Foraminifera From the Arctic Slope of Alaska

General Introduction and Part 1, Triassic Foraminifera

GEOLOGICAL SURVEY PROFESSIONAL PAPER 236-A

Foraminifera From the Arctic Slope of Alaska

By HELEN TAPPAN

General Introduction and Part 1, Triassic Foraminifera

GEOLOGICAL SURVEY PROFESSIONAL PAPER 236-A

Description and illustrations of the first Triassic foraminiferal fauna discovered in the Western Hemisphere

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1951

UNITED STATES DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, ***Secretary***

GEOLOGICAL SURVEY

W. E. Wrather, ***Director***

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 50 cents (paper cover)

OUTLINE OF THE REPORT

CONTENTS

ILLUSTRATIONS

FORAMINIFERA FROM THE ARCTIC SLOPE OF ALASKA

By Helen Tappan*

GENERAL INTRODUCTION

SIGNIFICANCE OF THE INVESTIGATION

During the field exploration and drilling in Naval Petroleum Reserve no. 4 and adjacent areas of the Arctic slope of Alaska (fig. 1), Foraminifera have been found in strata ranging in age from Triassic to Pleistocene. The writer began the study of these Foraminifera in January of 1947, under the naval oil program of the U. S. Geological Survey. The foraminiferal faunas are of considerable interest, for they are not only of local practical stratigraphic value in the northern Alaskan region, but also include the most varied and best-preserved Triassic foraminiferal fauna yet described, the first to be recorded from the Western Hemisphere, the only Lower Jurassic Foraminifera found on the North American continent, an extensive Cretaceous fauna including both Lower and Upper Cretaceous forms from an environment unlike that of most of the previously described American Cretaceous faunas, and a Pleistocene fauna that is similar in many respects to the fauna now living in the Arctic seas.

SOURCE OF MATERIAL

The work of the writer has been limited to the laboratory study of the Foraminifera. Core samples and well cuttings were supplied by the U. S. Geological Survey from the wells and core tests drilled during the time covered by this investigation. In addition, samples were obtained by seismograph parties at many of the shot-hole locations. The field samples were collected by many Survey geologists during geologic mapping and measuring of stratigraphic sections in the various parts of the Reserve over a period of about 5 years. Field data on the samples, both geographic and geologic, were supplied by these geologists.

The stratigraphic and paleontologic work in northern Alaska has been complicated by many conditions not usually encountered in exploration; a few of these are mentioned below.

Adverse climate.—Because of the extreme cold of the winters of northern Alaska, the field season is short, most of the field geology having been carried out during approximately 3 months of each year.

Remote location.—Because of the remoteness of the area and the consequent difficulties in obtaining supplies and in transporting material obtained, field plans had to be made long in advance, and only minor changes in these plans could be made once the field season was under way.

Difficult terrain.—The Coastal Plain province is an area of tundra, swamps, and lakes, and the only exposures are in a few low stream banks. There are better exposures farther inland, but they are also increasingly more difficult of access nearer the Brooks Range, and the rugged terrain adds to the hazards of field work.

Lack of geologic data.—The field studies in northern Alaska were largely exploratory, as virtually no details of the stratigraphy or of structural features were known. It was not even certain which geologic periods were represented in the area under investigation.

Intertonguing sediments.—A large part of the sediments represents intertonguing marine and nonmarine facies. This intertonguing complicates subsurface correlations, especially where surface exposures are lacking.

Restricted fauna.—The nonmarine facies contains only a few plants and the marine strata are only sparsely fossiliferous, some of the beds yielding no diagnostic megafossils. The stratigraphic section for each local area had first to be compiled, and the zone fossils noted where present, without regard to detailed long-range correlations. Only after this had been nearly completed was it possible to see where these zones fit into the generalized geologic sections.

Often, while the paleontologists were attempting to obtain stratigraphic information concerning the outcrop samples from the field geologists, in order that the

*Mrs. Alfred R. Loeblich, Jr.

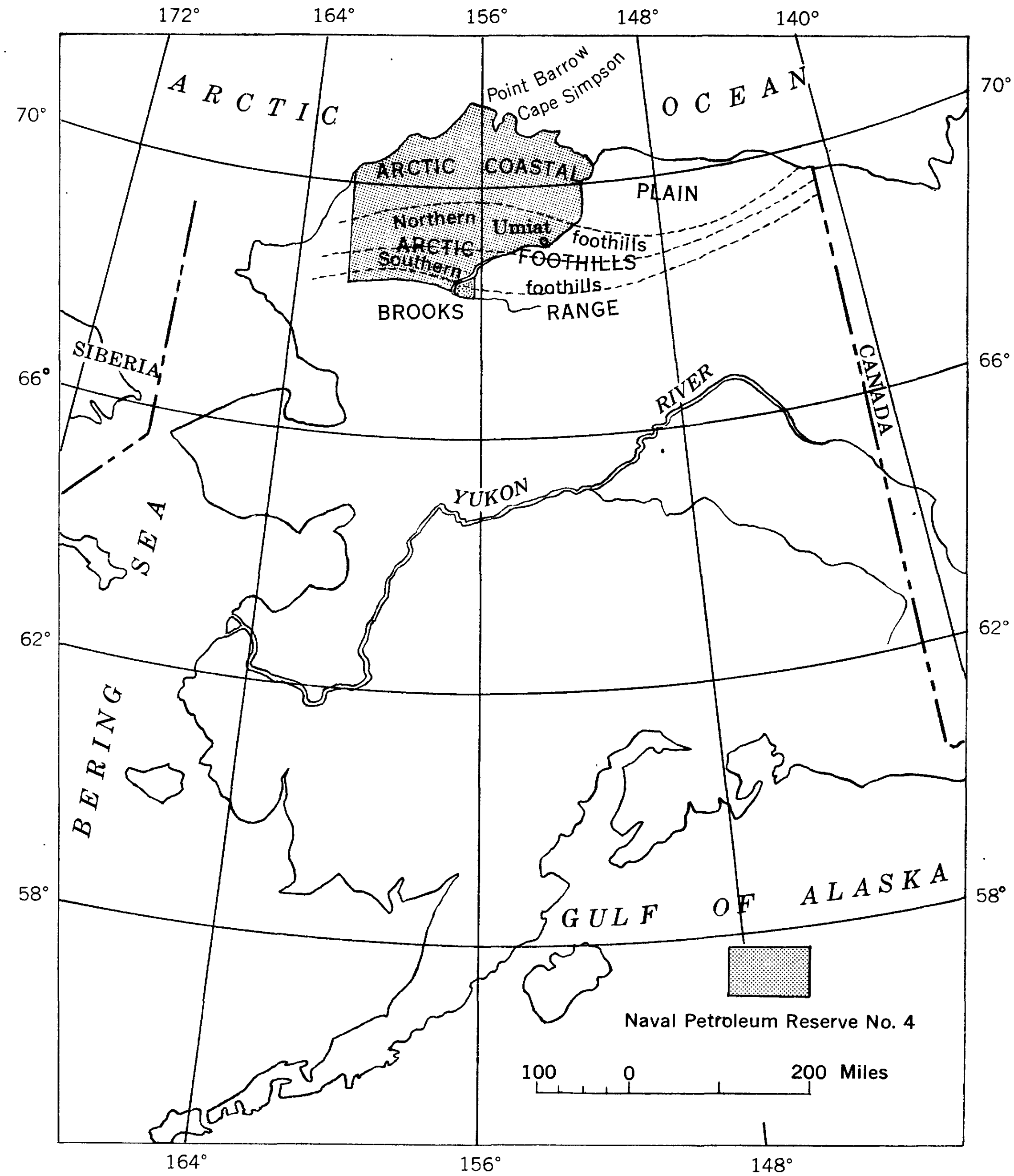


FIGURE 1.—Outline map showing location of Naval Petroleum Reserve no. 4, and the physiographic provinces of the Arctic slope of northern Alaska.

specific geologic ranges of the fossils could be determined, the field geologists simultaneously were requesting from the paleontologists data on the relative ages of the samples.

ACKNOWLEDGMENTS

This report has been made possible only by the active cooperation of many other geologists. The studies of the Foraminifera have been aided and encouraged in many ways throughout the past 3 to 4 years, by George L. Gates, former geologist in charge, Navy Oil Unit, under whose direction the work was begun, Ralph L. Miller, present geologist in charge, and George Gryc, Thomas G. Payne, and Allan N. Kover, geologists, Navy Oil Unit, U. S. Geological Survey. For the past year Harlan R. Bergquist has been with the Fairbanks Lab-

oratory as micropaleontologist, and many of the problems concerning the Foraminifera have been discussed with him.

As exploration in northern Alaska is still under way, it was necessary for the writer to set an arbitrary time limit for material to be included in this study. All outcrop material and well samples used in this study were obtained prior to 1950. The microfossil samples used herein were collected and stratigraphic sections measured during the geologic mapping from 1945 through 1949 by William L. Barksdale, Robert M. Chapman, Robert L. Detterman, William A. Fischer, George Gryc, Charles E. Kirschner, Ernest H. Lathram, William W. Patton, Richard G. Ray, Edward G. Sable, Karl Stefansson, Irvin L. Tailleur, Raymond M. Thompson, Robert F. Thurrell, Jr., Max L. Troyer, Edward J. Webber, Charles L. Whittington, and James H. Zumberge.

In addition to the microfossil samples picked in Washington by the writer and Alfred R. Loeblich, Jr., many microfossil samples have been picked in the Fairbanks Laboratory during the past 2 years by Tatiana Aschurkoff, Clyde Foster, William N. Lockwood, Octavia T. Pratt, Dorothy J. West, and Lucy Wiancko, under the direction of William N. Lockwood and Robert M. Chapman, former geologists in charge, and Thomas G. Roberts, present geologist in charge of the Fairbanks office, Navy Oil Unit, U. S. Geological Survey.

Acknowledgment is also made of the continued assistance of Alfred R. Loeblich, Jr., in the various phases of this study, from the washing and picking of samples through the preparation of the descriptions and illustrations for the present paper.

BIOSTRATIGRAPHY

In the northern Alaskan area, several factors modify the value of the microfossils for correlation, and any discussion of the Foraminifera should keep these limitations well in mind.

Sparsity of specimens.—As the total number of Foraminifera found in the northern Alaskan strata is well over 300 species, it might be assumed that microfossils are rather abundant. This is far from true. Unfortunately, many of the species are extremely rare, some being represented by a single specimen or two, even after the examination of many thousands of field samples and many more thousands of well samples during the past 3 to 4 years. About one-half to one-third of the samples are barren of microfossils, and many of the fossiliferous samples yield at most 5 to 10 specimens.

This sparsity of individuals is undoubtedly due to an adverse local environment, perhaps locally brackish water, which might be expected in the deposition of the intertonguing marine and continental facies, and which is further suggested by the intercalated coal beds. Quite probably also, the waters may have been too muddy, as indicated by the poorly sorted sediments, and deposition too rapid, as shown by the great thicknesses of similar sediments, to permit the development of an abundant and diversified foraminiferal fauna. The consolidation of the sediments may be another factor affecting the recovery of fossils from the older Mesozoic sediments, as microfossils may be present but their separation impossible by the commonly used washing procedure.

Generalized character of the fauna.—Because of the adverse environment, only the simpler types of Foraminifera occur, which could best adapt themselves to the unfavorable conditions. Because of this adaptability (a high ecological valence), not only could they exist in the relatively poor environments of the time, but they could also become geologically long-lived forms. Very similar species of some of these genera of Foraminifera actually do occur in beds deposited under comparable adverse conditions throughout the Mesozoic and Cenozoic.

Of approximately 85 genera represented in northern Alaskan sediments, not over half a dozen are restricted to one geologic period, most of them range throughout the post-Paleozoic, and a few occur as early as the Silurian. The most abundant species are invariably the long-ranging simple forms, and the geologically more restricted types may be represented in the collections by a single species and some by a single specimen. Furthermore, these restricted genera are with one or two exceptions confined to the Pleistocene sediments in Alaska. None of the so-called index genera for the Cretaceous are present and even genera of supposedly world-wide distribution, such as *Globigerina* and *Gümbelina*, occur sporadically in one or two zones of the Alaskan Cretaceous. The great majority of specimens are arenaceous, and represent such long-lived genera as *Haplophragmoides*, *Trochammina*, *Gaudryina*, *etc.* The genera themselves are thus of comparatively slight value in age determination, and even the species are of restricted use, for in large part they include only the most simple and unornamented forms, which are difficult to distinguish. In brackish-water and near-shore deposits, such as are found in Alaska, the foraminiferal assemblage may be similar throughout a great thickness of sediments, even though a number of restricted faunal zones are evident in an off-shore facies representing the same time interval. Thus, very similar species of some genera occur in most of the strata.

Poor preservation of the microfossils.—Most of the species of Foraminifera are arenaceous forms, the tests being composed of sandy material agglutinated to a chitinous base. They are easily distorted by pressure, even that due to consolidation of the shales, and the great distortion of these agglutinated specimens makes specific identification very difficult.

In some of the strata the rarer calcareous forms are represented by pyritic replacements only. As most of these are internal casts, any surface characters have been destroyed, making specific determination and in some specimens even the generic identity uncertain.

Facies character of the fauna.—The calcareous Foraminifera, and many of the arenaceous species as well, are usually found in an off-shore facies. In an unfavorable environment, such as was present in Alaska at the time of deposition, the faunas shift with the changing sedimentary environment. A faunal break may thus be due locally to a change of facies, and the same species may occur higher or lower in the section in another locality where the facies differs. A zone fossil of one locality may therefore be absent from the same stratigraphic level at another location. Some of the faunas are known only from the subsurface section; for example, that of the Lower Jurassic, and others were first found in the subsurface and later recognized in an isolated and comparatively distant outcrop, as was the Upper Triassic fauna. The subsurface Cretaceous rocks are much more fossiliferous than the exposed beds; many outcrops are either of continental or near-shore origin, and therefore not as fossiliferous as the down-dip deposits encountered in the wells.

Great distance from equivalent faunas.—It is difficult to compare the species, or to make correlations, when no material of equivalent age is known from nearby areas. No Triassic Foraminifera have been described from this hemisphere; the best Triassic fauna described is one from Germany that has little in common with that of Alaska. Foraminifera have been found in the Middle and Upper Jurassic beds of the western interior of the United States and Canada, but the only abundant and well-preserved Jurassic fauna in Alaska is from the Lower Jurassic strata. No Lower Jurassic species have been described from this continent.

The Cretaceous section includes beds ranging in age from Neocomian through Senonian, the mid-Cretaceous Albian being the most fossiliferous portion of the section. The Alaskan Cretaceous is thus equivalent in age to a portion of the very fossiliferous Cretaceous sediments of the Gulf coast, but the faunas have little in common other than age. The Gulf coast fauna is extremely varied, with many pelagic forms and a great abundance of calcareous and specialized types, but the Cretaceous of Alaska contains a dominantly arenaceous fauna and has almost no specialized forms. The great difference in fauna is undoubtedly due to different environmental conditions, the Gulf coast region having an abundance of many types of megafossils and a considerable variety of sediments, from clean and cross-bedded sands to clays and marly limestones. The Alaskan section contains sands and clays, but no limestones, and the clastic sediments are neither clean nor well-sorted, thus suggesting rapid sedimentation and muddy waters. These features may explain the faunal differences, as only very tolerant species could live in such an adverse environment. Even the macrofauna is lacking in variety, consisting largely of *Inoceramus* and a few ammonites.

The Cretaceous of Alaska is very similar lithologically and faunally to that of Canada, but is seemingly much more fossiliferous. More than 200 species of Foraminifera have been recovered from the Cretaceous of Alaska, whereas only about 50 species have been described from Canada.

The Pleistocene fauna is very similar to that described from Amchitka Island in the Aleutians, but the latter is of off-shore origin, containing an abundance of pelagic species. The northern Alaska assemblage, although dominantly calcareous, consists largely of genera which are notably tolerant of brackish water, and no pelagic forms are present. Many of the species are living off the present Arctic coast.

EXAMINATION AND ANALYSIS OF SAMPLES

In the early period of the Alaskan foraminiferal studies, the writer herself examined the washed residues, picking out the microfossils for study. After about a year, the quantity of material being received greatly increased, and from that time, the samples were both washed and picked in the Fairbanks Laboratory of the U. S. Geological Survey, and the faunal slides of microfossils supplied for study. When unusual faunas were found, or stratigraphic contacts questioned, additional unwashed material was requested, and this was washed and picked by the writer.

No specific names were used in the routine examination work; the various Foraminifera were identified generically and species were designated by letters in the charts and reports. This avoided the implication of correlations based on supposed affinities with previously described species. This method was also more convenient, as most species were new. After the local stratigraphic sequence had been established and correlation became feasible, specific identifications were made and the description and illustration of the entire fauna was begun. All figured types and numerous additional paratypes and hypotypes are deposited in the U. S. National Museum. The Foraminifera are illustrated by shaded camera lucida drawings prepared by the writer.

PREVIOUS WORK

As the areal geology and stratigraphy are not covered in this report, but are being described separately by other members of the U. S. Geological Survey, only the previous work on the Foraminifera is discussed here.

Very little on Alaskan Foraminifera has been published. Some have been described from Jurassic and Cretaceous strata of Canada by Cushman (1927, 1928, and 1943), Nauss (1947), and Wickenden (1932a, b, 1933, and 1949), and there are many papers on the equivalent faunas from the United States. Most of the latter are from a different paleo-geographic province and have little in common with the Alaskan faunas.

Pleistocene faunas have been described by Cushman (1941) from a submarine beach near Nome, Alaska, and by Cushman and Todd (1947) from Amchitka Island, Aleutians. Recent species have been described by Cushman (1920, 1933, and 1948) from the Alaskan coast, and many of these species also occur in the Pleistocene deposits.

A general summary of the micropaleontology of northern Alaska, by the writer has been included in an Oil and Gas Investigations Map (Payne and others in preparation). A few index species were illustrated on this map, and described in a brief article (Tappan, 1951).

SUMMARY

Although the microfauna is restricted in any one place or bed, the large quantity of material examined from northern Alaska has yielded approximately 350 species of Foraminifera. About 8 percent of these are from the Triassic, 12 percent from the Jurassic, 60 percent from the Cretaceous, and the remaining 20 percent Pleistocene.

Because of the lack of described equivalent foraminiferal faunas, correlations based on the Foraminifera alone have not been possible for all the strata studied in Alaska. In large part, age determinations are based on megafossils and the index Foraminifera then determined for the beds. They have then proved useful in places where macrofossils were not found.

Study of the foraminiferal fauna is of scientific value because it adds greatly to the knowledge of early Mesozoic forms, and because the faunas are largely of brackish or deltaic origin and belong to an ecologic facies that has been largely ignored. This relative neglect is probably due to the comparative scarcity of species and specimens in deposits of this type, and the absence of diagnostic genera among the few that are present.

PART 1. TRIASSIC FORAMINIFERA

ABSTRACT

Twenty-six new species of Foraminifera were obtained from the Upper Triassic of northern Alaska. This is the first record of Triassic Foraminifera in the western hemisphere. Eighteen genera are represented, one of them new, and there are nine families. Twelve species belong to the family Lagenidae, five to the Polymorphinidae, two each to the Trochamminidae and Lituolidae, and one each to the Ammodiscidae, Verneuilinidae, Buliminidae, Spirillinidae, and Rotaliidae. It is thus a more varied fauna than any previously described from the Triassic. The specimens are better preserved than Triassic Foraminifera known heretofore.

INTRODUCTION

The Upper Triassic rocks of Alaska contain fossiliferous black shales (including oil shale), bituminous limestones, chert, and sandstone. The Shublik formation was described by E. D. Leffingwell (1919) from the Canning River region, the type locality being at Shublik Island on the Canning River, at the southwest corner of the Shublik Mountains. Leffingwell noted that better outcrops occur in the region of the Sadlerochit River, however, where the structure is less complicated. The limestones contain abundant *Pseudomonotis*, *Terebratula* and *Rhynchonella.*

The Triassic Foraminifera here described were first observed in the samples from Simpson Test Well no. 1 (fig. 2), in Naval Petroleum Reserve No. 4, northern Alaska. This test well was drilled in 1948 at Cape Simpson and a Triassic macrofauna was identified by R. W. Imlay of the U. S. Geological Survey, in cores from the lower part of the well. A distinctive microfauna, previously unknown either in surface or subsurface material, was associated with the macrofossils. In the subsurface the Shublik formation consists of 245 feet of medium gray, well indurated silt shale, limy siltstone and silty limestone, containing intra-formational siltstone pebbles in the upper part. Pelecypods are abundant, especially *Halobia* and *Monotis*, and some cross-bedding was found in the lower beds.

During the summer of 1948, Edward G. Sable collected samples from exposures in the Sadlerochit River area that were found to contain the same Triassic microfauna previously observed in the subsurface cores. The outcrop material was not as fossiliferous, however. Where it crops out in the Sadlerochit River region, the basal part of the Shublik formation consists of 25 to 50 feet of nonfossiliferous siltstone, and sandstone contain-

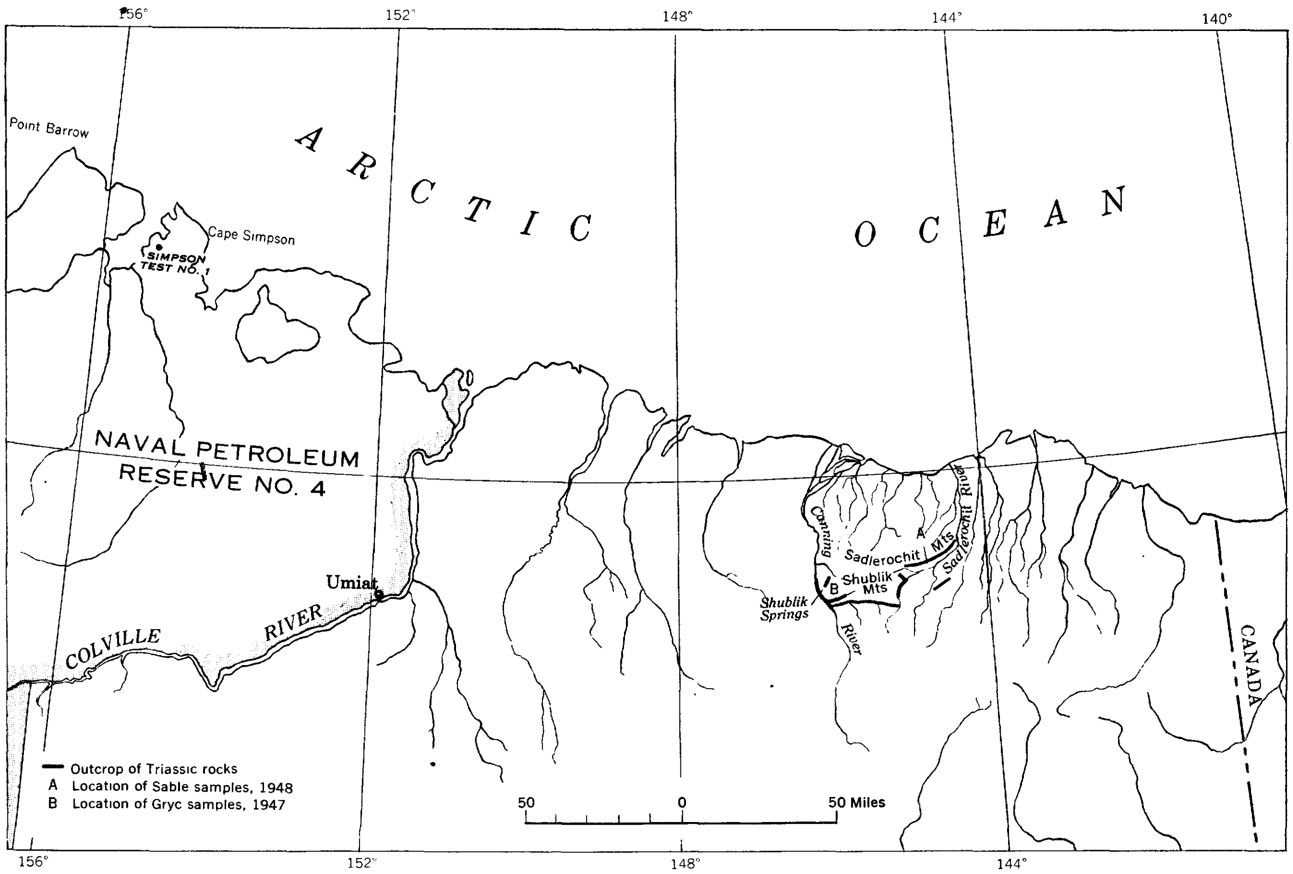


FIGURE 2.—Index map of the coastal region of northern Alaska, showing location of Simpson Test Well no. 1, and areas of Triassic outcrops containing Foraminifera.

ing numerous black pebbles. Above this is 175 to 250 feet of interbedded black calcareous shale and black silty limestone. In general, megafossils occur only in the limestones. They consist of an abundance of pelecypods, especially *Halobia* and *Monotis*, and many small brachiopods, chiefly terebratulids and rhynchonellids.

A few Triassic samples were collected in the Canning River area in 1947 by George Gryc, but only a single specimen of Foraminifera (a *Trochammina*) was found.

Of the 26 species here described from the Triassic Shublik formation, 20 were found in the samples from Simpson Test Well no. 1, and 11 were found in the outcrop samples from the Sadlerochit River. Only nine species are common to the two localities and one species was found only in the Canning River area.

PREVIOUS WORK ON TRIASSIC FORAMINIFERA

Foraminifera have been described from the Middle Triassic of Germany and the Alpine area, and from the Upper Triassic (Carnian, Norian and Rhaetian) of the Alpine area, England (Rhaetian), and New Zealand. The faunas are meager; they total only about 20 genera, most of them simple arenaceous forms or simple Lagenidae. The Alaskan fauna includes 18 genera, belonging to 9 families, and is thus the most varied single Triassic fauna yet recorded. Also, the specimens are better preserved than those of previously described Triassic faunas that include many Foraminifera known only in thin sections and not specifically identifiable.

In 1860 Jones and Parker described and referred to the Triassic a fauna from Chellaston, England. The fauna consisted of about 30 species, representing 6 genera. Later (Chapman, 1895, p. 310), these beds were determined to be Jurassic (Lias) in age and not Triassic.

The first true Triassic Foraminifera described were those from the Alpine area (Schwager, 1864). He found seven species, belonging to the genera *Dentalina*, *Marginulina*, *Cristellaria*, *Textularia*, and *Globulina*. All but the last two are members of the Lagenidae.

Reuss (1868) later described nine species, belonging to eight genera, from the Alpine Triassic. He found *Glandulina* (probably *Pseudoglandulina*), *Cristellaria*, *Marginulina*, *Globigerina*, *Polymorphina*, *Textilaria*, *Cornuspira*, and *Biloculina*.

In 1869 Gümbel described another Alpine Triassic fauna, which contained ostracode and holothurian remains, and also an apparently well-preserved fauna of 13 Foraminifera. One species of Foraminifera was doubtfully referred to a species of Jones and Parker, and the remaining 12 were described as new species. They represented 10 genera: *Cornuspira*, *Triloculina*, *Dentalina* (3 species), *Pseudoglandulina*, *Cristellaria*, *Nodosaria*, *Lingulina*, *Guttulina*, *Polymorphina*, and *Rotalia*.

Bornemann (1885) described four species, belonging to as many genera, from thin sections of the German Muschelkalk (Middle Triassic). All were referred to previously described species, which had been recorded from Permian to Recent by Brady. They represented *Ammodiscus*, *Trochammina*, *Nodosaria*, and *Dentalina*. Although unquestionably they are not identical with the living species to which they were referred, it is not possible to identify the species more accurately, as they are represented only by thin sections.

Mariani (1893) recorded 17 species from the Upper Triassic of Italy, belonging to 13 genera: *Cornuspira*, *Textularia*, *Cristellaria*, *Nodosaria*, *Marginulina*, *Lagena*, *Polymorphina*, *Bolivina*, *Rotalia*, *Truncatulina*, *Pulvinulina*, *Discorbina* and *Anomalina*. Only five of the species were described as new; the remainder were referred to already described species, or merely identified generically. As all are known only from thin sections, it would be very difficult, if not impossible, to recognize any of the species.

In 1895, Chapman described 26 species of Foraminifera from the Rhaetic of Somerset, England. Nine of these were described as new species. Most of the species were arenaceous, unlike the earlier described Triassic faunas dominated by the Lagenidae. Nine genera were represented: *Reophax*, *Haplophragmium* (probably *Ammobaculites*), *Ammodiscus*, *Nodosinella*, *Stacheia*, *Nodosaria*, *Marginulina*, *Bulimina* (probably a *Valvulina*, as it was arenaceous), and *Truncatulina* (probably an *Epistomina*). Part of the fauna was washed from clays, but only one of the calcareous forms was found in the washed residues (the *Truncatulina*). The other forms were found in thin sections of the limestones. The fauna was compared to the upper Paleozoic faunas, as well as to Jurassic faunas.

Chapman (1909) described a small fauna, including seven species of Foraminifera and three ostracods, from the Wianamatta shales of New South Wales. He considered these deposits brackish or estuarine, and the fauna contained an intermingling of Upper Triassic and Lower Jurassic types. Most of the specimens were only internal casts, but the shells of a few specimens were preserved. Six genera were represented: *Nubecularia*, *Haplophragmium*, *Endothyra*, *Discorbina*, *Truncatulina* and *Pulvinulina*. Only three species were described as new, the remainder were referred to species described from beds as old as Carboniferous and as young as Tertiary and Recent.

Vadasz (1911) described a large fauna from the Bakony Mountains in Hungary. However, his collection was accidentally mixed with Tertiary material, and a large percentage of the Foraminifera he described as from the Triassic are in reality Tertiary species. Although some of the species are quite obviously from the younger strata, it is impossible to be certain which of the species are actually from the Triassic. Thus this fauna must be discounted in determining the character of Triassic faunas, until additional work is done to isolate the Triassic assemblage.

In 1925, Kirchner recorded 11 species from the Muschelkalk, including 3 of the species previously found there by Bornemann. One species was described as new, but none were figured. Eight genera were represented: *Ammodiscus*, *Trochammina*, *Cornuspira*, *Nubecularia*, *Spiroloculina*, *Nodosaria*, *Dentalina* and *Marginulina*.

In 1945, Wirz again recorded a small fauna from the Alpine Triassic. As his specimens were found only in thin sections, none were identified specifically. The genera represented included *Ammodiscus*, *Glomospira*, *Ammobaculites* and *Dentalina*.

The only other record of a Triassic foraminiferal fauna is rather questionable. Chapman (1900) described a fauna from the Malverns, which he considered to be of Cambrian age, containing the calcareous genera *Lagena*, *Nodosaria*, *Dentalina*, *Cristellaria*, *Spirillina* and *Marginulina*. This was shown by Wood (1947) to have been derived from a loose fragment of Rhaetic or lower Liassic limestone, of glacial origin. All species were found only in thin sections, and thus are not diagnostic. In a discussion of Wood's paper, Barnard (Wood, 1947, p. 460) stated that he had seen only "a few casts of *Nodosaria* and *Lingulina* in the Rhaetic," but the abundance of *Spirillina* in the Malverns material was more like the Lias that he had studied. Thus this fauna, while certainly not Cambrian, may be Triassic, but is probably Jurassic.

CHARACTER OF THE ALASKAN TRIASSIC MICROFAUNA

Many of the Triassic outcrop samples from northern Alaska contain no microfossils. Locally this may be due to the condition of the sediments, as in the foothills of the Brooks range where the shales are too hard to be broken down for microfossils. The fauna which is here described was obtained only after rather rough treatment and prolonged boiling of the samples in addition to the usual washing process.

Some of the specimens of Foraminifera recovered from the Triassic shales are not well preserved. Many specimens of the calcareous species are filled with pyrite, and some specimens consist only of pyritic internal casts. Many of the lagenid species are represented both by the shells and the internal casts, but the species of the Polymorphinidae are known only from the internal casts. The arenaceous Foraminifera are generally better preserved. Although preservation is not as good as could be desired, the Alaskan specimens are better preserved than any Triassic Foraminifera previously described.

The Alaskan Triassic is more varied, having at least as many species as any other single Triassic fauna described, and nearly as many genera as previously recorded from all other Triassic areas. About 20 genera have been recorded from the Triassic. The present fauna includes 26 new species, belonging to 18 genera, of which 1 is new, and 9 families. Nearly one half of the species (12) belong to the family Lagenidae, 5 to the Polymorphinidae, 2 each to the Trochamminidae and Lituolidae, and 1 each to the Ammodiscidae, Verneuilinidae, Buliminidae, Spirillinidae, and Rotaliidae.

In general character the Alaskan fauna resembles already known Triassic faunas; it is strongly dominated by the Lagenidae, and includes simple arenaceous genera and early types of the Buliminidae, Polymorphinidae and Rotaliidae. There is nothing especially distinctive in the Triassic assemblage. It is very similar to the Lower Jurassic fauna, which however, includes many more species of the various genera. All the genera of Foraminifera present in the Triassic range throughout the post Paleozoic, with the possible exception of the genus *Sagoplecta*, here described as new. Additional study may even show that this genus ranges into later periods.

SYSTEMATIC DESCRIPTIONS

Family AMMODISCIDAE

Subfamily TOLYPAMMININAE

Genus TOLYPAMMINA Rhumbler, 1895

Tolypammina glareosa Tappan, n. sp.

Plate 2, figures 1, 2

Test attached, consisting of a long, undivided, sinuate tube of constant width throughout its length; wall coarsely arenaceous, surface rough; aperture formed by the open ends of the tube. Length of holotype 1.35 mm., greatest breadth of tube 0.18 mm. Length of paratype 0.62 mm.

Remarks: Tolypammina glareosa, n. sp. differs from *Hyperammina vagans* Brady in being more coarsely arenaceous, in having tubes of slightly smaller diameter and in lacking the constrictions in the wall.

Types and occurrence: Holotype (U.S.N.M. 106322) and paratype (U.S.N.M. 106323) from the Upper Triassic Shublik formation, from a core at 6331 feet, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Family LITUOLIDAE

Subfamily HAPLOPHRAGMIINAE

Genus TROCHAMMINOIDES Cushman, 1910

Trochamminoides vertens Tappan, n. sp.

Plate 2, figures 3, 4

Test free, tiny, planispiral, not involute, consisting of about two and one-half whorls, periphery broadly rounded; chambers numerous, about nine in the last whorl, inflated and subglobular; sutures distinct, straight, constricted; wall finely arenaceous, surface smoothly finished; aperture simple, at the end of the last formed chamber. Greatest diameter of holotype 0.23 mm., least diameter 0.21 mm., greatest thickness 0.05 mm.

Remarks: Trochamminoides vertens, n. sp. is similar to *T. coronus* Loeblich and Tappan, from the Lower Cretaceous Walnut clay, in size and general appearance, but differs in having more globular and inflated chambers, and in having only 9 chambers to a whorl instead of 12 to 14. *T. vertens* differs from *T. velascoensis* Cushman in having a more rounded periphery and less elongate chambers.

Types and occurrence: Holotype (U.S.N.M. 106324) and paratype (U.S.N.M. 106325) from cuttings at 6335 to 6340 feet and paratype (U.S.N.M. 106326) from cuttings at 6365 to 6370 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Genus AMMOBACULITES Cushman, 1910

Ammobaculites sthenarus Tappan, n. sp.

Plate 1, figures 1–3

Test free, large, robust, early portion planispiral, and involute, with the last chamber showing a tendency to uncoil, bi-umbilicate, periphery broadly rounded; chambers somewhat inflated, five to six in the last whorl, increasing rapidly in size as added; sutures distinct, constricted, straight; wall arenaceous, of medium sized grains with considerable cement, surface smoothly finished; aperture small and rounded, terminal on the final chamber. Length of holotype 1.09 mm., greatest diameter of coil 0.70 mm., greatest thickness 0.44 mm.

Remarks: This species is closest to *Ammobaculites goodlandensis* Cushman and Alexander from the Lower

Cretaceous of Texas, as both species have a large, biumbilicate planispiral portion and much reduced rectilinear portion. The present species differs in having fewer chambers in the last whorl and in having regular and smoothly rounded rather than sharply angular chambers.

Types and occurrence: Holotype (U.S.N.M. 106327) from cuttings at 6355 to 6360 feet, and figured paratype (U.S.N.M. 106328) from cuttings at 6435 to 6440 feet, both from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Family VERNEUILINIDAE

Genus GAUDRYINA d'Orbigny, 1839

Gaudryina adoxa Tappan, n. sp.

Plate 2, figures 5–7

Test free, tiny, triserial at the base, becoming biserial in the later portion; chambers numerous, increasing gradually in size as added; sutures distinct, straight, slightly depressed; wall finely arenaceous with considerable cement, surface smoothly finished; aperture an arch at the base of the final chamber. Length of holotype 0.26 mm., greatest breadth 0.10 mm. Length of figured paratype 0.21 mm., other specimens range from 0.13 to 0.31 mm. in length.

Remarks: This species is closest to *Gaudryina bearpawensis* Wickenden in general proportions and rounded chambers, but it is smaller and has a less well developed biserial portion. It differs from *Gaudryina hectori* Nauss and *G. canadensis* Cushman in its much smaller size, fewer biserial chambers, and lack of the occasional uniserial development of *G. canadensis*.

Types and occurrence: Holotype (U.S.N.M. 106329), figured paratype (U.S.N.M. 106330) and unfigured paratypes (U.S.N.M. 106331) from a core at 6347′8″ to 6348′8″, and unfigured paratypes (U.S.N.M. 106332) from the core at 6346 to 6349 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Family TROCHAMMINIDAE

Subfamily TROCHAMMININAE

Genus TROCHAMMINA Parker and Jones, 1859

Trochammina contornata Tappan, n. sp.

Plate 1, figures 4–6

Test large, free, coiled in a trochoid spiral, all chambers visible dorsally, only those of the last whorl visible from the ventral side, dorsal side convex, ventral side flattened, centrally umbilicate; chambers numerous, increasing very gradually in size as added, about 12 in the final whorl, 3½ whorls present in the holotype, chambers somewhat flattened, inflated slightly at the inner margins both dorsally and ventrally, so that a somewhat raised area parallels the spiral suture dorsally and an elevated ring surrounds the ventral umbilicus; sutures slightly depressed, very slightly curved backward at the periphery on the dorsal side, straight and radiate ventrally; wall finely arenaceous with considerable cement; aperture an arched slit at the base of the apertural face of the final chamber. Greatest diameter of holotype 0.75 mm., least diameter 0.68 mm., greatest thickness 0.18 mm.

Remarks: This species differs from *Trochammina labiosa* Höglund in being more than twice as large, in having 12 rather than eight chambers in the last whorl, in lacking the stellate umbilicus and in lacking the angular periphery of *T. labiosa.* The present species differs from T. *ribstonensis* Wickenden in being larger in size, in having 12 rather than 7 chambers in the final whorl, and in having less rounded chambers and a less lobulate periphery.

Types and occurrence: Holotype (U.S.N.M. 106333) from the Upper Triassic Shublik formation, in a faulted exposure north of Shublik Springs, about two miles northeast of the Canning River, at lat. 69°29′40″ north, long. 146°08′40″ west, in northeastern Alaska. Collected by George Gryc, 1947. Only one specimen was found.

Trochammina helicta Tappan, n. sp.

Plate 1, figures 7–9

Test free, large, robust, trochoid, ventrally umbilicate, all chambers visible dorsally, only those of the last whorl visible ventrally, periphery subangular; chambers numerous, 10 to 11 in the final whorl, increasing gradually in length and rapidly in thickness as added, flattened dorsally, inflated ventrally, much inflated adjacent to the small but deep, rounded ventral umbilicus; sutures somewhat obscure, radiate ventrally, slightly curved dorsally; wall finely arenaceous, with considerable cement; aperture obscure. Greatest diameter of holotype 0.83 mm., least diameter 0.62 mm., greatest thickness 0.57 mm.

Remarks: This species has some of the features of the genus *Conotrochammina* Finlay, but the chambers reach farther into the umbilical area on the ventral side, while *Conotrochammina* consists of a spirally wound septate tube, with all whorls visible ventrally as well as dorsally. The genotype of *Conotrochammina* has an umbilicus occupying one-third the diameter of the test. *Trochammina helicta*, n. sp. differs from *T. globigeriniformis altiformis* Cushman and Renz in having 10 chambers instead of only 4 in the final whorl, and is approximately ⅓ smaller.

Types and occurrence: Holotype (U.S.N.M. 106334) and unfigured paratypes (U.S.N.M. 106335) from the interbedded black calcareous shales and black silty limestones, from a 148-foot zone, from 353 to 501 feet below the top of the Upper Triassic Shublik formation, in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Family LAGENIDAE

Genus ASTACOLUS Montfort, 1808

Astacolus connudatus Tappan, n. sp.

Plate 2, figures 8–19

Test free, large, robust, planispiral, and involute in the early portion, later part becoming involute and uncoiling, periphery subacute, with a narrow keel; chambers numerous, increasing gradually in size as added, 7 to 13 in the final whorl; sutures slightly thickened, gently curved; wall calcareous, hyaline, surface smooth; aperture radiate, at the peripheral angle. Greatest diameter of holotype 0.78 mm., least diameter 0.52 mm., greatest thickness 0.23 mm. Other specimens range from 0.26 to 0.86 mm. in diameter.

Remarks: Specimens of this species are invariably filled with pyrite, and some specimens consist only of the internal pyritic casts. *Astacolus connudatus*, n. sp. is of approximately the same size as *Cristellaria* (*Astacolus*) *dubia* Franke, but has more of a tendency to uncoil, and possesses thickened sutures. The present species is smaller than *Cristellaria* (*Robulina*) *polyphragma* Reuss, and is proportionally thicker through the umbonal region.

Types and occurrence: Holotype (U.S.N.M. 106336), figured paratypes (U.S.N.M. 106337a–c) and unfigured paratypes (U.S.N.M. 106338) all from the interbedded black calcareous shales and silty limestones, 150 feet below the top of the Upper Triassic Shublik formation; figured paratypes (U.S.N.M. 106339a–c) and unfigured paratypes (U.S.N.M. 106340) from the upper 25 feet of the Shublik formation; unfigured paratypes (U.S.N.M. 106341) from a 27 foot zone, from 32 to 59 feet below the top of the Shublik formation; unfigured paratypes (U.S.N.M. 106343) from a 148 foot zone, from 353 to 501 feet below the top of the Shublik formation; and unfigured paratypes (U.S.N.M. 106344) from a 50 foot zone, from 674 to 724 feet below the top of the Shublik formation, all from the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Figured paratype (U.S.N.M. 106345) and unfigured paratypes (U.S.N.M. 106346) from a core at 6304 to 6314 feet, figured paratypes (U.S.N.M. 106347a–c) and unfigured paratypes (U.S.N.M. 106348) from a core at 6316 to 6334 feet, and unfigured paratypes (U.S.N.M. 106349) from cuttings at 6375 to 6380 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Genus MARGINULINA d'Orbigny, 1826

Marginulina prisca Tappan, n. sp.

Plate 2, figures 20–23

Test free, robust, elongate, slightly arcuate; chambers numerous, as many as seven, increasing very gradually in size from the rounded base; sutures distinct, thickened, straight; wall calcareous, hyaline, surface smooth; aperture terminal, radiate. Length of holotype 0.62 mm., greatest breadth 0.21 mm., other specimens range from 0.49 to 0.65 mm. in length.

Remarks: Marginulina prisca, n. sp. is similar in size and form to *Marginulina dentalina* Haeusler, but has less oblique sutures and lacks the longitudinal costae of that species. The present species differs from *M. dorsata* Cushman in being approximately one-half as large, and in having less constricted sutures.

Types and occurrence: Holotype (U.S.N.M. 106350) and unfigured paratypes (U.S.N.M. 106351) from a core at 6304 to 6314 feet in the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska. Figured paratype (U.S.N.M. 106352) and unfigured paratypes (U.S.N.M. 106353) from a 148 foot zone, from 353 to 501 feet below the top of the interbedded black calcareous shales and silty limestones of the Upper Triassic Shublik formation, in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Genus VAGINULINOPSIS Silvestri, 1904

Vaginulinopsis acrulus Tappan, n. sp.

Plate 3, figures 21–23

Test free, large, early portion close coiled, later portion uncoiling but slightly arcuate, periphery subacute; chambers numerous, low and broad, increasing gradually in size as added, about seven in the coil of the microspheric form, followed by seven to nine uncoiled chambers; sutures nearly straight, somewhat higher on the dorsal margin, obscure except when specimens are dampened; wall calcareous, hyaline, surface smooth; aperture at the dorsal angle, apparently radiate, but the preservation is poor and radial markings obscure. Length of holotype 0.94 mm., breadth of coil 0.26 mm., breadth of final chamber 0.34 mm., greatest thickness

0.26 mm. Other specimens range from 0.57 to 0.94 mm. in length.

Remarks: Vaginulinopsis acrulus, n. sp. is similar to *Marginulina indica* LeRoy in size, but has many more chambers, and has a more enrolled early portion. The present species differs from *Vaginulinopsis pachynota* ten Dam in lacking the thickened and elevated sutures of that species, in having less oblique and less depressed sutures.

Types and occurrence: Holotype (U.S.N.M. 106354) from cuttings at 6510 to 6515 feet, from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska. Figured paratype (U.S.N.M. 106355) and unfigured paratypes (U.S.N.M. 106356) from 150 feet below the top of the Upper Triassic Shublik formation, in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Genus NODOSARIA Lamarck, 1812

Nodosaria larina Tappan, n. sp.

Plate 3, figures 5–8

Test free, large, robust, elongate, consisting of a rectilinear series of subglobular chambers; usually only three to four chambers present, which are centrally inflated and show very little increase in diameter from the globular proloculus, final chamber somewhat produced at the apertural end to form a short neck; sutures distinct, straight, thickened, constricted; wall calcareous, hyaline, surface smooth; aperture rounded, at the end of the short neck. Length of holotype 0.49 mm., greatest breadth 0.21 mm. Other specimens range from 0.44 to 0.73 mm. in length.

Remarks: Nodosaria larina, n. sp. differs from *N. beyrichi* Neugeboren and *N. incerta* Neugeboren in being about one half as large, in having a less acuminate final chamber and less incised sutures. The present species is about one half as large as *N. concinna* Reuss, and has lower chambers and less incised sutures. It is about one third as large as *N. pupa* Karrer and has a less tapering test.

Types and occurrence: Holotype (U.S.N.M. 106360), figured paratype (U.S.N.M. 106361) and unfigured paratypes (U.S.N.M. 106362) all from a core at 6304 to 6314 feet, and unfigured paratypes (U.S.N.M. 106363) from a core at 6316 to 6334 feet, from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska. Figured paratype (U.S.N.M. 106364) and unfigured paratypes (U.S.N.M. 106365) from the upper 25 feet of the Shublik formation, and unfigured paratypes (U. S. N. M. 106366) from 353 to 501 feet below the top of the Shublik formation, in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948.

Nodosaria liratella Tappan, n. sp.

Plate 3, figures 17–20

Test free, tiny, elongate, slightly tapered, consisting of a rectilinear series of chambers; 7 to 8 chambers in well developed specimens, of greater breadth than height, increasing gradually in size from the rounded base; sutures straight, distinct, somewhat constricted; wall calcareous, hyaline, surface ornamented with about 10 low ribs; aperture terminal, rounded. Length of holotype 0.26 mm., greatest breadth 0.05 mm. Other specimens range from 0.13 to 0.26 mm. in length.

Remarks: Nodosaria liratella, n. sp. is approximately one-tenth as large as *Nodosaria inmutilata* Franzenau and differs from *N. intercostata* Reuss in being about one-fifth as large and in having less constricted sutures. The present species differs from *N. perpusilla* Chapman in being somewhat smaller, and in having lower chambers and a less acuminate final chamber.

Types and occurrence: Holotype (U.S.N.M. 106357), figured paratypes (U.S.N.M. 106358 a–b) and unfigured paratypes (U.S.N.M. 106359) from a core at 6304 to 6314 feet in the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Nodosaria shublikensis Tappan

Plate 3, figures 1–4

Nodosaria shublikensis Tappan, 1951, Cushman Found. Foram. Research, Contr. vol. 2, pt. 1, p. 1, pl. 1, figs. 1a, b.

Test free, elongate, rectilinear, subcylindrical; chambers numerous, increasing very little in size from the rounded base, slightly tapering at the apertural end; sutures somewhat obscure, straight; wall calcareous, hyaline, surface smooth, ornamented by eight low longitudinal costae crossing the sutures; aperture terminal, rounded. Length of holotype 0.60 mm., greatest diameter 0.21 mm.

Remarks: This species resembles *Nodosaria orthopleura* Reuss, in having an elongate test, high ribs and obscure sutures, but differs in having a more nearly cylindrical test, and rounded instead of tapering base.

Types and occurrence: Holotype (U.S.N.M. 106114) and figured paratype (U.S.N.M. 106115) from a 148-foot zone, from 353 to 501 feet below the top of the Upper Triassic Shublik formation, unfigured paratypes (U.S.N.M. 106367) from the upper 25 feet of the Shublik formation, unfigured paratypes (U.S.N.M. 106368) from 32 to 59 feet below the top of the Shublik formation, unfigured paratypes (U.S.N.M. 106369) from 150 feet below the top and unfigured paratypes (U.S.N.M. 106370) from 290 feet below the top of the Shublik formation, in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, in northeastern Alaska. Collected by Edward G. Sable, 1948. Figured paratype (U.S.N.M. 106116) and unfigured paratypes (U.S.N.M. 106371) from the core at 6316 to 6334 feet in the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Genus PSEUDOGLANDULINA Cushman, 1929

Pseudoglandulina densa Tappan, n. sp.

Plate 4, figures 9–13

Test free, sub-cylindrical, robust, of medium size; chambers about five in number, increasing very little in breadth, later chambers overlapping earlier ones, final chamber occupying about two-fifths the length of the test; sutures not distinct, but visible when specimen is dampened, sutures about equidistant, not depressed; wall calcareous, surface smooth; aperture terminal, radiate. Length of holotype 0.57 mm., greatest breadth 0.23 mm. Other specimens range in length from 0.36 to 0.57 mm.

Remarks: This species is similar in size and outline to *Glandulina subconica* Alth, but has lower and more numerous chambers, and the final chamber does not taper toward the aperture.

Types and occurrence: Holotype (U.S.N.M. 106381), figured paratype (U.S.N.M. 106382) and unfigured paratypes (U.S.N.M. 106383) from the upper 25 feet of the Upper Triassic Shublik formation, and unfigured paratypes (U.S.N.M. 106384) from 353 to 501 feet below the top of the Shublik formation in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, northeastern Alaska. Collected by Edward G. Sable, 1948. Figured paratype (U.S.N.M. 106385) from a core at 6316 to 6334 feet in the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Pseudoglandulina lata Tappan, n. sp.

Plate 3, figures 15, 16

Test free, small, rapidly flaring from the tiny base; chambers few, generally not more than four, much overlapping, final chamber forming about two-fifths the length of the test; sutures not distinct, about equidistant, straight and horizontal; wall calcareous, surface smooth; aperture terminal, rounded. Length of holotype 0.26 mm., greatest breadth 0.16 mm. Other specimens range in length from 0.26 to 0.31 mm.

Remarks: This species differs from *Pseudoglandulina simpsonensis*, n. sp. in being about one-half as large, in having a much more rapidly flaring test, and in lacking the slight neck of *P. simpsonensis*. *Pseudoglandulina densa*, n. sp. differs from the present species in being subcylindrical rather than flaring in outline. *P. lata*, n. sp. differs from *P. acuta* LeRoy in being about one-half as large and in lacking the acuminate extremities of that species.

Types and occurrence: Holotype (U.S.N.M. 106378) from the upper 25 feet of the Shublik formation, unfigured paratype (U.S.N.M. 106379) from 150 feet below the top of the formation, unfigured paratype (U.S.N.M. 106380) from 353 to 501 feet below the top of the formation, all from the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, northeastern Alaska. Collected by Edward G. Sable, 1948.

Pseudoglandulina simpsonensis Tappan, n. sp.

Plate 3, figures 9–14

Test free, elongate, tapering, composed of a series of rectilinear chambers; chambers numerous, increasing gradually in diameter as added, but increasing less rapidly in height, final chamber comparatively long, about twice the length of the immediately preceding chamber, tapering somewhat to form a slight neck at the apertural end; sutures distinct, straight, horizontal; wall calcareous, hyaline, surface smooth; aperture terminal, rounded, on a slight neck. Length of holotype 0.65 mm., greatest breadth 0.18 mm. Other specimens range from 0.31 to 0.88 mm. in length.

Remarks: This species is quite similar to *Pseudoglandulina obconica* (Reuss) from the Triassic of St. Cassian, but does not taper as much nor as regularly. No dimensions were given for Reuss's species, hence no comparison as to size can be made. *P. simpsonensis*, n. sp. differs from *P. scotti* Tappan and *P. traphera* Loeblich and Tappan in having lower chambers and a more regularly tapering test than these species.

Types and occurrence: Holotype (U.S.N.M. 106372), figured paratype (U.S.N.M. 106373) and unfigured paratypes (U.S.N.M. 106374) from a core at 6304 to 6314 feet and figured paratype (U.S.N.M. 106375) from cuttings at 6415 to 6420 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska. Figured paratype (U.S.N.M. 106376) and unfigured paratype (U.S.N.M. 106377) from a 27-foot zone, from 32 to 59 feet below the top of the Upper Triassic Shublik formation, in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, northeastern Alaska. Collected by Edward G. Sable, 1948.

Genus LINGULINA d'Orbigny, 1826

Lingulina alaskensis Tappan

Plate 4, figures 18–22

Lingulina alaskensis Tappan, 1951, Cushman Found. Foram. Research, Contr. vol. 2, pt. 1, p. 1, pl. 1, figs. 2a, b.

Test free, elongate, flattened, robust, margins subacute; early chambers widening rapidly from the rounded proloculus, later chambers increasing very little in size, so that sides of test are parallel; sutures distinct, not depressed, slightly arched centrally; wall calcareous, hyaline, surface smooth, ornamented only by a central longitudinal furrow, bordered on each side by a low rib; aperture terminal, simple. Length of holotype 0.52 mm., greatest breadth 0.21 mm., thickness through center 0.13 mm. Other specimens range from 0.29 to 0.57 mm. in length.

Remarks: This species resembles *Lingulina testudinaria* Franke, from the Lias of Germany, in the broad low chambers and central lengthwise groove. In *L. testudinaria* the groove is bordered by much stronger costae, and the sutures are limbate. The Alaskan species differs also in being shorter and narrower.

Types and occurrence: Holotype (U.S.N.M. 106117) and paratypes (U.S.N.M. 106118) from a core at 6304 to 6314 feet in the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska. Figured paratypes (U.S.N.M. 106119a–b) and unfigured paratypes (U.S.N.M. 106386) from 150 feet below the top of the Shublik formation, and unfigured paratypes (U.S.N.M. 106387) from 353 to 501 feet below the top of the Shublik formation, in the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, northeastern Alaska. Collected by Edward G. Sable, 1948.

Lingulina borealis Tappan, n. sp.

Plate 4, figures 5–8, 14–17

Test free, elongate, subovate in outline, early portion flaring rapidly, later portion with nearly parallel sides, compressed, periphery subacute; chambers numerous, wide and low, broadly arched centrally, generally 10 in well-developed specimens; sutures distinct when specimen is dampened, arched centrally and somewhat thickened; wall calcareous, hyaline, surface smooth; aperture terminal, slightly elongate. Length of holotype 0.49 mm., greatest breadth 0.16 mm., greatest thickness 0.10 mm. Other specimens range from 0.34 to 0.62 mm. in length.

Remarks: Lingulina borealis, n. sp. differs from *L. hibschi* Matouschek in being more elongate, and in having lower and more numerous chambers. It differs from *L. polymorpha* Costa in having more regularly arranged and arched chambers, and a less elongate aperture. The present species differs from *Frondicularia dolium* Terquem in being much smaller, and in having a less ovate cross-section.

Types and occurrence: Holotype (U.S.N.M. 106388) and figured paratypes (U.S.N.M. 106389a–b) from 353 to 501 feet below the top of the Upper Triassic Shublik formation, unfigured paratypes (U.S.N.M. 106390) from 150 feet below the top of the Shublik formation, and unfigured paratypes (U.S.N.M. 106391) from 290 feet below the top of the Shublik formation, all from the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, northeastern Alaska. Collected by Edward G. Sable, 1948. Figured paratype (U.S.N.M. 106392) from a core at 6316 to 6334 feet, and figured paratype (U.S.N.M. 106393) from a core at 6346 to 6349 feet, both from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Genus FRONDICULARIA Defrance, 1824

Frondicularia acmaea Tappan, n. sp.

Plate 4, figures 1–4

Test free, elongate, flaring broadly, somewhat compressed, periphery sharply angled, with a keel; chambers equitant, numerous, widening rapidly from the round proloculus, increasing very little in height, strongly angled at the center of the faces; sutures distinct when specimen is dampened, not depressed, sharply angled, and in some specimens the outline of the apertural necks of previous chambers can be seen through the wall; wall calcareous, hyaline, surface smooth, ornamented by two to three low continuous ribs on each side of the center of the faces of the test, the ribs paralleling the margins of the test and thus diverging sharply, crossing and obscuring the sutures; aperture terminal, rounded, on a slight neck. Length of holotype 0.73 mm., greatest breadth 0.29 mm., greatest thickness 0.10 mm.

Remarks: Because of its large size and comparatively delicate form, and the very hard and indurated nature of the enclosing beds, it has been impossible to secure large unbroken specimens of this species, although a number of fragments have been obtained, and some, such as the two specimens figured, are nearly complete. This species is similar to *Frondicularia affinis* Neugeboren in having about four continuous ribs on each face, and in having a carinate margin, but differs in having a much more flaring test, rather than subparallel sides, and in having more strongly angled sutures.

Types and occurrence: Holotype (U.S.N.M. 106394) and unfigured paratypes (U.S.N.M. 106395) from 150 feet below the top of the Upper Triassic Shublik formation, figured paratype (U.S.N.M. 106396) from the upper 25 feet of the formation, unfigured paratype (U.S.N.M. 106397) from 32 to 59 feet below the top of the formation, unfigured paratypes (U.S.N.M. 106398) from 290 feet below the top and unfigured paratypes (U.S.N.M. 106399) from 353 to 501 feet below the top of the Shublik formation, all from the banks of a southward-flowing tributary that enters the Sadlerochit River at approximately lat. 69°34′30″ north, long. 145°03′ west, on the south slope of the Sadlerochit Mountains, northeastern Alaska. Collected by Edward G. Sable, 1948.

Family POLYMORPHINIDAE

Subfamily POLYMORPHININAE

Genus EOGUTTULINA Cushman and Ozawa, 1930

Eoguttulina bulgella Tappan, n. sp.

Plate 4, figures 23, 24

Test free, elongate, tapering at the apertural end, base rounded; chambers in a spiral series, each farther removed from the base, increasing rapidly in size, final chamber occupying over one half the length of the test; sutures distinct; wall probably calcareous, but all specimens seen are preserved as pyritic casts, no ornamentation preserved; aperture radiate, at the end of the somewhat produced final chamber. Length of holotype 0.52 mm., greatest breadth 0.21 mm. Other specimens are from 0.47 to 0.52 mm. in length.

Remarks: This species is closest to *Eoguttulina liassica* (Strickland) from the Jurassic of England, but differs in being thicker centrally, with a tapering apertural extremity, in having more rapidly enlarging chambers and in having more nearly horizontal sutures, those of *E. liassica* being much more oblique.

Types and occurrence: Holotype (U.S.N.M. 106400) and unfigured paratype (U.S.N.M. 106401) from cuttings at 6380 to 6385 feet, and figured paratype (U.S.N.M. 106402) from cuttings at 6345 to 6350 feet, from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Genus SAGOPLECTA Tappan, n. gen.

Genotype: Sagoplecta goniata Tappan, n. sp.

Diagnosis: Test free, elongate, early portion biserial, later portion uniserial and quadrate or flattened with the later chambers equitant and chevron-shaped, overhanging earlier chambers at the angles of the test; wall calcareous; aperture terminal, radiate.

Remarks: This genus is closely related to the polymorphinid genus *Spirofrondicularia* Schubert (= *Quadrulina* Cushman and Ozawa), which it resembles in the overhanging corners of the angular terminal chambers. The present genus is distinctly biserial in the early stages, and *Spirofrondicularia* differs in having a tetraloculine early chamber arrangement. *Sagoplecta* resembles *Pyrulinoides* Marie in the early development, but differs in having the later uniserial equitant chambers. The chamber arrangement of *Sagoplecta* parallels that of *Parafrondicularia* Asano, which has been referred to the Lagenidae, but the present genus is related to the Polymorphinidae in having a thicker test and less regularly arranged chambers, while *Parafrondicularia* is compressed, and the regular chamber arrangement is more like that of *Frondicularia* or *Plectofrondicularia.*

"*Frondicularia*" *paradoxa* Berthelin, from the Jurassic of France, also is biserial with later uniserial equitant chambers. The carinate margins, compressed test, and simple rounded aperture suggest that this species is a lagenid and it should probably be referred to *Parafrondicularia.* It has been placed in *Flabellina,* but seems to have a definite biserial early stage, and show no true coiling.

The three species of *Sagoplecta* here described differ in one or more important specific characteristics, and the genus thus seems to have been well developed in the Upper Triassic. As no other species are known, the range is at present limited to the Upper Triassic.

Sagoplecta goniata Tappan, n. sp.

Plate 5, figures 1–8

Test free, elongate, triangular to rectangular in section, early biserial portion short, consisting of only two to five chambers, followed by one or two terminal uniserial chambers, which are triangular or quadrangular in section, angles bluntly rounded; chambers few, increasing rapidly in size as added, biserial chambers small, uniserial chambers with considerable overlapping of the earlier chambers, final chamber approximately one half the length of the test, and resembling an inverted cone, chamber margins nearest the base serrate, with a stronger lobe at the angles so that the chambers overhang farther at the angles; sutures distinct, depressed, early ones curved and oblique, later ones horizontal but arched on the faces of the test and recurved at the angles; wall probably calcareous, but specimens preserved only as pyritic casts, surface smooth, with no ornamentation other than the serrate lower margins of the chambers which very probably reflect the presence of ribs on the surface of the test, although no well-preserved specimens have been found to support this; aperture terminal, radiate. Length of holotype 0.65 mm., greatest breadth 0.29 mm., greatest thickness 0.21 mm. Other specimens range from 0.31 to 0.65 mm. in length.

Remarks: This species is closest to the Cretaceous *Spirofrondicularia rhabdogonioides* (Chapman) in general outline and subquadrate section, but differs in being twice as large, in being biserial to uniserial in plan rather than quadriserial, and in having a more produced final chamber. The present species is also ornamented by the serrate chamber margins (possibly reflecting surface ribs) but the Cretaceous species has no surface ornamentation.

Types and occurrence: Holotype (U.S.N.M. 106403) from cuttings at 6345 to 6350 feet, figured paratype (U.S.N.M. 106404) and unfigured paratypes (U.S.N.M. 106405) from a core at 6305 to 6306 feet, figured paratype (U.S.N.M. 106406) from cuttings at 6375 to 6380 feet, figured paratype (U.S.N.M. 106407) from cuttings at 6380 to 6385 feet, unfigured paratypes (U.S.N.M. 106408) from cuttings at 6355 to 6360 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Sagoplecta himatioides Tappan, n. sp.

Plate 5, figures 9–13

Test free, palmate, broad and flattened, early portion biserial, later portion with uniserial equitant chambers, periphery bluntly rounded; chambers broad and low, increasing rapidly in size as added; sutures distinct, much constricted, giving a serrate margin to the test, very strongly oblique in the early biserial portion and acutely angled in the uniserial portion; wall probably calcareous, although all specimens observed have been represented only by pyritic casts; aperture terminal, radiate. Length of holotype 0.47 mm., greatest breadth 0.34 mm., greatest thickness 0.23 mm. Other specimens range from 0.23 to 0.57 mm. in length.

Remarks: This species is closest to *Spirofrondicularia frondicularioides* (Chapman) in general outline, flattened test and equitant final chambers, but differs in having a biserial rather than quadriserial early portion, in having an elongate uniserial stage of as many as three broad low equitant chambers and in being more flattened in section, and nearly twice as large.

Types and occurrence: Holotype (U.S.N.M. 106409) and figured paratypes (U.S.N.M. 106410a–b) and unfigured paratypes (U.S.N.M. 106411) from a core at 6305 to 6306 feet, unfigured paratype (U.S.N.M. 106412) from cuttings at 6330 to 6335 feet, and unfigured paratype (U.S.N.M. 106413) from cuttings at 6455 to 6460 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Sagoplecta incrassata Tappan, n. sp.

Plate 5, figures 14–16

Test free, elongate, slightly flattened, ovate in section, early biserial portion reduced, consisting of only two to four biserial chambers, later portion consisting of uniserial equitant chambers, margins serrate, periphery rounded; chambers increasing gradually in size as added, overlapping previous chambers, final chamber reaching back nearly one-half the length of the test and much longer than previous chambers; sutures distinct, depressed, oblique in early portion, arched in later portion; wall calcareous, but all specimens preserved only as pyritic casts, no surface ornamentation; aperture terminal, slightly elongated, probably radiate. Length of holotype 0.70 mm., greatest breadth 0.26 mm., greatest thickness 0.18 mm. Other specimens vary from 0.29 to 0.70 mm. in length.

Remarks: This species differs from *Spirofrondicularia frondicularioides* (Chapman) in being about twice as large and more ovate in section, in having an early biserial stage followed by equitant uniserial chambers, and in the final chamber being about one-half the length of the test. *Sagoplecta incrassata*, n. sp. differs from *S. himatioides*, n. sp. in being more narrow and less compressed, in having less strongly angled sutures and in the final chamber being much produced, occupying approximately one-half the length of the test.

Types and occurrence: Holotype (U.S.N.M. 106414) from cuttings at 6375 to 6380 feet, figured paratype (U.S.N.M. 106415) from cuttings at 6325 to 6330 feet, unfigured paratypes (U.S.N.M. 106416) from cuttings at 6370 to 6375 feet, unfigured paratype (U.S.N.M. 106417) from cuttings at 6460 to 6465 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Genus PYRULINOIDES Marie, 1941

Pyrulinoides plagia Tappan, n. sp.

Plate 4, figures 25–27

Test free, elongate, acuminate at both extremities, chambers biserially arranged throughout, slightly inflated, increasing rapidly in size as added, final chamber extending from one-half to two-thirds the length of the test; sutures distinct, depressed, strongly oblique; wall probably calcareous, but all specimens are preserved only as pyritic casts, no ornamentation preserved; aperture terminal, radiate. Length of holotype 0.57 mm., breadth 0.26 mm., greatest thickness 0.13 mm. Other specimens vary in length from 0.13 to 0.57 mm.

Remarks: Although Marie stated that *Pyrulinoides* differed from *Polymorphina* in being circular in section rather than compressed, the present species is closer to the comparatively primitive *Pyrulinoides* than to the very advanced *Polymorphina*, which develops a sigmoid character while biserial and compressed throughout. *Pyrulinoides plagia*, n. sp. differs from *Pyrulinoides acuminata* (d'Orbigny) in being compressed in section, in having a slightly lobulate outline and in having a produced final chamber.

Types and occurrence: Holotype (U.S.N.M. 106418) from cuttings at 6380 to 6385 feet, figured paratype (U.S.N.M. 106419) and unfigured paratype (U.S.N.M. 106434) from a core at 6305 to 6306 feet, unfigured paratypes (U.S.N.M. 106435) from a core at 6304 to 6314 feet, unfigured paratypes (U.S.N.M. 106420) from cuttings at 6310 to 6315 feet, unfigured paratype (U.S.N.M. 106421) from cuttings at 6335 to 6340 feet, unfigured paratypes (U.S.N.M. 106431) from cuttings at 6345 to 6350 feet, unfigured paratypes (U.S.N.M. 106432) from a core at 6347′8″ to 6348′8″ and unfigured paratype (U.S.N.M. 106433) from cuttings at 6440 to 6445 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Family BULIMINIDAE

Subfamily VIRGULININAE

Genus BOLIVINA d'Orbigny, 1839

Bolivina lathetica Tappan, n. sp.

Plate 5, figures 17–19

Test free, tiny, elongate, tapered at the base, biserial throughout, ovate in section, periphery broadly rounded; chambers numerous, low and broad, increasing rapidly in size as added; sutures distinct, depressed, slightly oblique; wall probably calcareous, although all specimens found have been represented only by pyritic casts, no ornamentation preserved; aperture a short loop at the base of the final chamber. Length of holotype 0.23 mm., greatest breadth 0.10 mm., greatest thickness 0.08 mm. Other specimens range from 0.16 to 0.23 mm. in length.

Remarks: This species is closest to *B. incrassata* Reuss from the Cretaceous of Germany, but differs in being only about one-fourth as large, in having a more acutely angled base and a more rapidly flaring test.

Types and occurrence: Holotype (U.S.N.M. 106436) from cuttings at 6435 to 6440 feet, figured paratype (U.S.N.M. 106437) from a core at 6304 to 6314 feet, unfigured paratype (U.S.N.M. 106438) from a core at 6346 to 6349 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Family SPIRILLINIDAE

Subfamily SPIRILLININAE

Genus SPIRILLINA Ehrenberg, 1843

Spirillina gurgitata Tappan, n. sp.

Plate 5, figures 20–22

Test free, tiny, planispiral, consisting of a globular proloculus and coiled tubular second chamber which increases very little in diameter throughout its length; wall probably calcareous, hyaline, the only specimens found being represented by pyritic casts; aperture at the open end of the tube. Greatest diameter of holotype 0.13 mm., greatest thickness 0.03 mm. Greatest diameter of paratype 0.16 mm.

Remarks: This species is closest to *Spirillina orbicula* Terquem and Berthelin, from the Lower Jurassic, but differs in being considerably smaller and in the tubular chamber being of nearly the same diameter throughout.

Types and occurrence: Holotype (U.S.N.M. 106439) and figured paratype (U.S.N.M. 106440) from a core at 6304 to 6314 feet in the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Family ROTALIIDAE

Subfamily DISCORBINAE

Genus DISCORBIS Lamarck, 1804

Discorbis pristina Tappan, n. sp.

Plate 5, figures 23–25

Test free, small, trochoid, ventrally umbilicate, somewhat flattened, the 2½ whorls entirely visible dorsally, only the last whorl visible from the ventral side, periphery subacute; chambers increasing in size as added, about five to six in the last whorl; sutures distinct, depressed, radiate; wall probably calcareous, but specimens are represented only by pyritic casts; aperture obscure, but apparently slightly ventral, at the base of the final chamber. Greatest diameter of holotype 0.29 mm., least diameter 0.23 mm., greatest thickness 0.08 mm. Other specimens range in diameter from 0.16 to 0.29 mm.

Remarks: Discorbis pristina, n. sp. differs from *D. collinsi* Parr in being about one-half as large, in having a greater number of whorls, and in being more compressed.

Types and occurrence: Holotype (U.S.N.M. 106441) and paratype (U.S.N.M. 106442) from a core at 6316 to 6334 feet, unfigured paratypes (U.S.N.M. 106443) from a core at 6304 to 6314 feet, and unfigured paratype (U.S.N.M. 106444) from cuttings at 6335 to 6340 feet, all from the Upper Triassic Shublik formation, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

REFERENCES

Bornemann, J. G., 1886, Beiträge zur Kenntniss des Muschelkalks, insbesondere der Schichtenfolge und der Gesteine des Unteren Muschelkalks in Thüringen: Jahrb. der K. Preuss. geol. Landesanst. und Bergakad. zu Berlin, vol. 6, pp. 267–321, pls. 7–14.

Chapman, Frederick, 1895, On Rhaetic Foraminifera from Wedmore, in Somerset: Annals and Mag. Nat. History, vol. 16, 6th ser., no. 44, pp. 305–329, pls. 11, 12.

———, 1900, Foraminifera from an Upper Cambrian horizon in the Malverns; together with a note on some of the earliest-known Foraminifera: Geol. Soc. London Quart. Jour., vol. 56, pp. 257–263, pl. 15.

———, 1909, On some Microzoa from the Wianamatta shales, New South Wales: Records of the Geol. Surv. New South Wales, vol. 8, pt. 4, pp. 334–339, pl. 54.

Cushman, J. A., 1910–1916, A monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, 596 pp., 473 text figs., 135 pls.

———, 1920, The Foraminifera of the Canadian Arctic Expedition, 1913–1918: Rep. Canadian Arctic Exped., 1913–1918, vol. 9, pt. M, pp. 1–13, pl. 1.

———, 1927, Some Foraminifera from the Cretaceous of Canada: Trans. Royal Soc. Canada, 3rd ser., vol. 21, sect. 4, pp. 127–132, 1 pl.

———, 1933, New Arctic Foraminifera collected by Capt. R. A. Bartlett from Fox Basin and off the northeast coast of Greenland: Smithsonian Misc. Coll. vol. 89, no. 9, pp. 1–8, pls. 1–2.

———, 1941, Some fossil Foraminifera from Alaska: Cushman Lab. Foram. Research Contr., vol. 17, pt. 2, pp. 33–38, pl. 9.

———, 1943, *Gaudryina canadensis*, new name: Cushman Lab. Foram. Research Contr., vol. 19, pt. 2, pp. 27–28, pl. 6.

———, 1946, Upper Cretaceous Foraminifera of the Gulf Coastal region of the United States and adjacent areas: U. S. Geol. Survey Prof. Paper 206, 160 pp., 66 pls.

———, 1948, Arctic Foraminifera: Cushman Lab. Foram. Research Spec. Publ. 23, pp. 1–87, pls. 1–8.

——— and Todd, R., 1947, A foraminiferal fauna from Amchitka Island, Alaska: Cushman Lab. Foram. Research Contr., vol. 23, pt. 3, pp. 60–72, pls. 14–16.

——— and Wickenden, R. T. D., 1928, A new foraminiferal genus from the Upper Cretaceous: Cushman Lab. Foram. Research Contr., vol. 4, pt. 1, pp. 12–13, pl. 1.

Gümbel, C. W., 1869, Ueber Foraminiferen, Ostracoden und mikroskopische Thier-Ueberreste in den St. Cassianer und Raibler Schichten: Jahrb. d. k. k. Geol. Reichsanstalt, vol. 19, pp. 175–186, pls. 5, 6.

Jones, T. Rupert and Parker, W. K., 1860, On some fossil Foraminifera from Chellaston near Derby: Geol. Soc. London Quart. Jour., vol. 16, pp. 452–458, pls. 19–20.

Kirchner, H., 1925, Neue Fossilfunde im fränkischen Muschelkalk: Centralbl. fur Miner. Geol. und Paläont., Abt. B, pp. 21–26.

Leffingwell, Ernest de K., 1919, The Canning River region, northern Alaska: U. S. Geol. Survey Prof. Paper 109, 251 pp., 33 figures, 35 pls.

Mariani, E., 1893, Note paleontologiche sul trias superiore della Carnia occidentale: Annali del R. Instituto tecnico Antonio Zanon in Udine, ser. 2, Ann. 11, pp. 13–35, 3 pls.

Nauss, A. W., 1947, Cretaceous microfossils of the Vermilion area, Alberta: Jour. Paleontology, vol. 21, no. 4, pp. 329–343, pls. 48–49.

Payne, Thomas G. and others, Geology of the Arctic slope of Alaska: U. S. Geol. Survey Oil and Gas Invest., Prelim. Map., 2 sheets (in preparation).

Reuss, A. E., 1868, Paläontologische Beiträge, 8. Foraminiferen und Ostracoden aus den Schichten von St. Cassian: Sitz. d. K. Akad. Wiss., Abt. I, Bd. 57, pp. 101–109, pl. 1.

Schwager, G., 1864, in Dittmar's Die Contorta Zone: pp. 198–201, pl. 3, München.

Tappan, Helen, 1951, Northern Alaska index Foraminifera: Cushman Found. Foram. Research, Contr., vol. 2, pt. 1, pp. 1–8, pl. 1.

Vadasz, E. M., 1911, Triasforaminiferen aus dem Bakony: Resultate der Wissenschaft. Erforschung der Balatonsees, Paleont. der Umgebung des Balatonsees, Band 1, Teil 1, Abh. 1, pp. 1–44, 2 pls., 20 text figs.

———, 1933, Neuer Beitrag sur Frage der Triasforaminiferen im Bakony: Centralbl. Mineralogie, Abt. B, No. 3, pp. 173–178.

Wickenden, R. T. D., 1932a, A useful Foraminifera horizon in the Alberta shale of southern Alberta: Jour. Paleontology, vol. 6, no. 2, pp. 203–207, pl. 29.

———, 1932b, New species of Foraminifera from the Upper Cretaceous of the Prairie provinces, Royal Soc. Canada Trans., 3rd ser., vol. 26, sec. 4, pp. 85–92, pl. 1.

———, 1933, Jurassic Foraminifera from wells in Alberta and Saskatchewan: Royal Soc. Canada Trans., 3rd ser., sec. 4, vol. 27, pp. 157–170, pls. 1–2.

———, 1949, *Eoeponidella*, a new genus from the Upper Cretaceous: Royal Soc. Canada Trans., 3rd ser., vol. 42, sec. 4, pp. 81–82, figs. 1a–c.

Wirz, Albert, 1945, Beitrage zur Kenntnis des Ladinikums in Gebiete des Monte San Giorgio, Die Triasfauna der Tessiner Kalkalpen, 15: Schweizer, palaeont. Abh. Band 65, 84 pp., 3 pls., 8 text figs.

Wood, A., 1947, The supposed Cambrian Foraminifera from the Malverns: Geol. Soc. London, Quart. Jour., vol. 102, pp. 447–460, pls. 26–28.

INDEX

[Italic page numbers indicate descriptions]

○

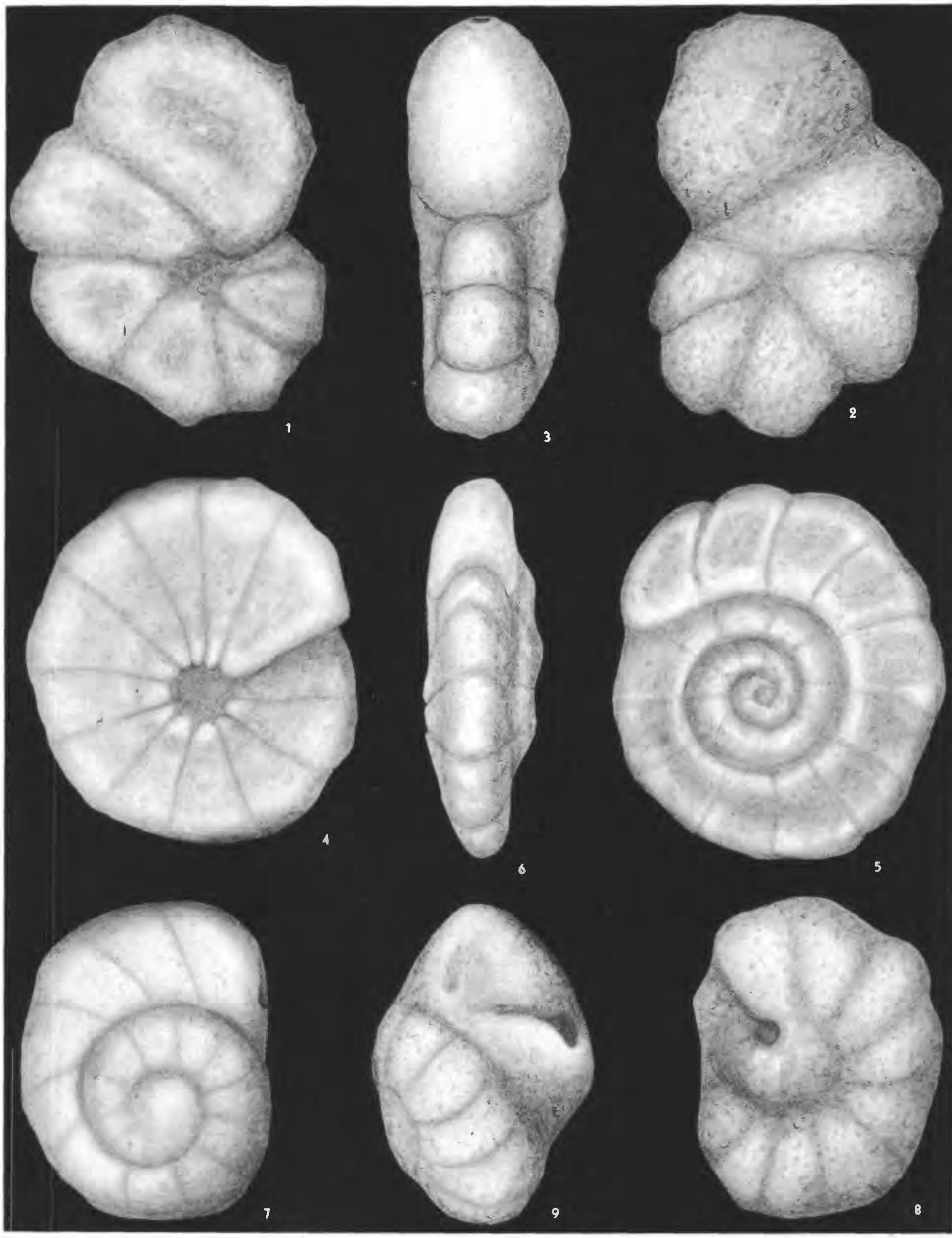
PLATES 1–5

PLATE 1

FIGURES 1–3. *Ammobaculites sthenarus* Tappan, n. sp. 1, Side view of paratype (U.S.N.M. 106328). 2, Side view of holotype (U.S.N.M. 106327); 3, edge view, showing terminal aperture. × 72. (p. 8)

4–6. *Trochammina contornata* Tappan, n. sp. 4, Ventral view of holotype (U.S.N.M. 106333), showing umbilicus; 5, dorsal view; 6, edge view. × 95. (p. 9)

7–9. *Trochammina helicta* Tappan, n. sp. 7, Dorsal view of holotype (U.S.N.M. 106334); 8, ventral view; 9, edge view. × 72. (p. 9)



LITUOLIDAE, TROCHAMMINIDAE

PLATE 2

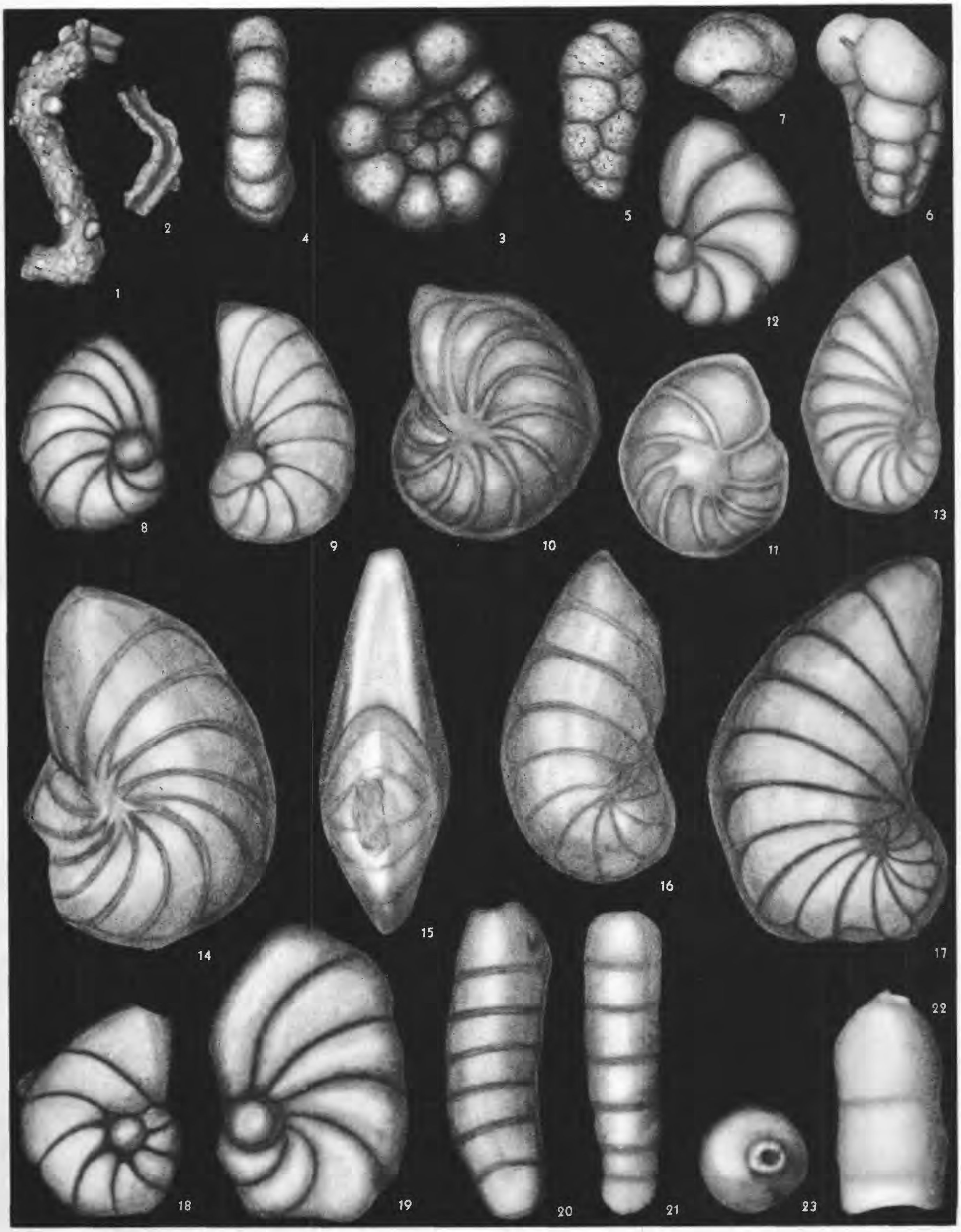
FIGURES 1–2. *Tolypammina glareosa* Tappan, n. sp. 1, External view of holotype (U.S.N.M. 106322). 2, View of attached side of paratype (U.S.N.M. 106323). × 41. (p. 8)

3, 4. *Trochamminoides vertens* Tappan, n. sp. 3, Side view of holotype (U.S.N.M. 106324); 4, edge view. × 158. (p. 8)

5–7. *Gaudryina adoxa* Tappan, n. sp. 5, Side view of paratype (U.S.N.M. 106330). 6, Side view of holotype (U.S.N.M. 106329); 7, top view. × 158. (p. 9)

8–19. *Astacolus connudatus* Tappan, n. sp. 8, Side view of paratype (U.S.N.M. 106347a). 9, Side view of paratype (U.S.N.M. 106339a). 10, Side view of paratype (U.S.N.M. 106339b). 11, Side view of paratype (U.S.N.M. 106339c). 12, Side view of paratype (U.S.N.M. 106345), represented by an internal pyritic cast only. 13, Side view of paratype (U.S.N.M. 106337a). 14, Side view of holotype (U.S.N.M. 106336); 15, edge view. 16, Side view of paratype (U.S.N.M. 106337b). 17, Side view of paratype (U.S.N.M. 106337c). 18, Side view of paratype (U.S.N.M. 106347b). 19, Side view of paratype (U.S.N.M. 106347c). × 95. (p. 10)

20–23. *Marginulina prisca* Tappan, n. sp. 20, Side view of holotype (U.S.N.M. 106350); 21, edge view. 22, Side view of paratype (U.S.N.M. 106352); 23, top view. × 95. (p. 10)



AMMODISCIDAE, LITUOLIDAE, VERNEUILINIDAE, LAGENIDAE

PLATE 3

FIGURES 1–4. *Nodosaria shublikensis* Tappan. 1, Side view of paratype (U.S.N.M. 106116). 2, Side view of holotype (U.S.N.M. 106114); 3, top view. 4, Side view of paratype (U.S.N.M. 106115). × 95. (p. 11)

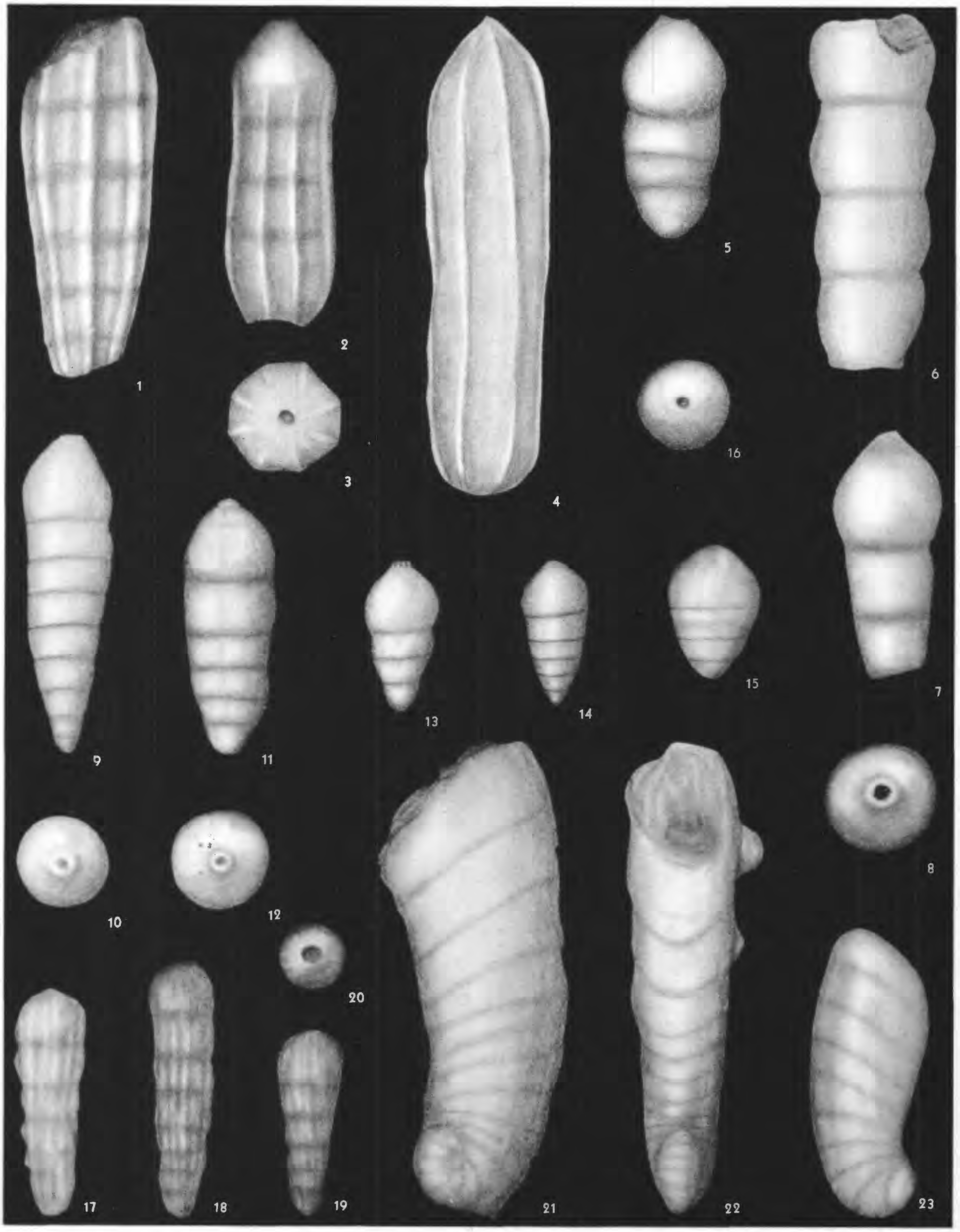
5–8. *Nodosaria larina* Tappan, n. sp. 5, Side view of paratype (U.S.N.M. 106364). 6, Side view of paratype (U.S.N.M. 106361). 7, Side view of holotype (U.S.N.M. 106360), showing subglobular chambers and constricted sutures; 8, top view. × 95. (p. 11)

9–14. *Pseudoglandulina simpsonensis* Tappan, n. sp. 9, Side view of holotype (U.S.N.M. 106372), showing closely appressed chambers, and tapering base; 10, top view. 11, Side view of paratype (U.S.N.M. 106376); 12, top view. 13, Side view of paratype (U.S.N.M. 106375). 14, Side view of paratype (U.S.N.M. 106373). × 95. (p. 12)

15, 16. *Pseudoglandulina lata* Tappan, n. sp. 15, Side view of holotype (U.S.N.M. 106378), showing small size, abruptly flaring test and unconstricted sutures; 16, top view. × 95. (p. 12)

17–20. *Nodosaria liratella* Tappan, n. sp. 17, Side view of paratype (U.S.N.M. 106358a), showing small size, obscure sutures and megalospheric form. 18, Side view of paratype (U.S.N.M. 106358b). 19, Side view of microspheric holotype (U.S.N.M. 106357), showing more tapering test; 20, top view. × 218. (p. 11)

21–23. *Vaginulinopsis acrulus* Tappan, n. sp. 21, Side view of microspheric holotype (U.S.N.M. 106354); 22, edge view. 23, Side view of megalospheric paratype (U.S.N.M. 106355). × 95. (p. 10)



LAGENIDAE

PLATE 4

FIGURES 1–4. *Frondicularia acmaea* Tappan, n. sp. 1, Side view of holotype (U.S.N.M. 106394), showing large flaring test, round proloculus, diverging longitudinal ribs, and carinate margins; 2, edge view. 3, Side view of paratype (U.S.N.M. 106396), showing character of apertural portion; 4, top view. × 95. (p. 13)

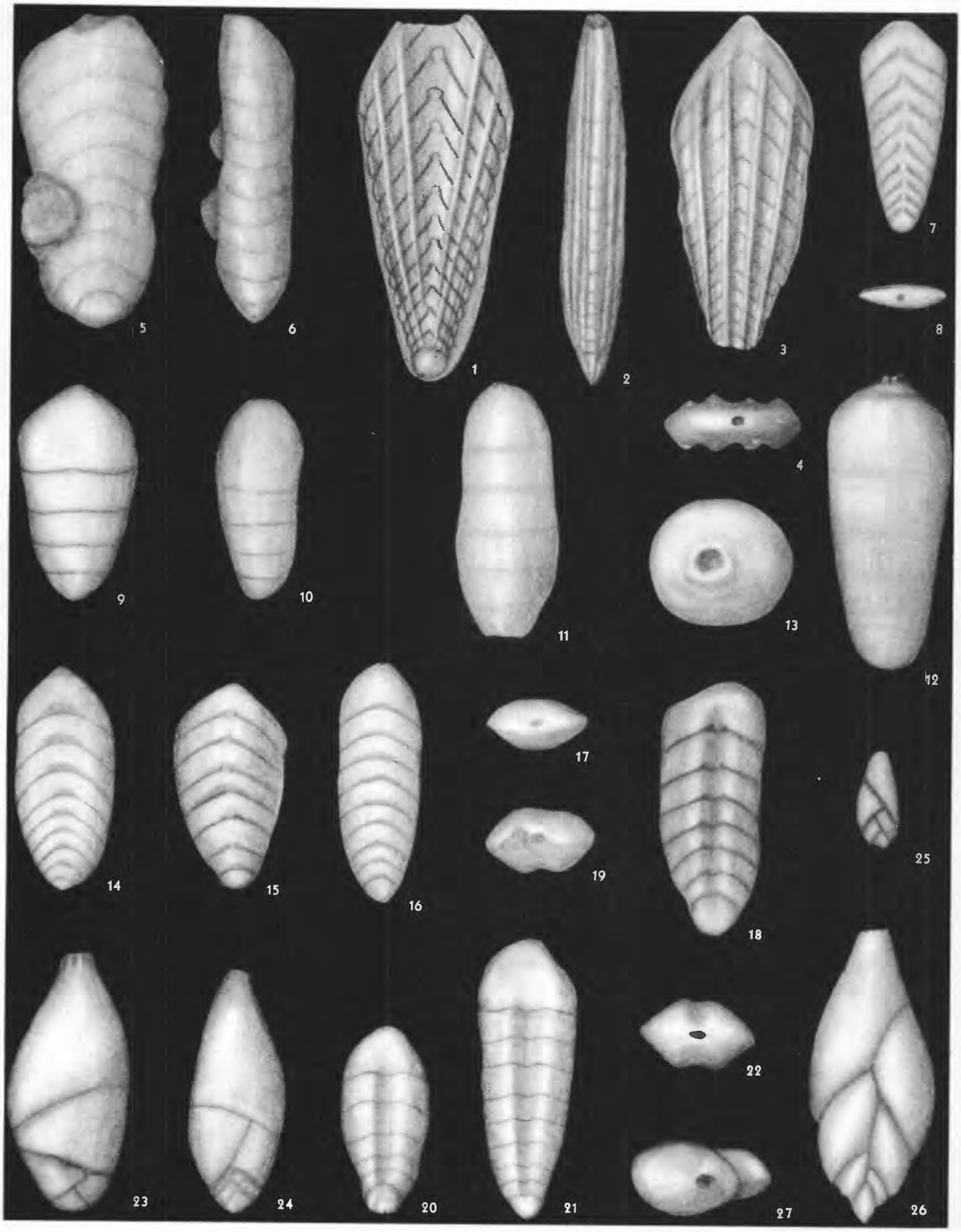
5–8, 14–17. *Lingulina borealis* Tappan, n. sp. 5, Side view of large megalospheric paratype (U.S.N.M. 106392); 6, edge view. 7, Side view of crushed and exfoliated microspheric paratype (U.S.N.M. 106393); 8, top view. 14, Side view of paratype (U.S.N.M. 106389a). 15, Side view of paratype (U.S.N.M. 106389b). 16, Side view of holotype (U.S.N.M. 106388); 17, top view. × 95. (p. 13)

9–13. *Pseudoglandulina densa* Tappan, n. sp. 9, Side view of crushed paratype (U.S.N.M. 106385); 10, edge view, showing amount of compression. 11, Side view of paratype (U.S.N.M. 106382). 12, Side view of holotype (U.S.N.M. 106381), showing slightly flaring test, obscure sutures and rounded base; 13, top view. × 95. (p. 12)

18–22. *Lingulina alaskensis* Tappan. 18, Side view of holotype (U.S.N.M. 106117), showing central longitudinal furrow and broadly arched sutures; 19, top view. 20, Side view of paratype (U.S.N.M. 106119a), a small megalospheric form. 21, Side view of large microspheric paratype (U.S.N.M. 106119b); 22, top view. × 95. (p. 13)

23, 24. *Eoguttulina bulgella* Tappan, n. sp. 23, Side view of holotype (U.S.N.M. 106400). 24, Side view of paratype (U.S.N.M. 106402). × 95. (p. 14)

25–27. *Pyrulinoides plagia* Tappan, n. sp. 25, Side view of paratype (U.S.N.M. 106419). 26, Side view of holotype (U.S.N.M. 106418), showing fusiform test, oblique sutures and biserial character; 27, top view. × 95. (p. 15)



LAGENIDAE, POLYMORPHINIDAE

PLATE 5

FIGURES 1–8. *Sagoplecta goniata* Tappan, n. gen., n. sp. 1, Side view of paratype (U.S.N.M. 106407). 2, Side view of microspheric holotype (U.S.N.M. 106403), showing biserial early chambers, followed by uniserial, subquadrate chambers, overhanging at the angles; 3, top view; 4, basal view, showing subquadrate section and biserial early chamber arrangement. 5, Side view of paratype (U.S.N.M. 106406), a megalospheric form with less well-developed biserial stage; 6, top view, showing asymmetrical quadrate section of small forms; 7, basal view, showing biserial chambers. 8, Side view of paratype (U.S.N.M. 106404), a small form, having only the biserial stage, but with the last chamber showing the early development of the quadrate later portion. × 95. (p. 14)

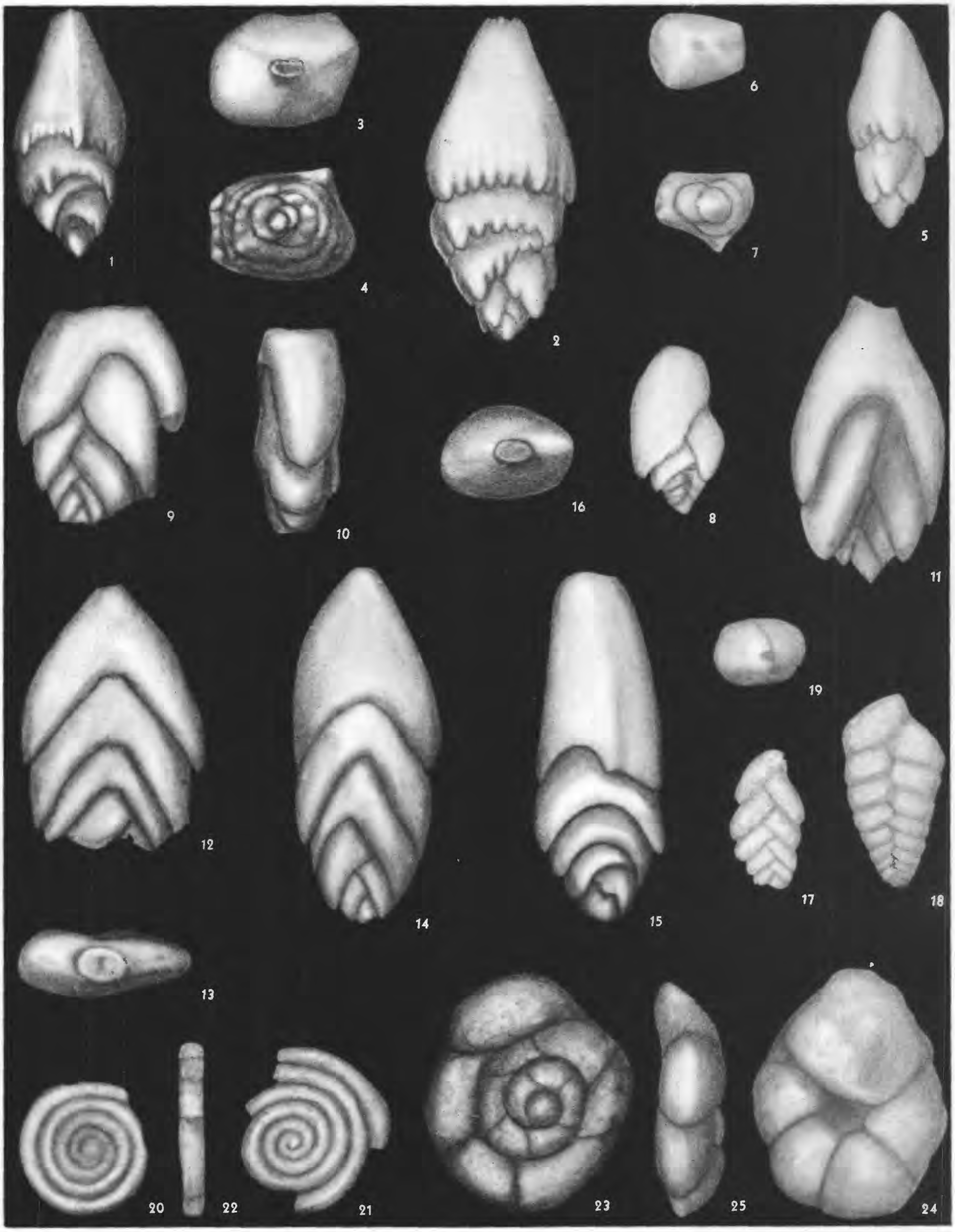
9–13. *Sagoplecta himatioides* Tappan, n. sp. 9, Side view of holotype (U.S.N.M. 106409), showing extensive development of the biserial stage, flattened character and later equitant chambers; 10, edge view. 11, Side view of paratype (U.S.N.M. 106410a), with very oblique sutures. 12, Side view of paratype (U.S.N.M. 106410b), with better uniserial development, showing strongly arched sutures; 13, top view, showing compressed form. × 95. (p. 15)

14–16. *Sagoplecta incrassata* Tappan, n. sp. 14, Side view of paratype (U.S.N.M. 106415), showing long final chamber. 15, Side view of holotype (U.S.N.M. 106414) showing biserial to uniserial development, and elongate final chamber; 16, top view, showing ovate cross-section. × 95. (p. 15)

17–19. *Bolivina lathetica* Tappan, n. sp. 17, Side view of paratype (U.S.N.M. 106437). 18, Side view of holotype (U.S.N.M. 106436), showing biserial tapering test; 19, top view, showing low arched aperture. × 158. (p. 16)

20–22. *Spirillina gurgitata* Tappan, n. sp. 20, Side view of holotype (U.S.N.M. 106439), a small but complete form. 21, Side view of larger broken paratype (U.S.N.M. 106440); 22, edge view. × 218. (p. 16)

23–25. *Discorbis pristina* Tappan, n. sp. 23, Dorsal view of holotype (U.S.N.M. 106441); 24, ventral view; 25, edge view. × 158. (p. 16)



POLYMORPHINIDAE, BULIMINIDAE, SPIRILLINIDAE, ROTALIIDAE