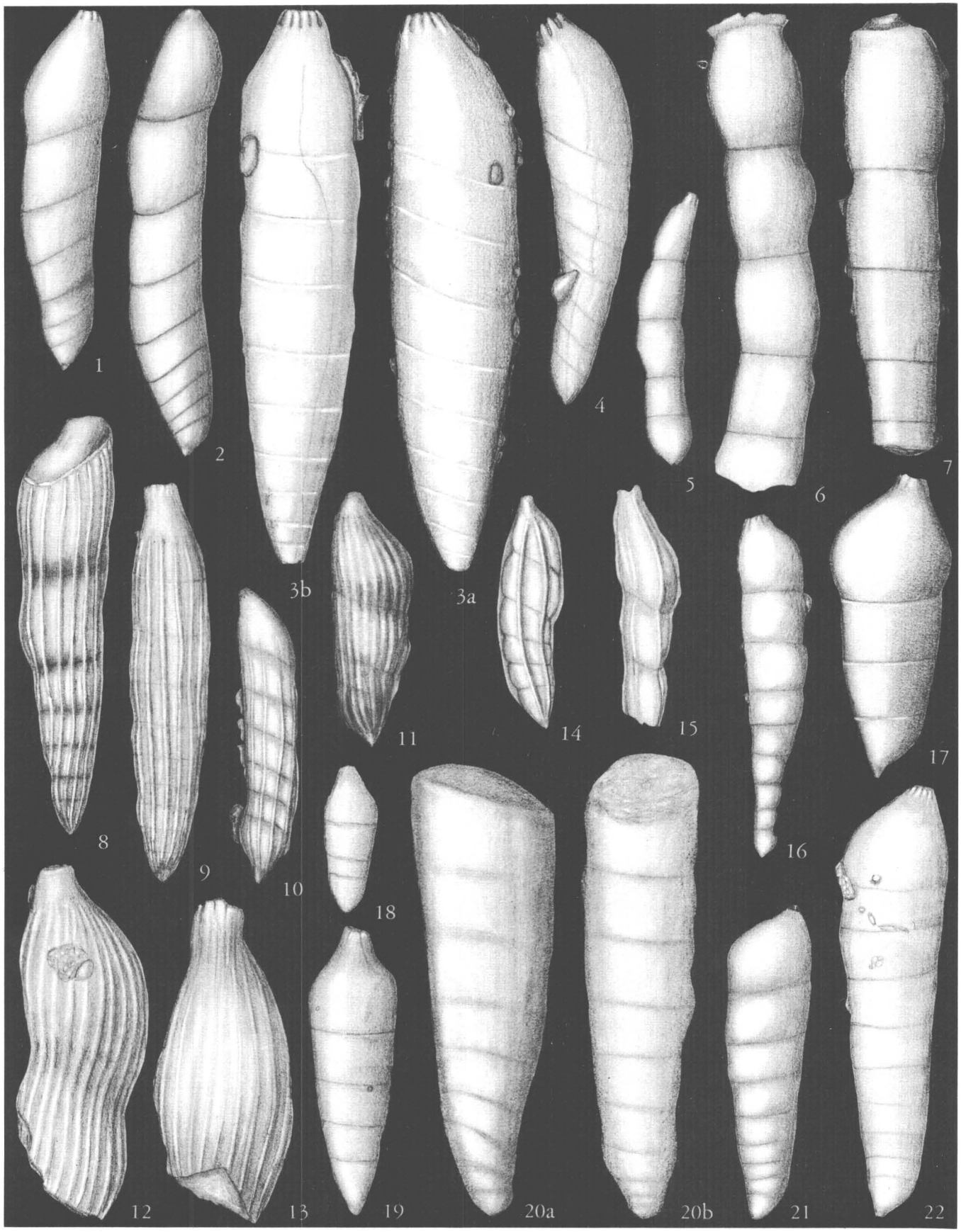
FIGURES 1–4. *Dentalina terquemi* d'Orbigny. 1, Hypotype (USNM P639a), showing low conical proloculus and later chambers of increasing height, × 95. 2, 3a, Side views of hypotypes (USNM P637a–b) showing large and robust character of this species, and well defined radiate aperture; 3b, edge view. 4, Hypotype (USNM P639b). Figs. 2–4, × 72. All from Lower Jurassic rocks of South Barrow Test Well 3. (p. 68).

5–7. *Dentalina exilis* Franke. 5, 6, Hypotypes (USNM P600a–b), showing arcuate test, and chambers of nearly equal size. 7, Hypotype (USNM P599), a fragment. Figs. 5–6, × 95. Fig. 7, × 158. All from Lower Jurassic rocks of South Barrow Test Well 3. (p. 66).

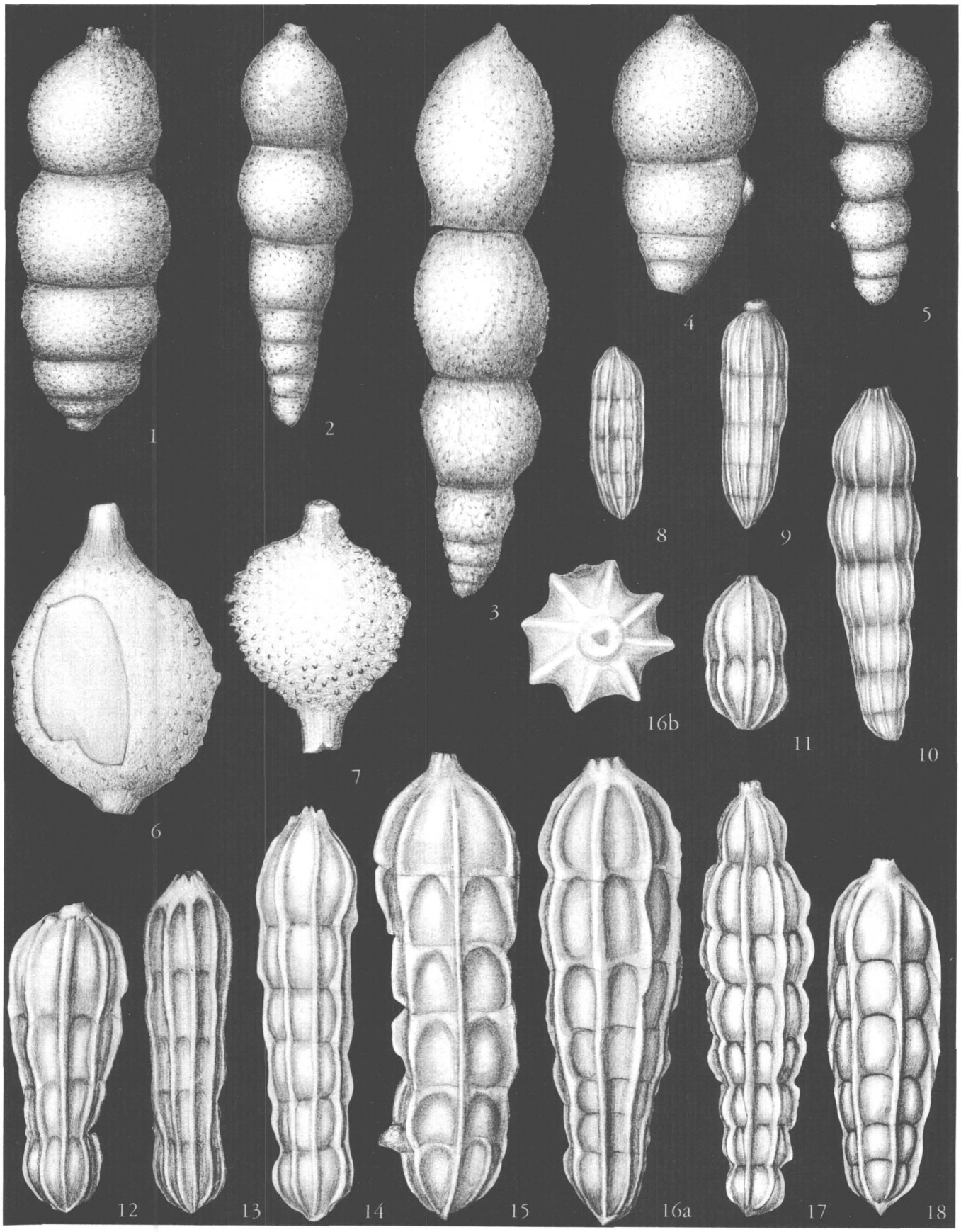
8–13. *Dentalina tenuistriata* Terquem. 8, Microspheric hypotype (USNM P627), showing flaring character, and numerous fine longitudinal ribs. 9, Hypotype (USNM P629), showing how ribs die out at the terminal portion of the test, leaving the neck bare. 10, Megalospheric hypotype (USNM P632a), showing large proloculus, and later chambers of nearly equal diameter common to this generation. 11, Hypotype (USNM P632b) showing apiculate base. 12, 13, Fragments of very large microspheric hypotypes (USNM P632c–d), showing the size attained by single chambers in the adult. All × 95. Lower Jurassic rocks of South Barrow Test Well 3. (p. 67).

14–15. *Dentalina clivosa* (Franke). 14, Hypotype (USNM P597), showing arcuate test, few longitudinal ribs and pointed base. 15, Hypotype, (USNM P598), showing somewhat produced final chamber. × 95. Lower Jurassic rocks of South Barrow Test Well 3. (p. 66).

16–22. *Vaginulina sherborni* (Franke). 16, Hypotype (USNM P660a), showing long, straight, tapering test. 17, Hypotype (USNM P660b), a small form, showing the apiculate base and radiate aperture. 18, Small hypotype (USNM P662). 19, Hypotype (USNM P664). 20a, Side view of large hypotype (USNM P668); 20b, edge view. 21, 22, Hypotypes (USNM P660c–d). Figs. 16, 18, 21–22, × 41; fig. 17, × 95; figs. 19–20, × 72. Fig. 20 from Lower Jurassic rocks of Simpson Test Well 1; all others from Lower Jurassic rocks of South Barrow Test Well 3. (p. 77).



DENTALINA, VAGINULINA



NODOSARIA

PLATE 24

FIGURES 1–5. *Nodosaria setulosa* Tappan. 1, Holotype (USNM P582), showing low early chambers, higher later chambers, and hispid surface. 2–4, Paratypes (USNM P579a–c), showing microspheric forms, increasing in diameter rather rapidly in the early portion. 5, Megalospheric paratype (USNM P579d), showing less flaring test, and more nearly equal sized chambers. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 73).

6–7. *Nodosaria apheilolocula* Tappan, new name. 6, Hypotype (USNM P520), showing globular chambers, with tubular connections, and hispid surface, × 158. 7, Hypotype (USNM P519), × 218. Lower Jurassic rocks of South Barrow Test Well 3. (p. 68).

8–10. *Nodosaria phobytica* Tappan, n. sp. 8, Small paratype (USNM P558). 9, Holotype (USNM P555), showing many low ribs, pointed base, and short neck. 10, Paratype (USNM P556). Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 71).

11–18. *Nodosaria mitis* (Terquem and Berthelin). 11, Juvenile hypotype (USNM P536a), of the type described as f. *juvensis* Franke of this species. 12, Hypotype (USNM P532), showing large proloculus, and continuous ribs. 13, Large hypotype (USNM P536b). 14, 18, Hypotypes (USNM P538a–b), showing apiculate base and flange-like ribs. 15, Hypotype (USNM P542), showing well developed neck. 16a, 17, Hypotypes (USNM P540a–b), showing flange-like ribs; 16b, top view. Lower Jurassic rocks of South Barrow Test Well 3. Fig. 13, × 41; other figs. × 72. (p. 70).

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PLATE 25

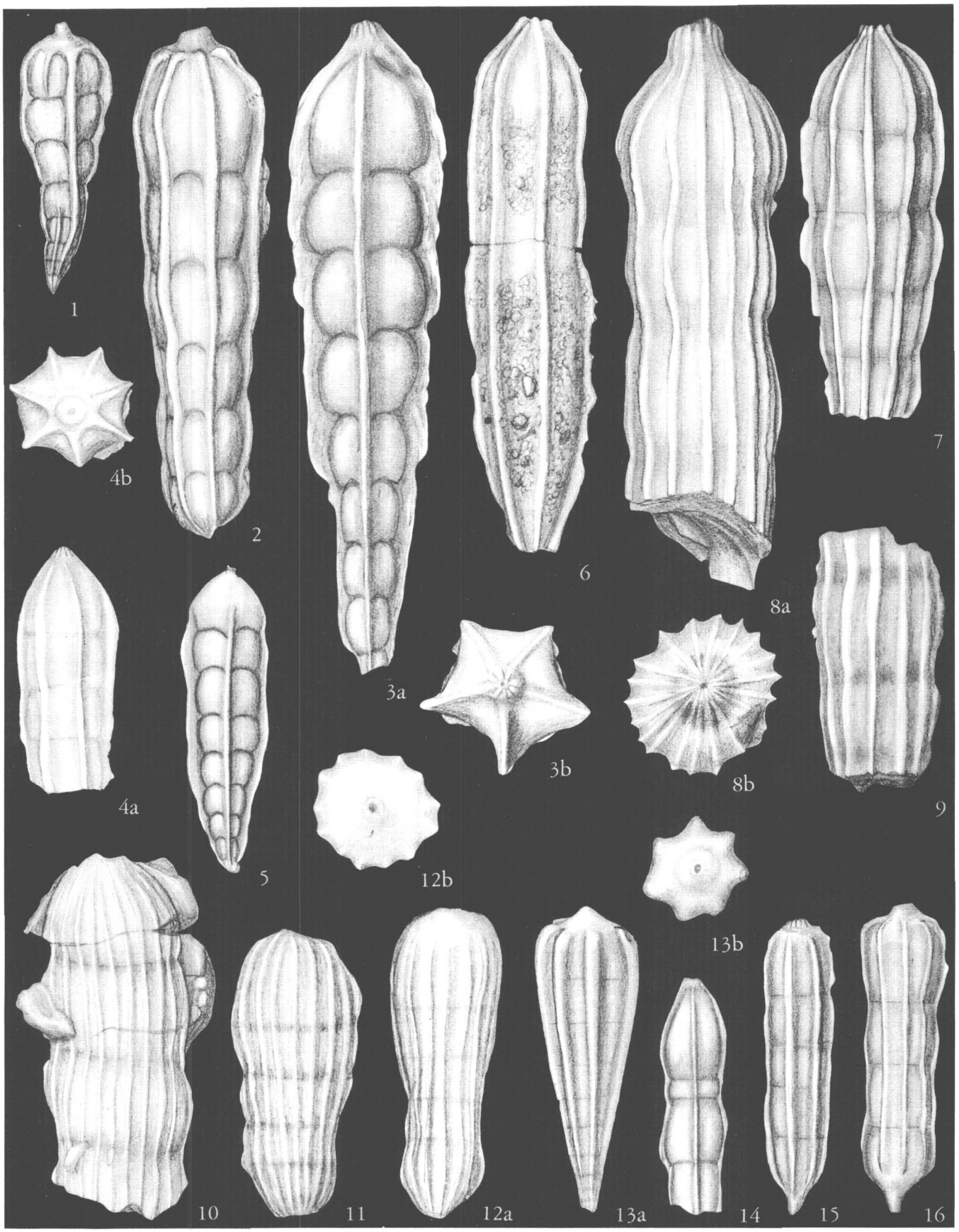
FIGURES 1–5. *Nodosaria radiata* (Terquem). 1, Hypotype (USNM P571), showing tapering microspheric test, and increase of ribs in later portion. 2, Megalospheric hypotype (USNM P568a), showing large proloculus, and nearly parallel-sided test, with flange-like ribs. 3a, Microspheric hypotype (USNM P565); 3b, top view, showing radiate aperture. 4a, Side view of hypotype (USNM P568b); 4b, top view. 5, Microspheric hypotype (USNM P568c). Fig. 4, × 41; other figs. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 72).

6–7. *Nodosaria vermicularis* (Terquem). 6, Hypotype (USNM P529), showing tapered base, indistinct sutures, and cylindrical test. 7, Hypotype (USNM P530). Lower Jurassic rocks of South Barrow Test Well 1. × 41. (p. 73).

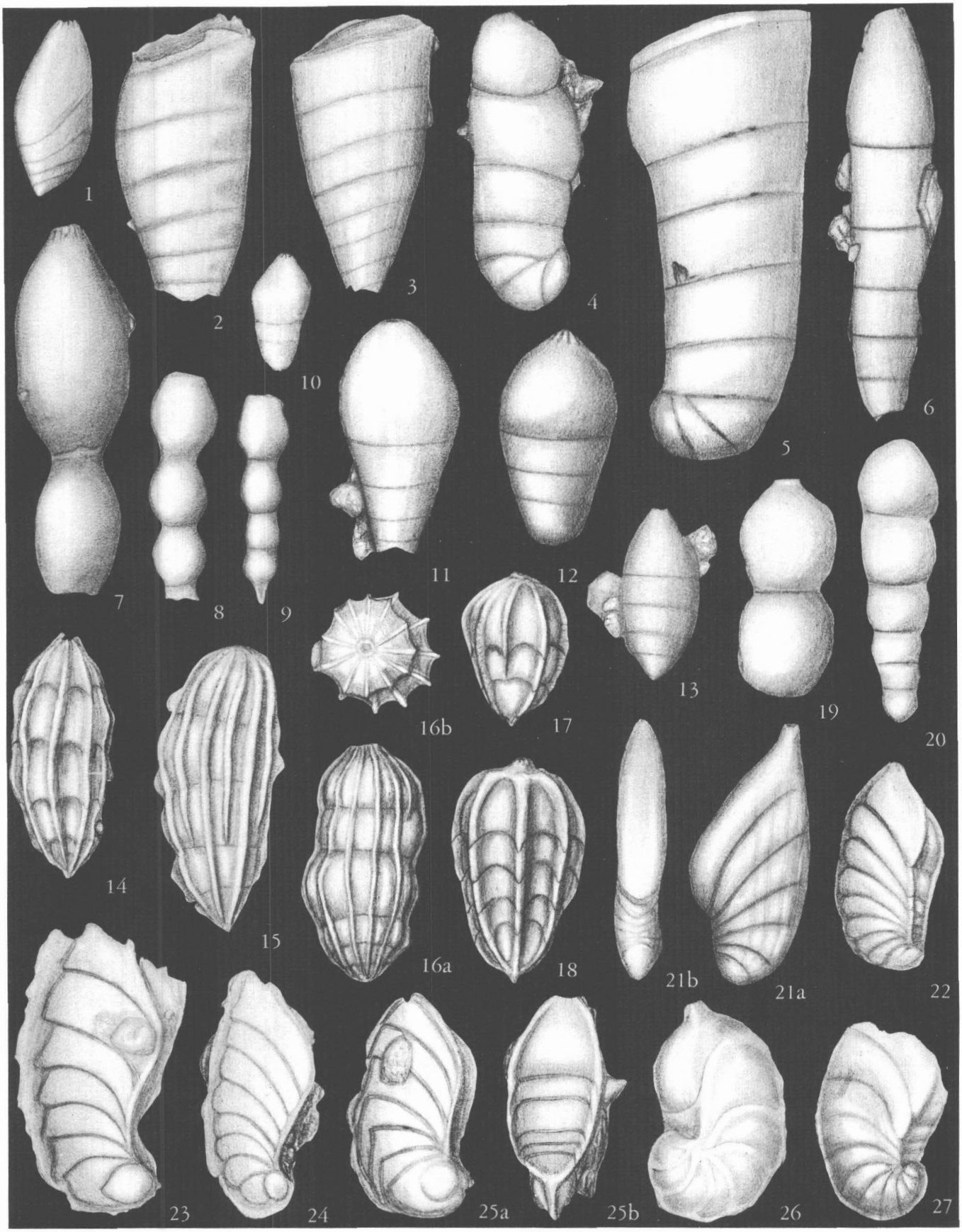
8–9. *Nodosaria prima* d'Orbigny. 8a, Side view of large massive hypotype (USNM P562); 8b, top view, showing numerous ribs, which continue to the aperture; Lower Jurassic rocks of South Barrow Test Well 3. 9, Fragment of hypotype (USNM P564), from the Lower Jurassic of Simpson Test Well 1. × 41. (p. 72).

10–12. *Nodosaria pachistika* Tappan, n. sp. 10, Paratype (USNM P551), showing large bulbous chambers, and numerous fine ribs. 11, Paratype (USNM P548). 12a, Side view of holotype (USNM P547), showing large proloculus, and somewhat lower later chambers; 12b, top view. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 71).

13–16. *Nodosaria berthelini* Tappan, n. sp. 13a, Side view of paratype (USNM P525a), showing flaring microspheric form, and broad rounded ribs; 13b, top view, showing smooth upper surface. 14, 15, Paratypes (USNM P525b–c), showing parallel sides of megalospheric generation. 16, Holotype (USNM P524), showing apiculate base, and short neck. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 69).



NODOSARIA



VAGINULINA, VAGINULINOPSIS, NODOSARIA, RECTOGLANDULINA, PLANULARIA, SARACENARIA

PLATE 26

FIGURE 1. *Vaginulina anomala* Blake. Hypotype (USNM P647), showing pointed base, triangular section and large final chamber. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 76).

2–3. *Vaginulina* sp. Figured specimens (USNM P669a–b), showing broad, flattened tests, triangular side view, and low chambers. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 78).

4–5. *Vaginulinopsis matutina* (d'Orbigny). 4, Hypotype (USNM P670), showing coiled base, and low chambers, gradually increasing in height. 5, Hypotype (USNM P671), showing larger form which is flattened in the later portion. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 78).

6. *Nodosaria candela* Franke. Hypotype (USNM P528), showing slender, elongate, and cylindrical test, and produced final chamber. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 69).

7–9. *Nodosaria regularis* Terquem. 7, Hypotype (USNM P573), showing two large elongate inflated chambers, broken from a much larger specimen. 8, Hypotype (USNM P574a), showing more rounded chambers of the early portion of the test. 9, Hypotype (USNM P574b), showing apiculate base. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 72).

10–11. *Rectoglandulina turbinata* (Terquem and Berthelin). 10, Hypotype (USNM P595), showing low early chambers, and inflated final chamber. 11, Larger hypotype (USNM P596), which is broken at the base. ×72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 75).

12. *Rectoglandulina brandi* Tappan, n. sp. Holotype (USNM P792), showing robust test, broad rounded base, gradually enlarging test, and radiate aperture. × 72. Upper Jurassic rocks of Topagoruk Test Well 1. (p. 74).

13. *Rectoglandulina oviformis* (Terquem). Hypotype (USNM P590), showing pupiform outline, conical proloculus, and final chamber of approximately equal breadth and height. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 74).

14–16. *Rectoglandulina multicostata* (Bornemann). Hypotypes (USNM P588a–c), showing pointed base, numerous continuous costae, and slightly constricted sutures; 16b, apertural view. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 74).

17–18. *Rectoglandulina quinquecostata* (Bornemann). 17, Hypotype (USNM P592), showing small form, of the type referred to *G. septangularis*, but with 9 ribs, which increased in number by intercalation after the first chamber. 18, Larger specimen (USNM P594), showing the same pointed base, low chambers, and higher final chamber, but with only 7 ribs, and similar in appearance to the type of *G. abbreviata* Bornemann. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 75).

19–20. *Nodosaria detruncata* Schwager. 19, Hypotype (USNM P586a), showing globular chambers, and short neck. 20, Hypotype (USNM P586b), showing more elongate test, and gradually increasing size of chambers. × 95. Upper Jurassic rocks of Welcome Creek, in the Siksikpuk-Nanushuk area. (p. 69).

21. *Planularia striata* (Issler). 21a, Side view of hypotype (USNM P674), showing early coil, low and broad and oblique later chambers, and produced dorsal angle; 21b, edge view, showing degree of compression. × 95. Lower Jurassic rocks of South Barrow Test Well 4. (p. 78).

22. *Saracenaria phaedra* Tappan, n. sp. Holotype (USNM P785), showing triangular test, slightly coiled base, and low, broad chambers. × 72. Upper Jurassic rocks of Topagoruk Test Well 1. (p. 64).

23–25. *Saracenaria segmentata* Tappan, n. sp. 23, 24, Paratypes (USNM P518a–b), showing rounded proloculus, low and broad later chambers, strongly angled margins of the face, and prominent flange-like dorsal keel. 25a, Side view of holotype (USNM P517); 25b, view of the apertural face, showing its broad flat nature, and marginal keels. × 72. Lower Jurassic rocks of South Barrow Test Well 3. (p. 65).

26. *Saracenaria topagorukensis* Tappan, n. sp. Holotype (USNM P782), showing planispiral and involute early coil, the inflated ventral margins of each chamber left as ridges just below each suture in the early portion of the test, and the slightly produced dorsal angle. × 72. Upper Jurassic rocks of Topagoruk Test Well 1. (p. 65).

27. *Saracenaria oxfordiana* Tappan, new name. Hypotype (USNM P786), showing planispiral coil, and sharply triangular later chambers, with narrow marginal keel and acute ventral margins. × 72. Upper Jurassic rocks of Topagoruk Test Well 1. (p. 64).

PLATE 27

FIGURES 1–2. *Lingulina polita* Tappan, n. sp. 1, Paratype (USNM P697), a broken microspheric specimen, showing gradually enlarging test, and highly arched chambers. 2a, Side view of holotype (USNM P696), a complete, although smaller megalospheric specimen, showing the lanceolate proloculus, and strongly arched later chambers; 2b, top view, showing ovate section and elongate aperture. × 95. Lower Jurassic rocks of South Barrow Test Well 3. (p. 76).

3–4. *Frondicularia terquemi* d'Orbigny. 3, Hypotype (USNM P727), showing small, tapering, compressed test, with two very obscure longitudinal costae. 4, Hypotype (USNM P726), a fragment of a larger specimen, showing completely smooth surface, marginal keels, and produced final chamber. × 95. Lower Jurassic rocks of South Barrow Test Well 3. (p. 81).

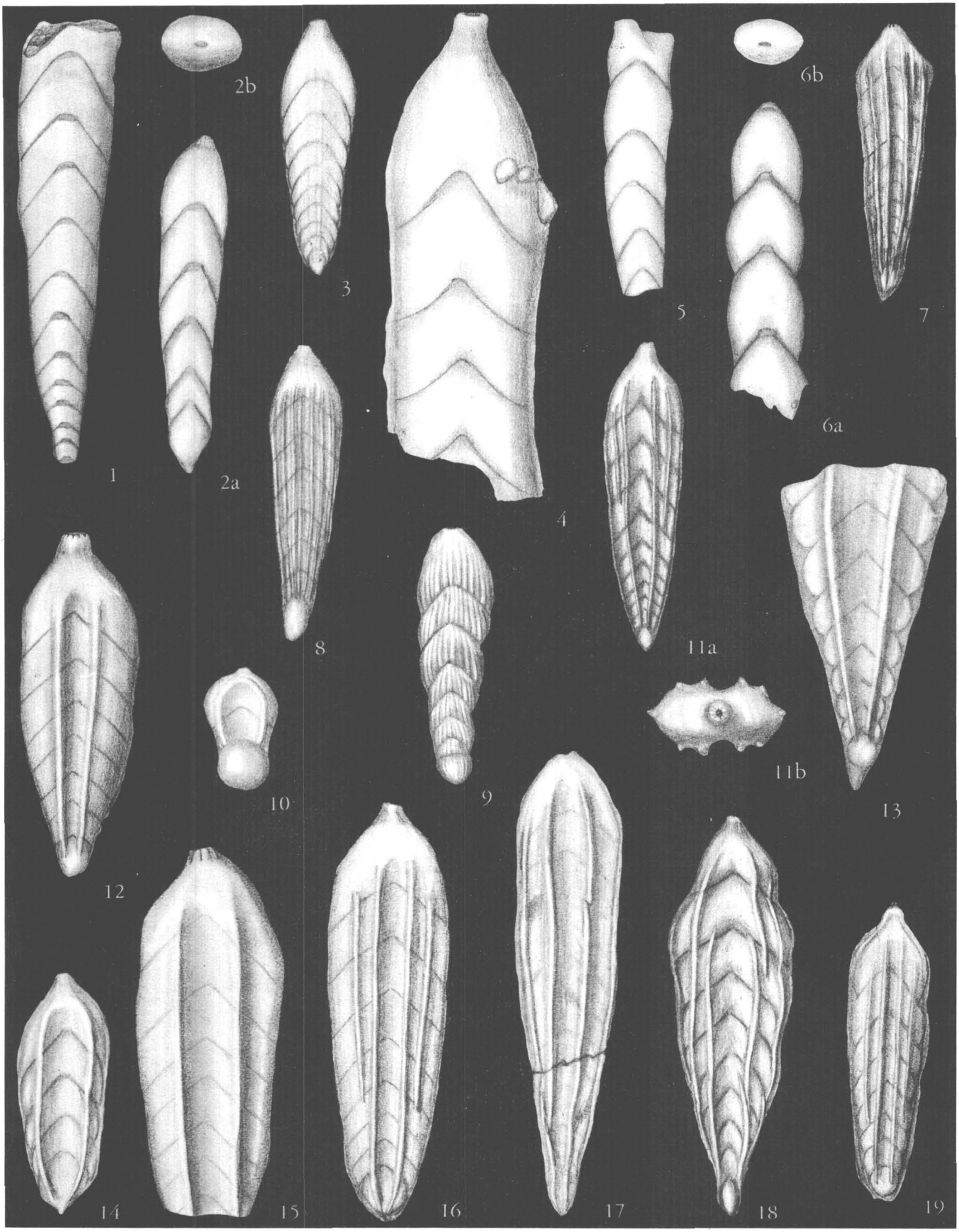
5–6. *Lingulina lanceolata* (Häusler). 5, Hypotype (USNM P694), showing a fragment of a test, with the comparatively high arched chambers. 6a, Hypotype (USNM P692), showing constricted sutures; 6b, top view, showing ovate section, and elongate aperture. × 95. Lower Jurassic rocks of South Barrow Test Well 3. (p. 75).

7. *Frondicularia baueri* Burbach. Hypotype (USNM P700), showing slightly tapering test, with longitudinal costae of equal strength. × 41. Lower Jurassic rocks of South Barrow Test Well 3. (p. 80).

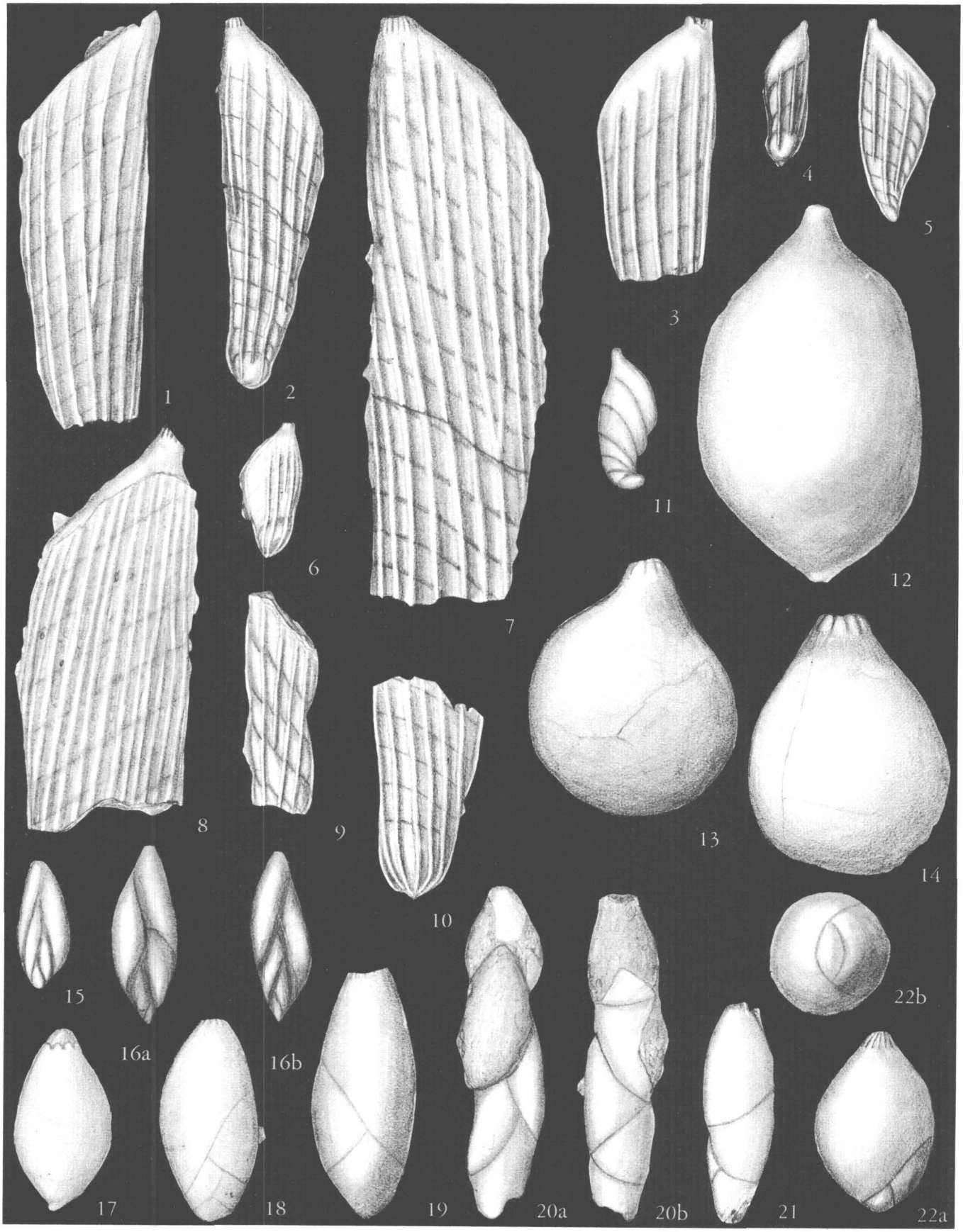
8–9. *Frondicularia squamosa* Terquem and Berthelin. Hypotypes (USNM P722a–b), showing numerous longitudinal costae of equal strength. × 95. Lower Jurassic rocks of South Barrow Test Well 3. (p. 81).

10. *Frondicularia* sp. Small specimen (USNM P795), with globular proloculus and two arched chambers, ornamented with two costae at each side of the central sulcus on each face. × 95. Upper Jurassic rocks of Topagoruk Test Well 1. (p. 82).

11–19. *Frondicularia lustrata* Tappan. 11a, Side view of holotype (USNM 106481), showing pointed base, central sulcus bordered by strong costae, with two slightly less prominent ones appearing to the outside of these in the later portion of the test; 11b, top view, showing the sulcus on each side, and the four costae, with lateral borders also costate. 12, 16. Hypotypes (USNM P708a–b), showing less prominent costae. 13, Paratype (USNM 106483), showing apiculate proloculus, and more rapidly flaring microspheric test. 14, Hypotype (USNM P717), showing a smaller megalospheric form, with nearly parallel sides. 15, Hypotype (USNM P713), showing only two ribs on each side of the test. 17, Paratype (USNM 106482a), a very large specimen. 18, Hypotype (USNM P705), showing flaring test, longitudinal sulcus and lateral ribs, and produced final chamber. 19, Hypotype (USNM P715), showing a megalospheric form. Lower Jurassic rocks of South Barrow Test Well 3. Figs. 11a, 17, 19, × 41; fig. 11b, × 72; all others × 95. (p. 80).



LINGULINA, FRONDICULARIA



CITHARINA, LAGENA, EOGUTTULINA, PALEOPOLYMORPHINA, GLOBULINA

PLATE 28

FIGURES 1–10. *Citharina fallax* (Payard). 1, Hypotype (USNM P677), showing broad, flattened test, longitudinal ribs, and bifurcation of ribs. 2, Hypotype (USNM P685), showing a complete test, with rounded proloculus, low and broad oblique later chambers, and produced dorsal angle with radiate aperture. 3, Broken hypotype (USNM P681a), showing slight increase in height of later chambers. 4, Juvenile hypotype (USNM P681b), showing rounded proloculus with faint basal spine, and few ribs. 5, Complete microspheric hypotype (USNM P675), showing somewhat ovate proloculus, subtriangular test and few ribs. 6, Small hypotype (USNM P688), with slightly ovate proloculus and few ribs. 7, 10, Hypotypes (USNM P679a–b), which are almost certainly fragments of a single specimen, as they are similar in all respects, even to the presence of iron-staining along one margin, although a connecting segment is missing; 7, shows the large size attained by this species, and the numerous ribs on the adult test, and well developed radiate aperture; 10, shows a globular proloculus, with short basal spine, and beginning of the many ribs. 8, Broad hypotype (USNM P681c), showing numerous ribs, which are slightly oblique, increasing in number by addition of new ribs on the ventral margin. 9, Narrow hypotype (USNM P683), showing adult chambers of a form such as the juvenile of fig. 4, with comparatively few ribs. All from Lower Jurassic rocks of South Barrow Test Well 3. × 41. (p. 79).

11. *Citharina frankei* Tappan, new name. Hypotype (USNM P691), showing compressed, slightly curved form with produced dorsal angle, and absence of any ornamentation. Lower Jurassic rocks of South Barrow Test Well 3. × 95. (p. 79).

12. *Lagena liasica* (Kübler and Zwingli). Hypotype (USNM P796), showing elongate smooth test, with apiculate base, and short narrow neck. Upper Jurassic rocks of Topagoruk Test Well 1. × 158. (p. 82).

13–14. *Lagena aphela* Tappan, n. sp. 13, Paratype (USNM P733), showing nearly spherical test, short broad neck and radiate aperture; × 218. 14, Holotype (USNM P731), a somewhat larger and more ovate specimen, with well-developed radiate aperture; × 158. Lower Jurassic rocks of South Barrow Test Well 3. (p. 82).

15–16. *Eoguttulina metensis* (Terquem). 15, Small hypotype, (USNM P743a), showing oblique chambers, and fusiform outline. 16a, b. Opposite sides of hypotype (USNM P743b), showing slightly depressed sutures, and comparatively large final pair of chambers. Lower Jurassic rocks of the Sadlerochit River area. × 95. (p. 83).

17–19. *Eoguttulina liassica* (Strickland). 17, 18, Hypotypes (USNM P738a–b), showing ovate and inflated test, and radiate aperture. 19, Hypotype (USNM P740), a somewhat larger specimen. Lower Jurassic rocks of South Barrow Test Well 3. × 72. (p. 83).

20–21. *Paleopolymorphina vagina* (Terquem). 20a, b, Opposite sides of large hypotype (USNM P745). 21, Hypotype (USNM P746). Lower Jurassic rocks of South Barrow Test Well 3. × 41. (p. 83).

22. *Globulina topagorukensis* Tappan, n. sp. 22a, Side view of holotype (USNM P798), showing globular test, with small early chambers and radiate aperture; 22b, basal view, showing chamber arrangement. Upper Jurassic rocks of Topagoruk Test Well 1. × 95. (p. 84).

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