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320. SOME UNIFYING CHARACTERISTICS OF SPECIES DIVERSITY

L. B. GIBSON
Mobil Oil Corporation, Field Research Laboratory, Dallas, Texas

ABSTRACT

Benthonic species diversity, or the relative concentration of species in a population, is viewed as being related to environmental dynamics. It is suggested that the capacity for successive populations to become diverse is limited by degrees of variation in environmental factors and the natural supply of suitable adaptations. In nature fewer adaptations appear to be available for variable environments than for stable ones. It is proposed that the geographic distributions of species diversity can be used to reliably map net variability within environments in marine areas.

The distribution of foraminiferal diversity in the Mississippi Sound is used to illustrate the correlation between environmental variability and population diversity. Populations of low diversity were found associated with environments of high wave and current activity or conditions in which salinity, temperature and turbidity, as a function of depth, were unstable. With increasing depth and the stabilization of these factors, population diversity increased.

INTRODUCTION

In recent years numerous papers dealing with species diversity have been published. Most of these deal with various mathematical forms of this characteristic. Comparatively less effort has been expended to explain the biologic-ecologic factors that determine diversity distributions within plant and animal communities.

An effort will be made in this paper to examine some of the regional aspects of benthonic foraminiferal species diversity and to relate these to variable states of the environment.

Historical Synopsis.—That which has been referred to in the literature as diversity index is a measure of the relative concentration or variety of species within a biologic community. Since the preliminary examination of the statistic by Fisher (Fisher *et al.*, 1943) and Yule (1944), other measures have been proposed to characterize population variety (*e.g.*, Williams, 1944, 1951, 1952, 1954; Simpson, 1949; Goodall, 1952; Yount, 1956; Kornicker and Odum, 1958; Odum, *et al.*, 1960; Ellison, 1964). More recently, increased use has been made of entropy. This and related sample-distribution statistics have been used by biologists to measure the degree of uniformity in the distribution of species within a population (*e.g.*, Branson, 1953; Margalef, 1956, 1957, 1958a, 1958b; Brillouin, 1956; Patten, 1962; Hulbert, 1963; Miller and Kahn, 1963).

Although it has long been known that natural communities are well organized, the mathematical techniques which provide statistical descriptions of this organization are relatively new. One such mathematical display of organization is expressed as the logarithmic relationship between the distributions of species and of individuals (Williams, 1951; Odum, *et al.*, 1960). Williams showed that the numbers of species represented by 1, 2, 3, 4, ... etc., individuals are logarithmically related to total number of individuals in a population. It was illustrated that for 1 to N numbers of individuals the relationship was best characterized by the well-known logarithmic series:

$$ax,\ ax2/2,\ ax3/3,\ ax4/4,\ \ldots\ axN/N,$$

where a and x are constants and x is less than 1. Another organizational feature is exhibited in the distribution of calculated species diversities. Communities characterizing "normal" environments have higher species diversity than do communities from environments which experience extreme conditions (Odum and Kornicker, 1958).

Odum, Cantlon and Kornicker (1960) explained the logarithmic distribution of species frequencies within communities as being due to a high degree of order within nature. This order was described as hierarchal and as one in which the more numerous forms perform the basic occupations or functions within the community. The species in this sense represent ordered functional niches. Within the hierarchy, the rare occupations (subsidiary species) are related to the more common occupations (dominants) in fixed ratios which are related to one another on a per capita support basis. The trend within ecosystems is toward the development of greater faunal complexity and organization within successive communities.

Recently, Margalef (1963) inferred that the organized nature of communities, resulting from the arrangement of their elements into definite patterns, was itself a reflection of the efficiency with which energy was utilized within the ecosystem. Margalef postulated that species variety develops complex trophic levels within a community and that this in itself supports a high degree of organization. He also concludes that, through time, communities within the ecosystem normally tend to become more complex (mature), and that in time and in stable environments, increasingly intricate coactive relationships develop within each successive community. The complex or mature community in this way represents a natural tendency for population elements to be arranged in a manner that will provide for the most equitable distribution of energy. This Margalef feels must be the organizer of compositional complexity in populations, for larger numbers of elements provide numerous routes along which "energy cascades through a more considerable number of steps." For these reasons he concludes that highly diverse communities are accompanied by a low, nonmechanical energy flow per unit.

Summary of Biologic-Ecologic Aspects of Diversity.—As previously indicated, there appears to be a logarithmic relationship between the distributions of species and individuals within natural communities. Further, measures of diversity indicate that species variety tends to be high in "normal" marine environments and low in environments influenced by extreme conditions. In conjunction with these observations, most empirical evidence suggests that, in the distributions of marine benthon, species variety is lowest near shore and greatest in deeper portions of the continental shelf. Furthermore, species diversity tends to be generally greater in the lower than in the higher latitudes at the same depths.

These relationships seem to suggest that the distribution of benthonic variety is associated with degrees of variation in the environment. Variations in the prime determinate marine factors, such as salinity, temperature, currents, etc., appear to be of major importance. These generally tend to vary most within shallow-water environments or in the higher latitudes. One may also generalize that with increasing depth and distance from shore the same ecologically determinate factors tend to become stabilized or to vary within narrow limits. This tendency is accompanied by a general increase in benthonic diversity with depth. The only exception to this increase appears to be the result of the eventual effect that depth has upon food supply. From these relationships, one inescapable general conclusion appears to be that, in areas of primary production within the marine province, benthonic species diversity tends to be correlatable with degrees of variability in environmental conditions.

The apparent close relationship between distributional variety and states of environmental conditions, however, does not alone describe the mechanisms involved. These appear related to the ecologic uniqueness of the species. It seems at least subjectively valid to accept these specific utilitarian attributes or ecological differences of species as representing distinct occupational roles (Odum, Cantlon and Kornicker, 1960). In this sense a community may be visualized as a complex structure in which various specific occupations are represented. Species variety within a community may then be regarded as a measure of the number of occupational roles or niches in the environment.

Species variety in any given natural community does not come about abruptly. As Margalef (1963) points out, communities under stable environmental conditions only tend to become compositionally diverse (complex). This tendency is accompanied by the formation of increasingly long food chains and complex coactive relations between species. The development of complexity is, then, an integral part of succession. Although marine successions are not as completely documented as are those of terrestrial plant communities, similar tendencies are recognized in them. As far as environmental conditions allow, succession in this sense is an adaptive community process wherein additions of species cumulatively create additional functional sublevels or occupational niches for still other species. If undisturbed, complexity (maturity, in the sense of Margalef) will be maintained at a level determined by environmental extremes and available adaptations. As environmental conditions become unfavorable, the successional process ceases and population complexity decreases. The stage of community complexity or diversity also is, therefore, a function of the degree of variability in the ecologically determinate factors distinguishing a given environment and of the availability of suitable adaptations. It is not purely a feature determined by the internal support relationships between the species forming the community.

Internal population diversity when collectively viewed in these terms becomes more than a population statistic. The values also represent a summation of the limiting conditions of the environment. In generally reflecting this and being related to environmental dynamics, the measure offers a means by which dissimilar habitats and diverse populations may be mapped and viewed in common terms.

CASE EXAMPLE

Methods and Statistics Employed.—The diversity calculation used for this paper is based on the statistic of Yule (1944) as modified by Simpson (1949). Simpson regarded the statistic as an unbiased estimator of population variety for any sample size. The reciprocal of Simpson's statistic, which is utilized as the sample diversity, is

$$\frac{N \quad (N-1)}{\sum_{i=1}^{K} n_i \, (n_i - 1)}$$

where N is the total number of individuals counted, n_i is the number of individuals of the i^{th} species and K is the number of species*.

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* Diversity cannot be zero for any N > 1, and is indeterminate for any N of 1 or 0.

TABLE 1

Example of a Computer Tabulation of the Data On Foraminiferal Frequencies, Phleger (1954)

Mississippi Sound Station No. 1324

Total Number Benthonic 4100

Total Number Species 9

1 Species Code	2 Given Per Cent	3 Adjusted Per Cent	4 Computed Number
15	2	.01980	81.2
60	36	.35644	1461.4
68	3	.02970	121.8
259	14	.13861	568.3
69	17	.16832	690.1
90	3	.02970	121.8
247	2	.01980	81.2
110	6	.05941	243.6
154	18	.17822	370.7

Computed Benthonic Diversity 4.71169

The diversity distributions of Recent benthonic foraminiferal populations in a part of the Gulf of Mexico are used in the case example. The values have been calculated from the basic data regarding foraminiferal counts in the area as published by Phleger (1954), Parker (1954), and Treadwell (1955). These forms represent only a small segment of the organisms present in the study area, but for purposes of this study it has been assumed that the diversity of an important segment of a population can generally be regarded as a valid estimator of the diversity of the total population, because of the dependent and cumulative nature of niche formation in natural communities.

Example of Calculations.—Diversity calculations were made of the foraminiferal counts, previously published, on each of approximately two hundred and seventy-five sample stations in the study area. The calculations were made with the programmed use of an electronic computer. Table 1 is an example of a computer run for one of Phleger's (1954) sample stations (Station 1324).

As indicated in the table, identified species were assigned a number code. Column number two indicates the per cent frequencies of each species in the total population of 4100 individuals, as recorded by Phleger. Since the given per cents were calculations and were evidently rounded off to the nearest whole number, it was necessary to include in the computer program instructions to adjust the given values so that they would total 100. Column three is, therefore, the calculated error in the given per cent frequencies, adjusted proportionately. The last row includes the computed number of each individual species obtained from the adjusted frequencies and the given total population count. The numbers in this row are the raw data used in the calculations. The calculations (using whole numbers) performed to obtain the benthonic diversity for Station 1324 are:

$$\frac{4100\quad(4100-1)}{81(81-1)+1461(1461-1)+122(122-1)+568(568-1)+690(690-1)+122(122-1)+81(81-1)+244(244-1)+371(371-1)} =$$

$$\frac{16805900}{6480+2133060+14762+322056+475410+14762+6480+59292+533630} = \frac{16805900}{3565932} = 4.71169$$

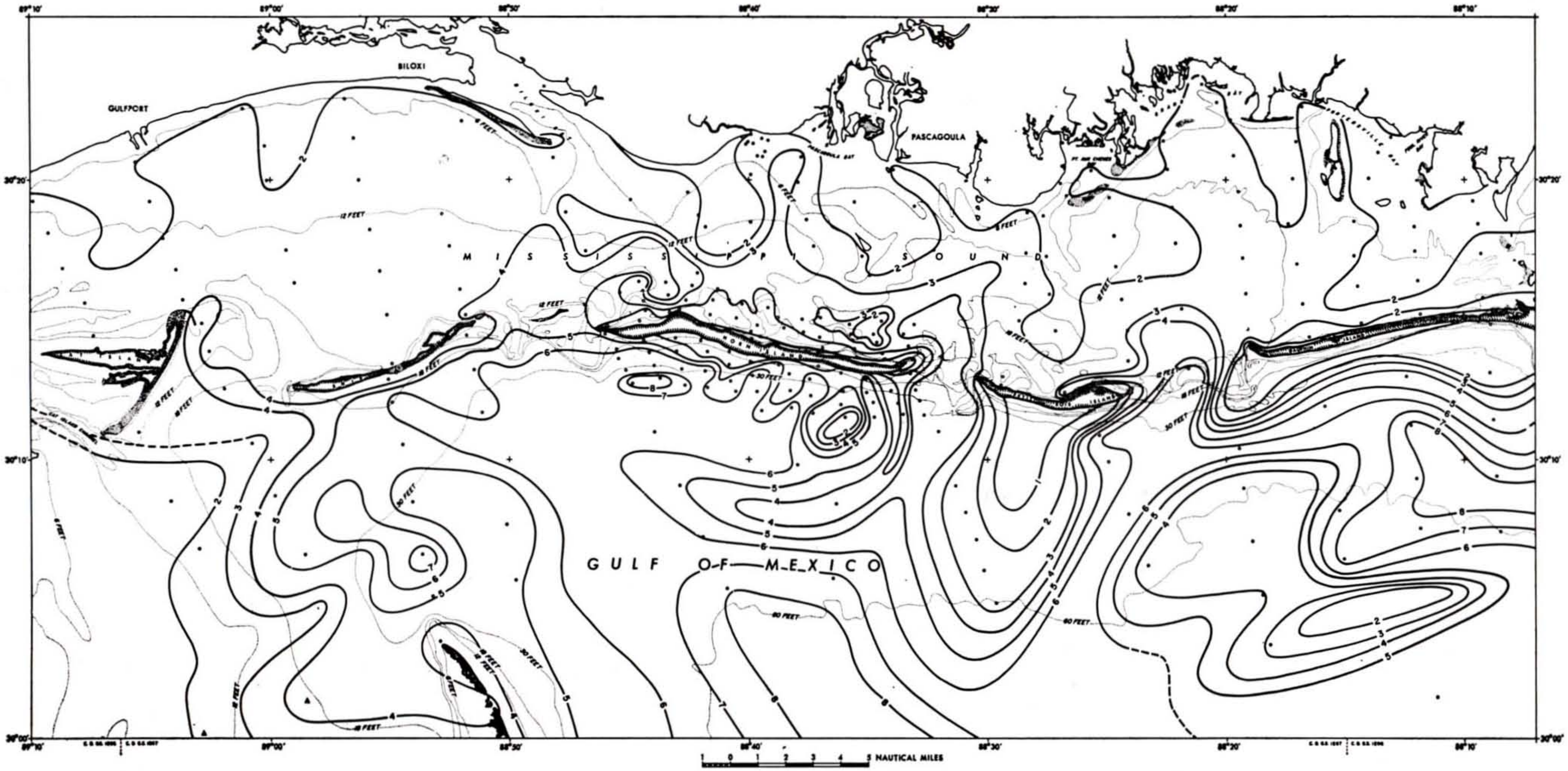
Mississippi Sound Area, Environmental Characteristics.—The Mississippi Sound area, located in the north central portion of the Gulf of Mexico, is bounded on the west by the Mississippi River delta and on the north by the coasts of eastern Louisiana, Mississippi and westernmost Alabama. Regional ecological aspects of this area have been described by Fuglister (1947), Scruton (1956), Phleger (1954), Curray (1960) and Ludwick (1964). The pertinent information contained in these reports is summarized below.

The near-shore areas in the Mississippi Sound are separated from the open gulf by barrier islands that are effective in preventing the invasion of marine waters along a broad front. Marine waters enter the protected sound areas primarily as bottom flows through the island passes. Behind the barrier islands, seasonal fluctuations in salinity are the rule. During periods of low rainfall, normal open gulf salinities may be maintained, but during seasons of high rainfall the waters are diluted by fresh water from surrounding marshes and streams. In the open gulf, salinities are much less variable throughout the year.

Surface temperatures within the area are seasonally variable, with a range between seasonal maxima and minima on the order of 25°F (Fuglister, 1947).

Within the region, water-mass drive is effected both through tides and currents. The tidal ranges may slightly exceed one foot. Tidal ebb and flow is the primary mechanism responsible for the exchange of the turbid and low salinity waters in the areas behind the barrier islands with waters of the open gulf. Passes between the islands are the avenues through which the bulk of the water must pass, and at these sites relatively high current velocities periodically are developed. The prevailing southeasterly winds in the region generate waves that develop westerly longshore drift currents along the seaward margins of the barrier islands.

The bottom sediments in the area are predomi-

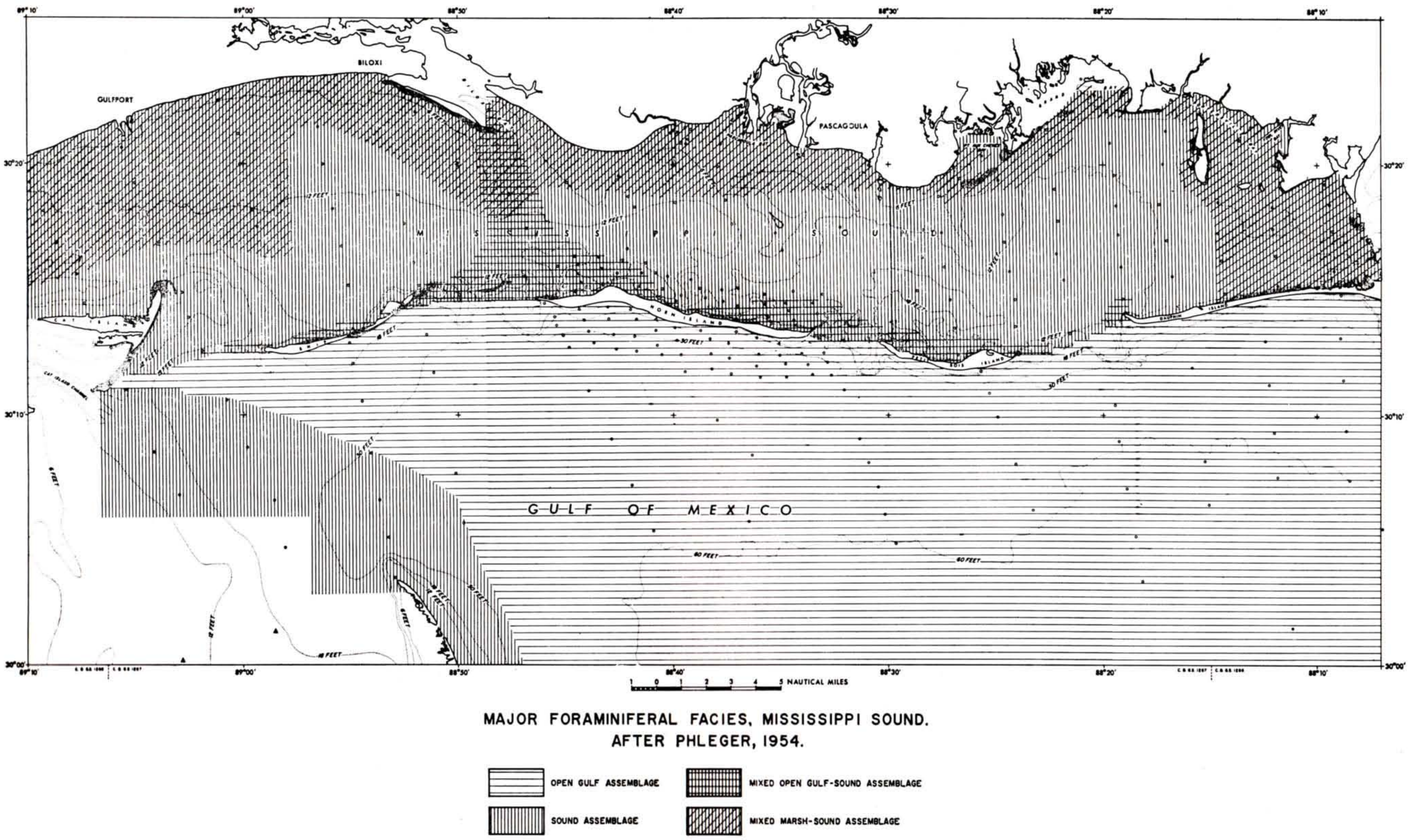


DIVERSITY DISTRIBUTIONS, MISSISSIPPI SOUND AREA, VALUES CALCULATED FROM PHLEGER, 1954, PARKER, 1954 TREADWELL, 1955.

- PHLEGER, 1954
- PARKER, 1954
- ▲ TREADWELL 1955

TEXT FIGURE 1

Diversity distributions, Mississippi Sound. Distributions shown by drawing smooth lines through or near sample locations yielding values of equal magnitude.



TEXT FIGURE 2

Reproduction of the regional aspects of foraminiferal populations in the Mississippi Sound area, as reported by Phleger (1954), showing open gulf (horizontal lines), sound (vertical lines) and mixed facies (line composites).

nantly fine- and very fine-grained terrigenous clastics. Sediments immediately adjacent to the Mississippi River delta are composed of deltaic clays and silts (Shepard, 1956). Clays and silts predominate in the Mississippi Sound areas. Fine-grained sands are found over most of the shelf area south and east of the sound area and apron the barrier islands. The sediment distributions in the Mississippi Sound area have been discussed by Ludwick (1964).

Mississippi Sound, Diversity Distributions.—The degree to which the previously discussed ecological factors are reflected in the regional distributions of diversity in the area of text figs. 1 and 2 are discussed below. The diversity values, which have been calculated from data on the population counts published by Phleger (1954), Parker (1954) and Treadwell (1955), are contoured by drawing smooth lines through station locations which yield diversity values of equal magnitude.

1. In text fig. 1, Mississippi Sound is marked by lower diversity values than the open gulf, largely because of the variability of salinity and temperature of the waters of this area. Because of its shallowness and periodic inflow of fresh water into it from streams and swamps, salinities are quite variable in the sound. Temperatures vary widely during the year because of the shallow water depth. It appears that these fluctuations are the main environmental determinants limiting population complexity within the sound.

Diversity values immediately behind the barrier islands in the Mississippi Sound are higher than in parts of the sound immediately adjacent to land. These values probably developed as a consequence of the low wave and current energy in these areas and the near-normal marine waters which evidently are banked behind the islands as the result of tidal ebb and flow.

2. The off-shore islands are defined by low isodiversity contours. These low values reflect the relatively high mechanical energy to which, in this area, the populations are subjected. The shallow depths, the seasonal temperature fluctuations, the wave action and the effects of the littoral drifts that define the regular seaward margins of the barrier islands are the major environmental factors limiting population diversity.

The islands defining Mississippi Sound are primarily shaped by the westerly drift currents, which also appear to be responsible for the configuration of the isodiversity contours off Dauphin Island. The sand-body configurations around the barrier islands (shown by Ludwick, 1964, fig. 11.6) coincide with the diversity minima and the shape of sandy areas associated with the barrier islands. The configuration of both the diversity fields and the bottom-sediment lithology shown by Ludwick around both Petit Bois and Dauphin Islands suggests that the coastal drift here returns to the open gulf in a southwesterly direction.

3. The barrier islands are marked by aprons of increasing diversity along their seaward margins. Higher values coincide with passes between the islands through which open gulf waters invade the sound. Along the island chain, diversities diminish westward, indicating that the importance of the passes in water-mass exchange also diminishes westward in the area.

As shown in text fig. 1, the island passes are marked by relatively high diversities. These values reflect the fact that marine waters enter the sound through these inlets. Normal marine conditions are maintained at these points. As a result, relatively high diversity fields extend landward within the sound opposite these passes.

4. The configuration of the low diversity fields on the seaward side of Horn Island is influenced by the westward flowing littoral drift as well as by the currents associated with tidal ebb and flow. The low diversity field immediately south of Horn Island (center of map) is interpreted to represent a somewhat turbulent area formed as the result of the confluence of tidal currents with an invading marine tongue of water from the open gulf. This ecologically more stable mass of marine water is probably responsible for the high diversity field in the bottom central portion of the map. This region must be relatively more stable with respect to salinity, temperature and dynamic bottom conditions than is the remaining area. This lens of marine water advances northwestward as a bottom flow and is evidently responsible for the relatively high diversity field around Ship Island. The interaction of this current and the tidal currents that are being directed west by the littoral drift probably develops a moderately turbulent field south of Horn Island. This postulated turbulence is represented by the irregular diversity contours along the seaward coast line of the island. The irregularity is most pronounced in the area adjacent to the pass at the eastern end of the island and diminishes toward the western extremity of the island. This is possibly indicative of a lessening in net turbulence in that direction.

Text fig. 2 illustrates the foraminiferal aspects recognized by Phleger (1964) in the Mississippi Sound area. As this map illustrates, Phleger was able to characterize open gulf, sound, and mixed marsh and sound facies.

The open gulf faunas, which occur to the seaward of the barrier islands and as far west as Cat Island, are composed of over 90% calcareous forms. Behind the barrier islands, the sound faunas are primarily arenaceous. The marsh and sound faunas, which occur in areas of the sound adjacent to the land mass, are impoverished and represented by a particular suite of species.

The inter-island passes and the regions immediately behind the islands are marked by mixed faunas of the open gulf and sound species.

As shown in text fig. 2, the faunal aspects generally define the open gulf and sound environments. There is, however, a gradational change in faunal aspects between the two environments, and within the sound the faunal changes are also gradational. By comparing the faunal aspects with the diversity distributions, however, much more information can be obtained about the environmental complex. For example, mechanical energy distributions can be established within the province marked by the relatively high diversity faunas of the open gulf. In addition, routes along which the masses of open marine water invade the area and the avenues along which the gulf waters enter the sound can be more readily demonstrated. With the oceanographic data obtainable from the diversity distributions, it is possible to establish more accurate relationships between those dynamic environmental factors that influence the various faunal aspects of the area.

CONCLUSION

The diversity concept offers an important means by which a population of organisms may be described quantitatively. Further, the natural distribution of population diversity strongly suggests that actual variety is a real function of environmental variability and the degree to which it limits normal successional processes. In this sense, the distribution of the variety within populations becomes a means by which dissimilar habitats and qualitatively different populations may be compared in terms of environmental dynamics and variability.

This hypothesis is supported by an example which showed that the lower diversity values were regionally indicative of unstable or variable environmental conditions. Lower values were found to be associated either with high wave or current activity (as around the barrier islands), or with conditions in which salinity, temperature and turbidity, as a function of shallow water depths (as within the Mississippi Sound), were unstable. Further, it is evident from diversity distributions within the study area that with increasing depth and more stable marine conditions population diversity increased. In this manner, faunal aspects can be related to one another in terms of the environmental conditions that limit population development.

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321. PLANKTONIC FORAMINIFERAL BIOFACIES IN THE OKHOTSK SEA

JERE H. LIPPS AND JOHN E. WARME
Department of Geology, University of California, Los Angeles

ABSTRACT

Seven species of planktonic foraminifera were found in bottom sediments of the Okhotsk Sea, which borders the eastern part of the Soviet Union. The composition of this planktonic fauna is most similar to the Subarctic Fauna previously described from the adjacent Pacific Ocean. The distribution of species in the sea corresponds with patterns of sea-surface currents which influence sea-surface temperatures and salinities. The number of planktonic foraminiferal tests per 50 grams of bottom sediment is greatest in offshore basins where the terrigenous sedimentation rate is probably lower and plankton production higher. Nearshore areas are devoid, or nearly so, of planktonic foraminifera. Maximum abundance may be related to overlying surface convergences. Four planktonic foraminiferal biofacies are tentatively recognized on the floor of the Okhotsk Sea: a "coastal" region bordering mainland coasts contains no or few tests; a "northern" region above 54°N has two cold-water species; a "central" region has seven species; and a "southern" region near Sakhalin and Hokkaido Islands contains warm-water species.

INTRODUCTION

Planktonic foraminifera are well known for their value in correlation, but have been largely ignored for paleoecological interpretations, probably because of the prevalent view that they drift great lateral distances after death (Fagerstrom, 1964, p. 1205). Contrary evidence indicates, however, that planktonic organisms become incorporated in seafloor sediments soon after death (Murray, 1897, p. 22; Belyaeva, 1963, 1964; Zhuse, 1962, p. 28). Although the computed settling velocities of individual microplankton skeletons are low, the actual settling time is apparently very short, resulting in a correspondence between water-column and seabottom distributions. This is probably because these smaller skeletons are ingested by zoo-plankton and incorporated into faecal pellets (Harvey, 1960, p. 24) which have much higher settling velocities (Riedel, 1963, p. 877; Calvert, 1966). Because oceanic plankton is ecologically sensitive, often being restricted to water masses having distinct physical and chemical properties (Johnson and Brinton, 1963), the paleoecological usefulness of fossil plankton is enhanced, but its value for long-distance correlation may be restricted (also see Parker, 1965).

Owen (1867, p. 153-156) and Murray (1897, p. 20-22) long ago observed that species of planktonic foraminifera were restricted to approximate latitudinal belts, probably being controlled by temperature distributions (Bradshaw, 1959, p. 56). In addition to temperature, planktonic foraminifera are sensitive to many other factors, most of which are not yet well understood. Nevertheless, the broad general patterns of planktonic foraminiferal distributions are known for all oceans (see Bradshaw, 1959; Belyaeva, 1963, 1964; Barash, 1964; Bé, 1959; Phleger, 1954). Because it is in regions along the continental edges that most rocks bearing fossil planktonic foraminifera were deposited, the distribution of modern species in similar areas today should be useful in future paleoecologic investigations.

Our purpose is to document the planktonic foraminiferal fauna of such a marginal area, the Okhotsk Sea, and to relate its distribution to reported conditions within the sea. This study is based on surface sediment from eleven gravity cores (internal diameter = 5 cm.) and data collected by Soviet scientists.

Previous Work

Planktonic foraminifera from the Okhotsk Sea have not been investigated in detail despite considerable study by Russian workers of the organisms, oceanography and marine geology (see Zenkevitch, 1963, for summary and additional references). Shchedrina (1953) recorded four species of planktonic foraminifera from the Okhotsk Sea, and she later (1958) listed five more from near the southern end of Sakhalin Island. From 300 bottom samples, Saidova (1957, 1960, 1961, p. 114) noted the presence of abundant *Globigerina pachyderma* and *G. bulloides* and recorded the abundance of planktonic foraminiferal tests in the sediments. As she was concerned primarily with the ecology and distribution of benthonic foraminifera, planktonic species were not documented in detail. Loeblich and Tappan (1964, p. C124) stated that planktonic foraminifera did not occur in the Okhotsk Sea, suggesting that the Kurile Island chain was a barrier to them.

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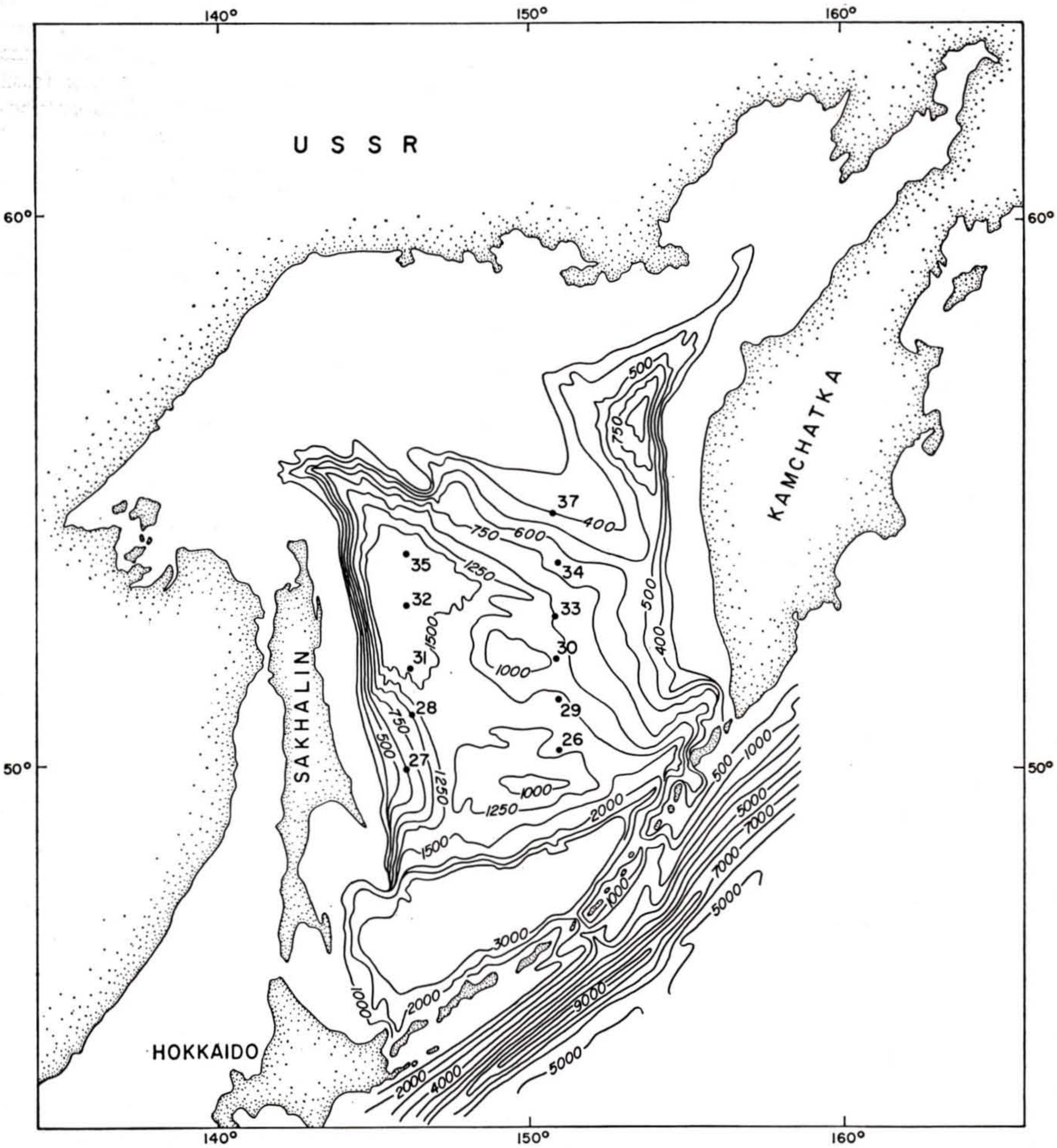
THE OKHOTSK SEA

Basin Characteristics

The Okhotsk Sea is an almost completely enclosed basin bounded on the north and west by mainland Russia, on the northeast by the Kamchatka Peninsula, on the southeast and south by the Kurile Islands, and on the southwest by the islands of Sakhalin and Hokkaido (text fig. 1). It has an area of 1,590,000 km.^{2} (approximately the same as the Gulf of Mexico) and a volume of 1,365,000 km.^{3} (Zenkevitch, 1963, p. 601). The floor of the sea is marked by several basins, troughs and submarine hills (text fig. 1; Udintsev, 1957), and has an average depth of 859 meters and a maximum of 3657 meters in the Iuzhnaya Deep-Water Basin (Zenkevitch, 1963, p. 601). The Kurile Islands form a sill between the Okhotsk Sea and the Pacific Ocean, the



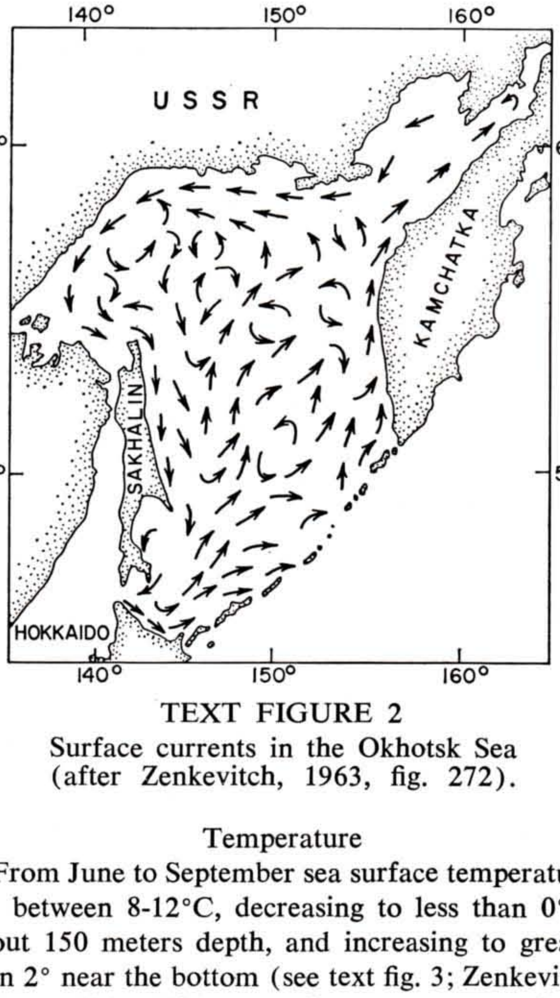
TEXT FIGURE 1

Submarine topography of the Okhotsk Sea (after Bezrukov, 1960, fig. 3) and localities of samples used in this study.

deepest passage being in the Boussole Strait (2318 meters). Dietz (1954, p.1219) believed the Okhotsk Sea basin was similar to the Kurile, Japan Sea and Ryukyu basins, in that they appear to be portions of the continental shelf which have been depressed deeper than the "normal" shelf.

Currents

Circulation into the Okhotsk Sea is restricted by the Kurile Islands, although some currents from the Pacific enter through inter-island passages just south of Kamchatka (text fig. 2). These warmer surface currents flow northward along Kamchatka, branching and flowing westward. Cooler waters flow southward on the western side and then into the Sea of Japan and through the southern Kurile Islands. Warmer-water currents also enter the southern part from the Japan Sea and the Pacific Ocean.



TEXT FIGURE 2

Surface currents in the Okhotsk Sea (after Zenkevitch, 1963, fig. 272).

Temperature

From June to September sea surface temperatures are between 8-12°C, decreasing to less than 0° at about 150 meters depth, and increasing to greater than 2° near the bottom (see text fig. 3; Zenkevitch, 1963, p. 604). The sea surface temperatures begin to decrease in the fall, and by December ice floes form in the northern part of the sea. Floes cover the entire sea by March, gradually retreating and disappearing by June (Zenkevitch, 1963, p. 538).

Salinity

Salinities are lower at the surface than at deeper levels (text fig. 3) and are greatly affected by runoff from the adjacent land. The watershed area of the Okhotsk Sea is about 2,666,000 km.^{2}, of which the major part, including much of Manchuria, is drained by the Amur River (Bezrukov, 1960, p. 21). The Amur River enters the northwest part of the Okhotsk Sea and dilutes surface waters there and to the south (text fig. 3).

Sediments

On the basis of 400 bottom samples, Bezrukov (1960, figs. 3 and 4) indicated that the distribution of sediments is generally controlled by submarine topography. Shallow border areas and submarine highs are covered by sand and, more rarely, by gravel. Sediments near the Kurile Islands and Kamchatka are rich in volcanic glass (Petelin, 1957, p. 96-99), and most of the central basin is covered by silts and clays with a high diatom content. Diatom frustules commonly comprise over 90% of the coarse fraction ($>43\mu$) of the sediments from our cores. Menard (1964, p. 164) gave a sedimentation rate greater than 1 cm./1000 years in the deep basin of the southern Okhotsk Sea and a lower rate for the rest of the area.

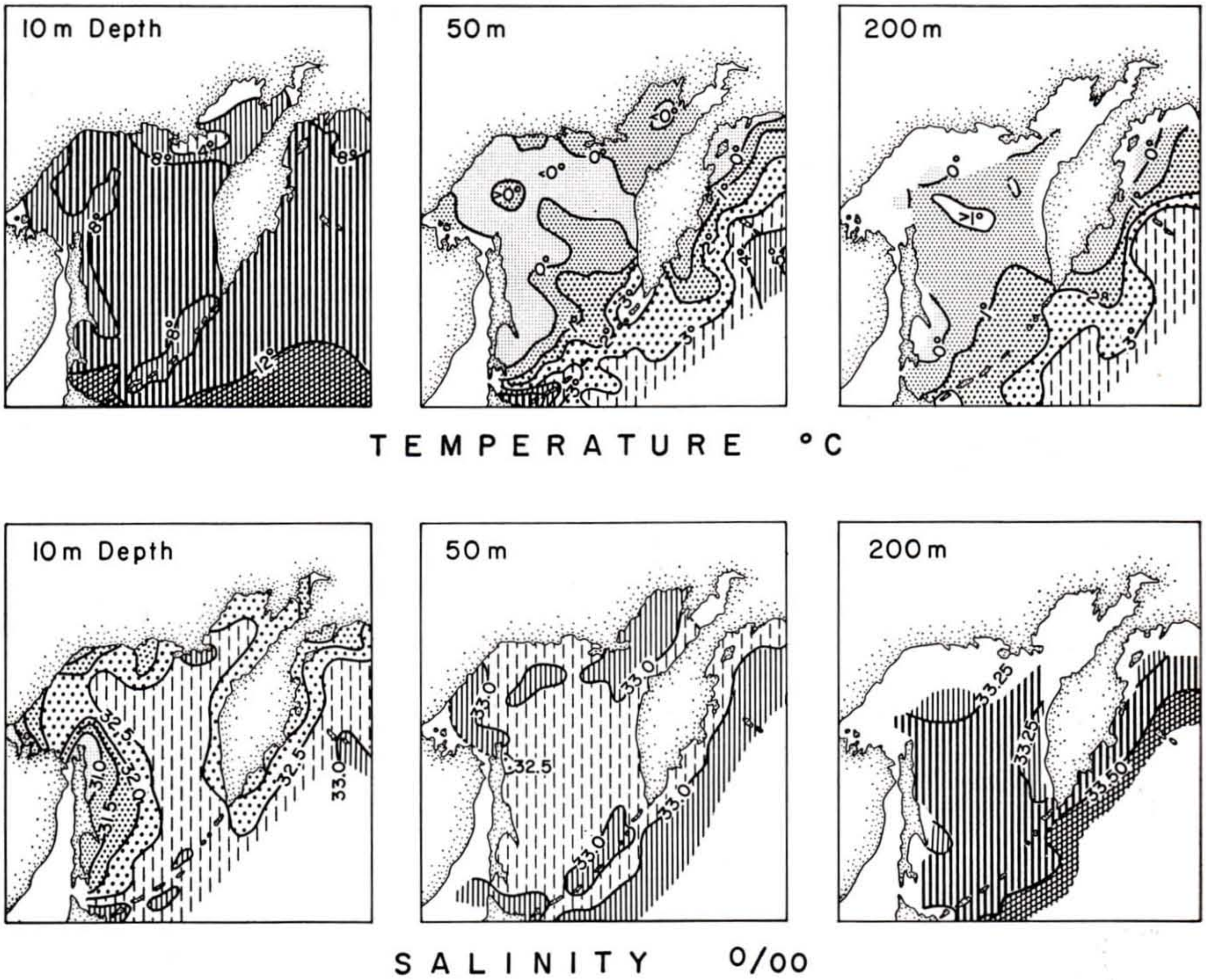
Sediment analyses made by the Naval Civil Engineering Laboratory on our eleven cores are summarized in Table 1. Several of the cores contained pebbles suspended in a matrix of silty clay. These pebbles were probably ice-rafted. Small core diameters (5 cm.) prevented recovery of larger clasts, and the short cores obtained in this fine-grained sediment indicate that such clasts may have prevented penetration by the corer. Bedding was generally poor in the cores; even volcanic shard layers were disturbed. The cause of this disturbance could not be determined.

PLANKTONIC FORAMINIFERAL FAUNA

Seven species of planktonic foraminifera were found in the top three inches of our eleven cores. These species are listed in Table 1, figured on Plate 9 and discussed individually below.

Faunal Relations

The planktonic foraminiferal fauna of the Okhotsk Sea is similar to that of the Subarctic and Transition Faunas described by Bradshaw (1959) from the adjacent Pacific Ocean. All of the Transition Fauna species are present except *Orbulina universa* d'Orbigny. This species was arbitrarily regarded as a "marker" for the northern limit of the Transition Fauna (Bradshaw, 1959, p. 52). All of the species found in the Okhotsk Sea are also present in the Subarctic Fauna except *Turborotalia scitula* which, however, occurs patchily throughout the Pacific and can tolerate cooler waters. The northern limit of *T. scitula* is not well defined and may not be critically related to water mass, current or temperature patterns. *Globigerina pachyderma* and *G. bulloides* occur abundantly in the Okhotsk Sea, as they do in the Subarctic Fauna region. Because of the abun-



TEXT FIGURE 3

Temperature and salinity at 10, 50 and 200 meters in the Okhotsk Sea (modified from Zenkevitch, 1963, figs. 234, 236).

Sample Number	26	27	28	29	30	31	32	33	34	35	37
Latitude (N)	50°10′	49°58′	50°55′	51°03′	52°03′	51°58′	53°02′	52°56′	54°05′	54°02′	54°58′
Longitude (E)	151°00′	146°00′	146°06′	151°11′	150°56′	146°03′	146°00′	151°11′	151°03′	146°00′	151°04′
Depth (M)	1143	593	823	1225	1010	1463	1648	929	571	1620	326
% sand	20	4	3	2	19	7	6	20	6	8	53
% silt	36	33	45	40	31	18	28	30	44	44	24
% clay	44	63	52	58	50	75	66	50	50	48	23
Turborotalia scitula	X				X		X	X			
Globigerinita glutinata	X				X	X		X			
G. uvula	X				?			X			
Globigerina bulloides	X			X	X	X	X	X	X	X	
G. eggeri	X			X	X	X		X			
G. pachyderma	X		X	X	X	X	X	X	X	X	X
G. quinqueloba				X	X	X	X	X			

TABLE 1

Locality descriptions, depth, sediment size analysis and planktonic foraminifera of bottom cores (5 cm. diameter) taken in the Okhotsk Sea.

dance of these two species and the absence of *O. universa,* the Okhotsk Sea fauna is most similar to the Subarctic Fauna of the North Pacific. This Pacific fauna occurs south of Hokkaido northward, probably into the Arctic Sea. The restricted water exchange between the Okhotsk Sea and the Pacific does not seem to affect the specific composition of the planktonic foraminiferal fauna.

Distribution

Most planktonic organisms are extremely sensitive to environmental changes, of which temperature and salinity may be most critical (Johnson and Brinton, 1963, p. 381). Other factors, such as inorganic and organic solutes, pH and biologic interactions, also are probably important. The influence of these factors on planktonic foraminifera, as well as on many other groups, has not been tested experimentally. Based on regional oceanic studies, however, temperature seems to be a major factor controlling foraminifera distribution (Bradshaw, 1959, p. 56).

The complete distribution of planktonic foraminifera in the Okhotsk Sea cannot be determined on the basis of our samples. These data, together with that published in Russia, indicate that species distribution corresponds with, but is not necessarily determined by, sea-surface temperatures, salinities, currents, basin configuration and sedimentation rate.

The distribution of all plankton, including foraminifera, corresponds well with sea-surface temperature, although not with that of greater depths (text fig. 3). During the summer, cold-water plankton predominates in the northern part of the sea; warmer-water forms, such as the copepod *Calanus tonsus* (Lubny-Gertsyk, 1955, p. 68, fig. 2), are present in the southeast and central regions while subtropical planktonic faunas and floras occur in the southernmost areas near Sakhalin (Zenkevitch, 1963, p. 607). The distributional pattern of the foraminifera found in this study and reported by previous investigators also corresponds with sea-surface temperature.

The cold-water species *Globigerina pachyderma* and *G. bulloides* occur in nearly all samples. These two species constitute more than 95% of the total planktonic foraminifera in the samples. Species more indicative of warmer waters in the Pacific Ocean (Bradshaw, 1959, p. 51) are found in samples collected below areas influenced by Pacific currents entering through the Kurile Island Straits (text fig. 2). These include the Transition Fauna species *Globigerina eggeri* (large), *G. quinqueloba, Globigerinita glutinata, G. uvula* and *Turborotalia scitula,* some of which also range into cooler waters. In the region near the southernmost coast of Sakhalin, Shchedrina (1958, p. 19) found the warm-water species *Globigerinoides ruber* (d'Orbigny) and *G. conglobatus* (Brady). These species are present in warm currents entering from the Japan Sea and have not been found in more northerly parts of the Okhotsk Sea.

A general correlation is also found between foraminiferal distributions and salinities. Areas of greater species diversity and abundance correspond to areas of normal marine sea-surface salinities, except on the western side of the sea (text fig. 3). Foraminiferal distributions show little correlation with salinities at depth (text fig. 3).

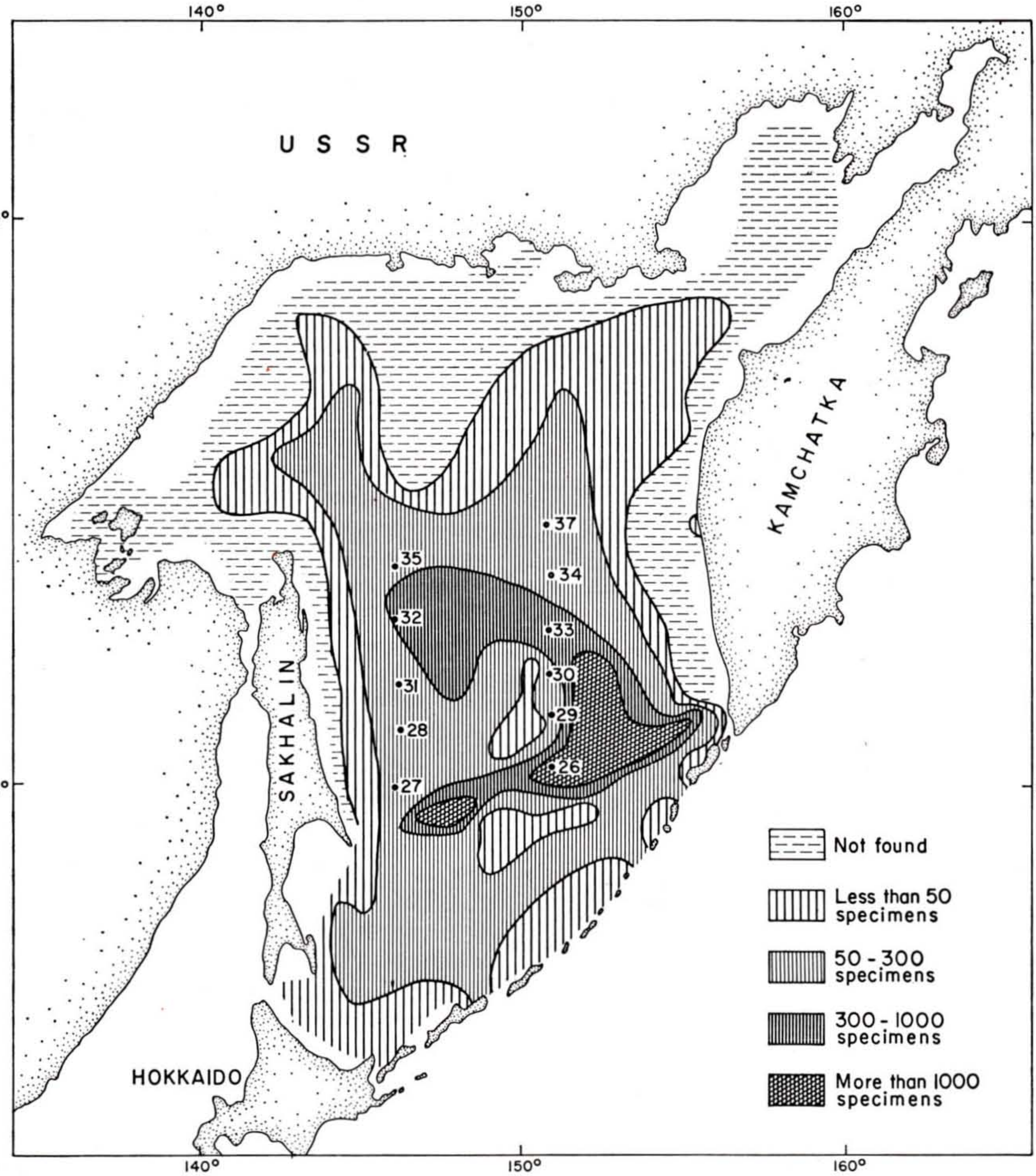
Abundance

Saidova (1957, fig. 3; 1960, fig. 4; 1961, fig. 34) recorded the abundance of total planktonic foraminiferal tests per 50 grams of sediment in the Okhotsk Sea (text fig. 4). Within the Okhotsk Sea, planktonic foraminifera and oceanic diatoms (Zhuse, 1962, p. 62, fig. 5) are absent from sediments in coastal waters. Murray (1897, p. 19) noted that planktonic foraminifera decreased shoreward and that they were generally absent near shore throughout the world. Phleger (1954) also observed this phenomenon, suggesting that terrestrial runoff restricted the approach of oceanic plankton to coastal areas.

In the Okhotsk Sea, planktonic foraminifera are generally more abundant in sediments of the deeper basins below about 300 meters. These deeper areas, for the most part, underlie surface waters influenced by currents from the Pacific Ocean and contain finer sediments. Higher concentrations of the foraminifera are also present in regions near the Kurile Islands, where Pacific currents enter the sea (Saidova, 1961, p. 114). The increase in plankton skeletons in sediments of these deeper basins farther from shore is probably due to a lower rate of terrigenous sedimentation and, possibly, a higher rate of plankton production in the overlying waters.

The maximum concentration of planktonic foraminiferal tests (text fig. 4) is in an area of varying topography and sediments but lies below current convergences within the Okhotsk Sea. Plankton production in convergence areas is known to be high (Sverdrup, Johnson and Fleming, 1942, p. 809) and may account for higher concentrations of skeletons in the bottom sediments in such areas. Foraminifera and other plankton may also be killed in convergences because of temperature changes or depletion of nutrients (Murray, 1897, p. 23; Sverdrup, Johnson and Fleming, 1942, p. 787).

There is a correspondence between abundance of planktonic foraminifera and oceanic diatoms in the sediments of the Okhotsk Sea (compare Saidova, 1961, fig. 34 with Zhuse, 1962, fig. 5). Planktonic foraminifera may utilize diatoms as food since benthonic forms are known to do so (Myers, 1943, p. 441). The coincident distributions of the two groups,



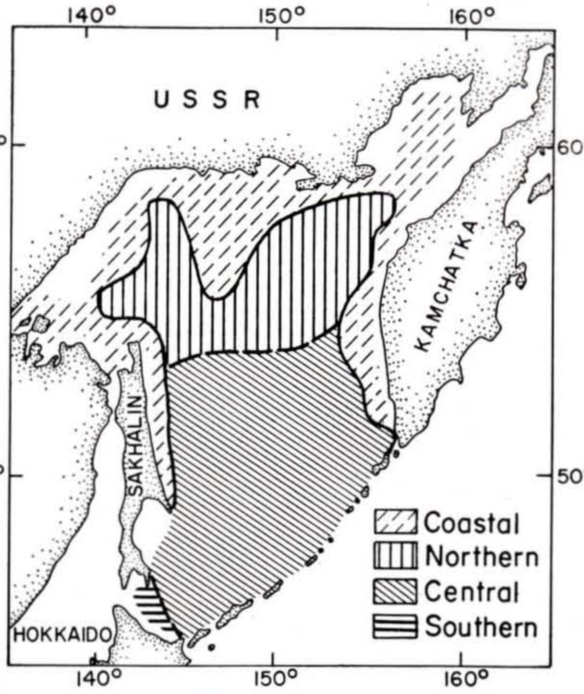
TEXT FIGURE 4
Abundance of planktonic foraminiferal tests per 50 grams of bottom sediment in the Okhotsk Sea (after Saidova, 1957, fig. 3).

however, probably are independent of each other and simply controlled by similar physical factors.

Planktonic Foraminiferal Biofacies

The sediments of the Okhotsk Sea are tentatively divided into four geographic regions based on their planktonic foraminiferal content, as described below: "coastal," "northern," "central" and "southern" (text fig. 5).

Sediments of the coastal region contain no or few planktonic foraminiferal tests. This region borders all the mainland coasts within the Okhotsk Sea, corresponding with the shallow shelf bordering the basin. Sediments of the northern region, above 54° N latitude, contain only *Globigerina pachyderma* and *G. bulloides,* in varying abundance. Within the central region, sediments contain these two species, but also *Globigerina eggeri, G. quinqueloba, Globigerinita glutinata, G. uvula* and *Turborotalia scitula.* The southern region is reported to contain *Globigerinoides ruber* and *G. conglobatus.*



TEXT FIGURE 5

Planktonic foraminiferal biofacies indicated by the results of this study and previously published data (see text).

FAUNAL COMPOSITION

Seven species of planktonic foraminifera were found during this study (Table 1). Remarks concerning morphology of the specimens and distribution of species are included below, together with references to previously published data concerning them in the North Pacific Ocean. Systematic arrangement is based on wall microstructure and follows Lipps (in press). All species are illustrated on Plate 9.

Family GLOBOROTALIIDAE

Turborotalia scitula (Brady)

Plate 9, figures 3a-c

Pulvinulina scitula BRADY, 1882, Roy. Soc. Edinburgh, Proc., vol. 11, (1880-1882), no. 111, p. 716. BANNER and BLOW, 1960, Cushman Found. Foram. Research, Contr., vol. 11, no. 1, p. 27, pl. 5, fig. 5 (lectotype).

Globorotalia scitula (Brady). SHCHEDRINA, 1953, Akad. Nauk SSSR, Inst. Zool., Trudy, vol. 13, p. 16. BRADSHAW, 1959, Cushman Found. Foram. Research, Contr., vol. 10, p. 44, pl. 8, figs. 5, 6. PARKER, 1962, Micropaleontology, vol. 8, p. 238, pl. 6, figs. 4-6. A. B. SMITH, 1963, Cushman Found. Foram. Research, Contr., vol. 14, p. 3, pl. 2, figs. 22-23.

Only a few specimens of this species were found, occurring in four samples. Most of these specimens are identical to the lectotype selected by Banner and Blow (1960, p. 27), although in some the spire is somewhat higher than normal.

This species occurs sporadically throughout the Pacific Ocean (Bradshaw, 1959, text-fig. 36; Parker, 1962, p. 239). Higher concentrations occur in the cool waters of the California Current off Washington State and near Japan. The Okhotsk Sea occurrences are the most northerly records in the western Pacific thus far, although in the east the species is present to nearly 50° N (Smith, 1964, text-fig. 1).

Turborotalia scitula was regarded as part of a mixed warm-water fauna by Bradshaw (1959, p. 54), being found throughout all warmer waters but also occurring in cooler waters. It has not been reported from the Subarctic Fauna in the North Pacific.

Globigerinita glutinata (Egger)

Plate 9, figures 1a-c

Globigerina glutinata EGGER, 1893, Abhandl. K. Bayer. Akad. Wiss. Munchen, CL II, vol. 18, p. 371, pl. 13, figs. 19-21.

Globigerinita glutinata (Egger). BRADSHAW, 1959, Cushman Found. Foram. Research, Contr., vol. 10, p. 40, pl. 7, figs. 7, 8. PARKER, 1962, Micropaleontology, vol. 8, p. 246, pl. 9, figs. 1-16. A. B. SMITH, 1963, Cushman Found. Foram. Research, Contr., vol. 14, p. 3, pl. 2, figs. 26-28.

Globigerinita glutinata is present in samples collected below surface waters influenced by currents from the Pacific Ocean. Specimens from the Okhotsk Sea do not have bullae; all specimens have high-spired trochoid tests with a simple umbilical aperture.

In the Pacific Ocean this species ranges from subpolar to tropical waters, being most abundant in warmer waters (Bradshaw, 1959, p. 40; Parker, 1962, p. 249).

Globigerinita uvula (Ehrenberg)

Plate 9, figures 2a-b

Pylodexia uvula EHRENBERG, 1861, K. Preuss. Akad. Wiss. Berlin, Monatsber., p. 276, 277, 308. EHRENBERG, 1873, K. Akad. Wiss. Berlin, Abh., Jahrg. 1872, pl. 2, figs. 24-25.

Globigerina bradyi Wiesner, 1931, *in* DRYGALSKI, E., Deutsche Südpolar Exped. 1901-1903, Bd. 20 (Zool. Bd. 12), p. 133. BANNER and BLOW, 1960, Cushman Found. Foram. Research, Contr., vol. 11, p. 5, pl. 3, figs. 1 (lectotype), 2. A. B. SMITH, 1963, Cushman Found. Foram. Research, Contr., vol. 14, p. 2, pl. 2, figs. 24-25.

Globigerinoides minuta NATLAND, 1933, Univ. Calif., Scripps Inst. Oceano., Bull., Tech. Ser., vol. 4, p. 150, pl. 7, figs. 2, 3.

Globigerinoides cf. *G. minuta* Natland. BRADSHAW, 1959, Cushman Found. Foram. Research, Contr., vol. 10, p. 40, pl. 7, figs. 9-11.

Globigerinita uvula (Ehrenberg). PARKER, 1962, Micropaleontology, vol. 8, p. 252, pl. 8, figs. 14-26.

This species is very rare in Okhotsk Sea samples. Our specimens are very high-spired, similar to those figured by Parker (1962, pl. 8, figs. 14-26), and were found in samples from the eastern side of the sea near the maximum influence of Pacific waters.

In the Pacific, the species is most common in subpolar regions (Bradshaw, 1959, p. 42, as *Globigerinoides* cf. *G. minuta;* Parker, 1962, p. 253).

Family GLOBIGERINIDAE

Globigerina bulloides d'Orbigny

Plate 9, figures 5a-c

Globigerina bulloides D'ORBIGNY, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 177. SHCHEDRINA, 1953, Akad. Nauk SSSR, Zoologicheskogo Inst., Trudy, vol. 13, p. 16. SHCHEDRINA, 1958, Issled. Dal'nevostochnykh morei SSSR, vyp. 5, Kurilo-Sakhalin Ekspeditsii, Trudy, vol. 1, p. 19. BRADSHAW, 1959, Cushman Found. Foram. Research, Contr., vol. 10, p. 33, pl. 6, figs. 1-4. BANNER and BLOW, 1960, Cushman Found. Foram. Research, Contr., vol. 11, p. 3, pl. 1, figs. 1 (lectotype), 4. BELYAEVA, 1960, Akad. Nauk SSSR, Inst. Okeano., Trudy, vol. 32, p. 161. SAIDOVA, 1961, Ekologiya foraminifer i paleogeografiya dal'nevostochnykh morei SSSR i severo-zapadnoi chasti Tikhogo Okeana, Akad. Nauk SSSR, Inst. Okeano., p. 114. PARKER, 1962, Micropaleontology, vol. 8, p. 221, pl. 1, figs. 1-8. A. B. SMITH, 1963, Cushman Found. Foram. Research, Contr., vol. 14, p. 2, pl. 1, figs. 1-4.

This species occurs commonly in all foraminiferal samples, except 27 and 28, and displays a wide range of variation within each sample, from smaller individuals with low apertures to large individuals with very wide apertures. Four or five chambers occur in the last whorl. These variations also are present throughout the Pacific Ocean and have been adequately illustrated and discussed by Parker (1962, p. 221, pl. 1, figs. 1-8).

Globigerina bulloides is most abundant in the cool waters of the high latitudes in the North and South Pacific Ocean (Bradshaw, 1959; Parker, 1962). This species is a characteristic constituent of cold-water faunas and in the North Pacific belongs to the Subarctic Fauna, but also occurs abundantly in the Transitional Fauna and sporadically in warmer-water faunas.

Globigerina eggeri Rhumbler

Plate 9, figures 6a-c

Globigerina eggeri Rhumbler, 1901, in BRANDT, Nordisches Plankton, Lief. 1, no. 14, p. 19, text-fig. 20 (*after* Brady, 1884, Rept. Voy. Challenger, Zool., vol. 9, pl. 79, fig. 17, "*G. dubia* Egger"). SHCHEDRINA, 1958, Issled. Dal'nevostochnykh morei SSSR, vyp. 5, Kurilo-Sakhalin Ekspeditsii, Trudy, vol. 1, p. 19. BRADSHAW, 1959, Cushman Found. Foram. Research, Contr., vol. 10, p. 35, pl. 6, figs. 5, 8-10. BANNER and BLOW, 1960, Cushman Found. Foram. Research, Contr., vol. 11, p. 11, pl. 2, fig. 4 (lectotype). A. B. SMITH, 1963, Cushman Found. Foram. Research, Contr., vol. 14, p. 2, pl. 1, figs. 8-11.

This species is present in samples from areas of warmer-water currents in the Okhotsk Sea. Bradshaw (1959, p. 36) found larger specimens of *G. eggeri* restricted to the Transitional and warmer-water faunas, although smaller specimens range into the Subarctic Fauna.

Globigerina pachyderma (Ehrenberg)

Plate 9, figures 7a-c

Aristerospira pachyderma EHRENBERG, 1861, K. Preuss. Akad. Wiss. Berlin, Monatsber., p. 276, 277, 303. EHRENBERG, 1872, K. Akad. Wiss. Berlin, Abh., Jahrg. 1873, pl. 1, fig. 4.

Globigerina bulloides d'Orbigny var. *borealis* BRADY, 1881, Ann. Mag. Nat. Hist., ser. 5, vol. 8, no. 48, p. 412. BANNER and BLOW, 1960, Cushman Found. Foram. Research, Contr., vol. 11, p. 4, pl. 3, fig. 4 (lectotype).

Globigerina pachyderma (Ehrenberg). SHCHEDRINA, 1953, Akad. Nauk SSSR, Inst. Zoologicheskogo, Trudy, vol. 13, p. 16. SHCHEDRINA, 1958, Issled. dal'nevostochnykh morei SSSR, vyp. 5, Kurilo-Sakhalin Ekspeditsii, Trudy, vol. 1, p. 19. BRADSHAW, 1959, Cushman Found. Foram. Research, Contr., vol. 10, p. 36, pl. 6, figs. 20-23. BELYAEVA, 1960, Akad. Nauk SSSR, Inst. Okeano., Trudy, vol. 32, p.161. SAIDOVA, 1961, Ekologiya foraminifer i paleogeografiya dal'nevostochnykh morei SSSR i severo-zapadnoi chasti Tikhogo Okeana, Akad. Nauk SSSR, Inst. Okeano., p. 114. PARKER, 1962, Micropaleontology, vol. 8, p. 224, pl. 1, figs. 26-35, pl. 2, figs. 1-6. A. B. SMITH, 1963, Cushman Found. Foram. Research, Contr., vol. 14, p. 2, pl. 2, figs. 15-18.

Globigerina pachyderma is the most abundant and variable planktonic species occurring in the Okhotsk Sea. It is present in great quantities in all samples (except 27) and far outnumbers all other planktonic species. Nearly all specimens coil sinistrally in our samples. Specimens vary from small compact forms with restricted, umbilical or extra-umbilical apertures to specimens over twice as large with wider apertures and more numerous chambers. Specimens resembling the lectotype of *G. bulloides* var. *borealis* Brady (Banner and Blow, 1960, p. 4) occur with typical *G. pachyderma* in all samples. These specimens are small *G. pachyderma* which have not yet deposited a thick secondary layer of calcite on the test wall or formed the last overlapping chamber.

Globigerina pachyderma is characteristic of coldwater faunas throughout the world. Specimens from Polar regions are reported to be mostly left-coiling (Bandy, 1960, p. 673).

Globigerina quinqueloba Natland

Plate 9, figures 4a-c

Globigerina quinqueloba NATLAND, 1938, Univ. Calif., Scripps Inst. Oceanography Bull., Tech. Ser., vol. 4, p. 149, pl. 6, fig. 7. BRADSHAW, 1959, Cushman Found. Foram. Research, Contr., vol. 10, p. 38, pl. 6, figs. 24, 25. PARKER, 1962, Micropaleontology, vol. 8, p. 225, pl. 2, figs. 7-16. A. B. SMITH, 1963, Cushman Found. Foram. Research, Contr., vol. 14, p. 3, pl. 1, figs. 5-7.

Globigerina groenlandica SHCHEDRINA, 1946, Arktich. Nauchno-Issled. Inst., Dreif Eksped. Glavs. Ledok. Parokh. "G. Sedov" 1937-1940, Trudy, vol. 3 (Biol.), p. 145, pl. 4, fig. 23.

A few specimens of this species occur in areas affected by the influx of Pacific Ocean water. They show little variation. In the Pacific Ocean this species is abundant in the regions characterized by the Subarctic and Transition Faunas and rare in more southerly areas (Bradshaw, 1959, p. 18).

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVII, PART 4, OCTOBER, 1966

322. SOME LOWER PALEOCENE FORAMINIFERA FROM THE ANITA FORMATION, SANTA BARBARA COUNTY, CALIFORNIA

BENJAMIN N. AKPATI
University of California, Los Angeles

ABSTRACT

Eight foraminiferal species are described and illustrated from the Anita Formation, Lower Paleocene (Ynezian), Western Santa Ynez Mountains, Santa Barbara County, California. They include species of the genera **Quadratobuliminella** (Turrilinidae), **Yneziella** new genus (Eouvigerinidae), **Dentalina** and **Vaginulina** (Nodosariidae), **Ellipsopolymorphina** (Pleurostomellidae) and **Coryphostoma** (Caucasinidae). The fauna is correlative to that of the Midway Group of the Gulf Coast and is also similar to that of the Danian of the Bavarian Alps and France.

INTRODUCTION

This paper resulted in part from an earlier unpublished Master's thesis study of the micropaleontology of the Jalama and Anita Formations, West Santa Ynez Mountains, Santa Barbara County, California. The described species are from the Anita Formation.

This is the first known occurrence of *Quadratobuliminella* and the new genus *Yneziella* in North America. The new genus here described has been assigned to the family Eouvigerinidae because of its general appearance, chamber arrangement and apertural characters. The foraminiferal species *Quadratobuliminella pyramidalis* was originally described by deKlasz (1953) from the Danian of the Bavarian Alps and France. The fauna of these localities (deKlasz, 1953, p. 434) is very similar to that of the Anita Formation, Lower Paleocene (Ynezian) of California.

These species from the Anita Formation occur in gray rusty-brown mudstone in association with abundant planktonic foraminifera such as *Globigerina, Lagena, Globulina, Lenticulina* and other Nodosarids which suggests a relatively deep temperate to warm-water environment (Akpati, 1966, pp. 14-16, pl. V).

All holotypes have been deposited in the Invertebrate Paleontological Collection, Department of Geology, University of California, Los Angeles.

ACKNOWLEDGMENTS

The writer is greatly indebted to the Department of Geology, University of California, Los Angeles, for providing the necessary laboratory facilities and for financial assistance in preparation of the illustrations and manuscript. Dr. H. Loeblich originally suggested the study and encouraged and guided the writer in preparation of this manuscript for publication. The writer is also grateful to Drs. Jere H. Lipps and William V. Sliter of the University of California, Los Angeles for assistance and encouragement, and particularly to Dr. Lipps for help in the study of wall structures. Illustrations of the foraminifera were drawn by camera lucida by Miss Margaret Rogers, scientific illustrator.

LOCALITY

All specimens here described are from UCLA fossil localities 5322, and 5324, the latter stratigraphically 10 feet higher than the former. The sediments consist of a gray-rusty brown, well-indurated, glauconitic mudstone, exposed in a roadcut east of Salsipuedes Creek, about 0.70 miles north of the junction of the old Jalama road with the new Jalama road, 2.1 miles south of Jalama School and 3.6 miles west of California State Highway No. 1; 550 ft. elevation, N.W. of the intersection of longitude 120° 23′ 38″ W. and latitude 34° 32′ 32″ N., Lompoc Hills Quadrangle (USGS, 1947), Santa Barbara County, California (text fig. 1).

SYSTEMATIC DESCRIPTIONS

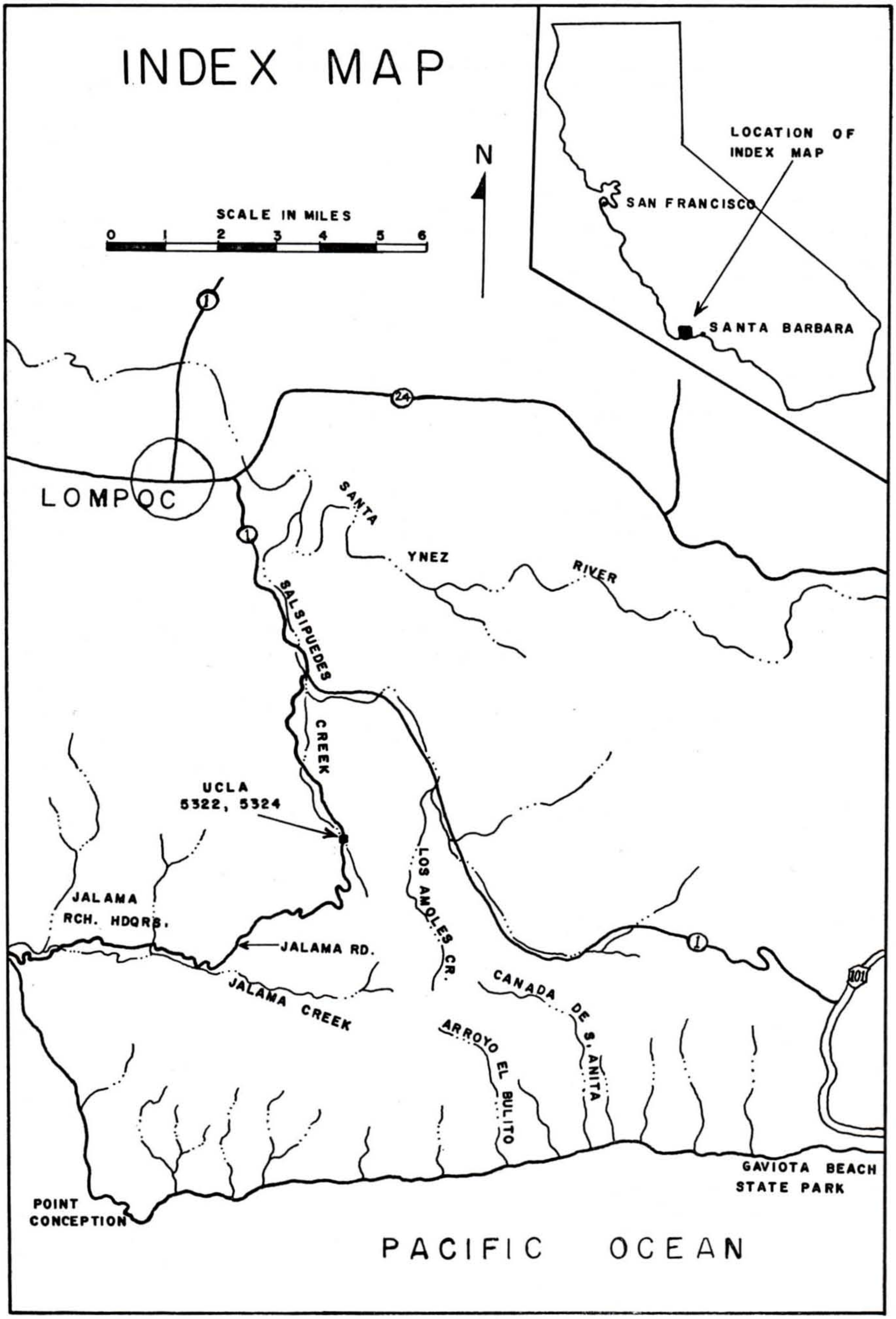
The classification followed is that of A. R. Loeblich, Jr. and Helen Tappan, 1964. Figured specimens are deposited in the Invertebrate Paleontological Collection, Department of Geology, University of California, Los Angeles, California.

Order FORAMINIFERA Eichwald, 1830
Family TURRILINIDAE Cushman, 1927
Genus **Quadratobuliminella** de Klasz, 1953
Quadratobuliminella pseudopyramidalis n. sp.
Plate 10, figures 1a-b, 2, 3

Test free, slightly elongate, about 1½ times as long as broad, somewhat tapering from subacute initial end to broadly rounded apertural end; chambers distinct, globular, less elongate and rather "shapeless" in early stage, 4 chambers to a whorl in adult, quadrate in section and quadriserially arranged; chambers much inflated and rather uniform in shape, increasing gradually in size toward the aperture; sutures distinct, depressed; aperture low and umbilical; wall calcareous, finely perforate, radial in structure, surface smooth except for fine grooves radiating from the aperture.

Holotype length 0.340 mm., greatest breadth 0.255 mm.

Remarks.—This species has the general shape of *Buliminella*? *christyi* Mallory but differs in having a strongly quadrate section and in lacking the



TEXT FIGURE 1
Index map of the area under investigation.

coarsely perforate and bluntly spinose wall. It is very close to *Quadratobuliminella pyramidalis* de Klasz (from the Danian of the Bavarian Alps, and southwestern France) but differs in having radial grooves in the apertural region. Specimens show a great degree of variation, from short and broad to comparatively elongate, and from a centrally located, depressed aperture to an elongate, comma-shaped depressed opening extending into the face of the terminal chamber. These variations probably represent different stages of development.

Occurrence.—Holotype from UCLA fossil locality 5324.

Superfamily BULIMINACEA Jones, 1875

Family EOUVIGERINIDAE Cushman, 1927

Genus **Yneziella** n. gen.

Type Species.—*Yneziella salsipuedensis,* new species.

Test free, elongate, about 3 pairs of biserial chambers in early stage, rather compressed, later with 3 to 4 uniserial, strongly inflated chambers, sutures distinct, depressed, slightly arcuate; aperture terminal and central; wall finely perforate, radial in structure, surface smooth to finely striate or spinose.

Remarks.—This genus resembles *Tubitextularia* Sulc, 1927 in general appearance but differs in being more compressed and in having a distinctive apertural character. It differs from *Rectobolivina* in the more inflated chambers, slightly twisted test, and terminal crescentic aperture which resembles that of *Stilostomella.*

Occurrence.—Anita Formation, L. Paleocene (Ynezian), Western Santa Ynez Mountains, Santa Barbara County, California.

Yneziella salsipuedensis, new species

Plate 10, figures 4, 5, 6a-b

Test free, elongate, uniformly biserial in early portion, uniserial in adult; chambers rather compressed to slightly inflated, somewhat overlapping, periphery rounded; sutures distinct, depressed, arcuate; wall smooth, finely perforate, calcareous, radial in structure; aperture terminal with slight tooth, leaving an arched slit.

Holotype, length 0.357 mm., diameter of largest chamber 0.187 mm.

Paratype, length 0.408 mm., largest diameter 0.170 mm.

Remarks.—This species differs from *Y. loeblichae* n. sp. in having more compressed chambers, a uniformly biserial early portion and smoother wall. It differs from *Y. sliteri* n. sp. in having a longer biserial portion, and in lacking the spines at the base of each chamber. It resembles *Bifarina regularis* Keller, but the latter has a cylindrical neck and phialine lip.

Occurrence.—Holotype is from UCLA fossil locality no. 5324.

Yneziella loeblichae n. sp.

Plate 10, figures 7a-b

Test free, elongate, chambers biserial in early stage, arranged in slightly arcuate or straight series, later chambers uniserial, slightly compressed and may be inflated; sutures distinct, somewhat depressed and arcuate, spines on lower margin of each chamber; wall calcareous, finely perforate, radial in structure, surface smooth except for a row of acicular spines extending backward at the basal chamber margins, aperture terminal.

Holotype, length 0.442 mm., largest diameter 0.204 mm.

Remarks.—This species is quite variable, as some specimens have more compressed chambers than others, and sutures range from horizontal to more or less arched. The species somewhat resembles *Plectofrondicularia minuta* Sullivan (1962, University of California Publ. Geol. Sci., Vol. 37, no. 4, p. 269, pl. 13) in general appearance, but lacks the strongly spinose subacute periphery. The biserial stage comprises more than half the test.

This species is named for Dr. H. Tappan Loeblich under whom the writer studied while at the University of California, Los Angeles, and who has encouraged him to do this study.

Occurrence.—Holotype from UCLA fossil locality 5324.

Yneziella sliteri n. sp.

Plate 10, figures 8a-b

Test free, elongate, tapering, biserial early portion rather compressed, later increasing rapidly in breadth, uniserial inflated chambers becoming circular in cross-section; sutures distinct, depressed, slightly to moderately arched; wall calcareous, finely perforate, radial in structure, surface in early portion smooth, becoming irregularly spinose in later chambers which are low and broad; aperture terminal.

Holotype, length 0.612 mm., breadth of largest chamber 0.255 mm.

Remarks.—This specimen resembles *Y. loeblichae* n. sp., but differs in having strongly inflated later chambers entirely covered by irregularly distributed acicular spines. The last biserial chamber overlaps the earlier ones.

Occurrence.—Holotype is from UCLA fossil locality no. 5324.

Family NODOSARIIDAE Ehrenberg, 1838

Genus **Dentalina** d'Orbigny, 1826

Dentalina lippsi n. sp.

Plate 10, figures 9a-d

Test free, elongate rectilinear, circular in cross section, rounded base, tapering rather rapidly toward aperture giving an ampulla-shape to the whole test; two distinct chambers; sutures distinct, flush with surface, slightly arched on one side and horizontal on the other; wall thick, calcareous, finely perforate; aperture terminal, radiate, slightly projecting.

Length of holotype 0.612 mm., diameter 0.272 mm.

Remarks.—This species resembles *Pseudoglandulina cylindracea* (Reuss) but differs in having only two chambers, and a rapidly tapering apertural end.

This species is named for Dr. Jere Lipps, Department of Geology, University of California, Los Angeles, for his helpful assistance in identifications and in wall structure study of the specimens described in this paper.

Occurrence.—This species occurred at UCLA fossil locality 5324.

Genus **Vaginulina** d'Orbigny, 1826

Vaginulina anitana n. sp.

Plate 10, figures 10a-c, 11

Test free, of medium size, elongate, moderately compressed; chambers low, few, about four, carinate to subcarinate periphery, comparatively large, inflated to rounded proloculus; sutures curved, distinct, flush with surface in initial end, later becoming very strongly limbate; wall calcareous, moderately perforate; aperture radiate, at the dorsal angle and slightly projecting.

Length of holotype 1.505 mm., widest chamber 0.595 mm.

Remarks.—This species resembles *Vaginulina incompta* Reuss var. *striata* Hucke but the latter has broader chambers and lacks a radiate aperture. It differs from *V. gaultina* Berthelin emend. Bartenstein in having limbate sutures, a subcarinate periphery and fewer chambers. It has the general appearance of *V. alsatica* Deecke particularly in having a subcarinate periphery and radiate aperture but the latter possesses nonlimbate sutures. *V. robusta* Plummer (Univ. Tex. Bull. 2644, p. 112, pl. 6, figs. 4a, b) from the Paleocene (Midway) of Texas is very similar to *V. anitana* n. sp. but differs in being ovoid rather than lenticular in section, in having more inflated chambers, more oblique sutures which are thickened and raised completely around the test, and the apertural chamber rather more inflated with protruding apertural neck.

Occurrence.—The holotype occurred at UCLA fossil locality 5324, paratypes from UCLA locality 5322.

Superfamily CASSIDULINACEA d'Orbigny, 1839

Family CAUCASINIDAE Bykova, 1959

Genus **Coryphostoma** Loeblich and Tappan, 1962

Coryphostoma paleocenica n. sp.

Plate 10, figures 12a-b

Test free, elongate, narrow, about 5 times as long as broad in adult, greatest breadth near apertural end, apical tip rounded; chambers distinct, biserial and more or less cuneiform, about eight pairs, slightly compressed, with a tendency to become uniserial and somewhat inflated toward apertural end; sutures distinct, transparent in places, slightly depressed to flush with surface, very strongly oblique and slightly curved; wall smooth, finely perforate, granular in structure; aperture ovate to elliptical, extending from base of final chamber to a nearly terminal position.

Length of holotype 0.527 mm., greatest breadth 0.136 mm., greatest thickness 0.085 mm.

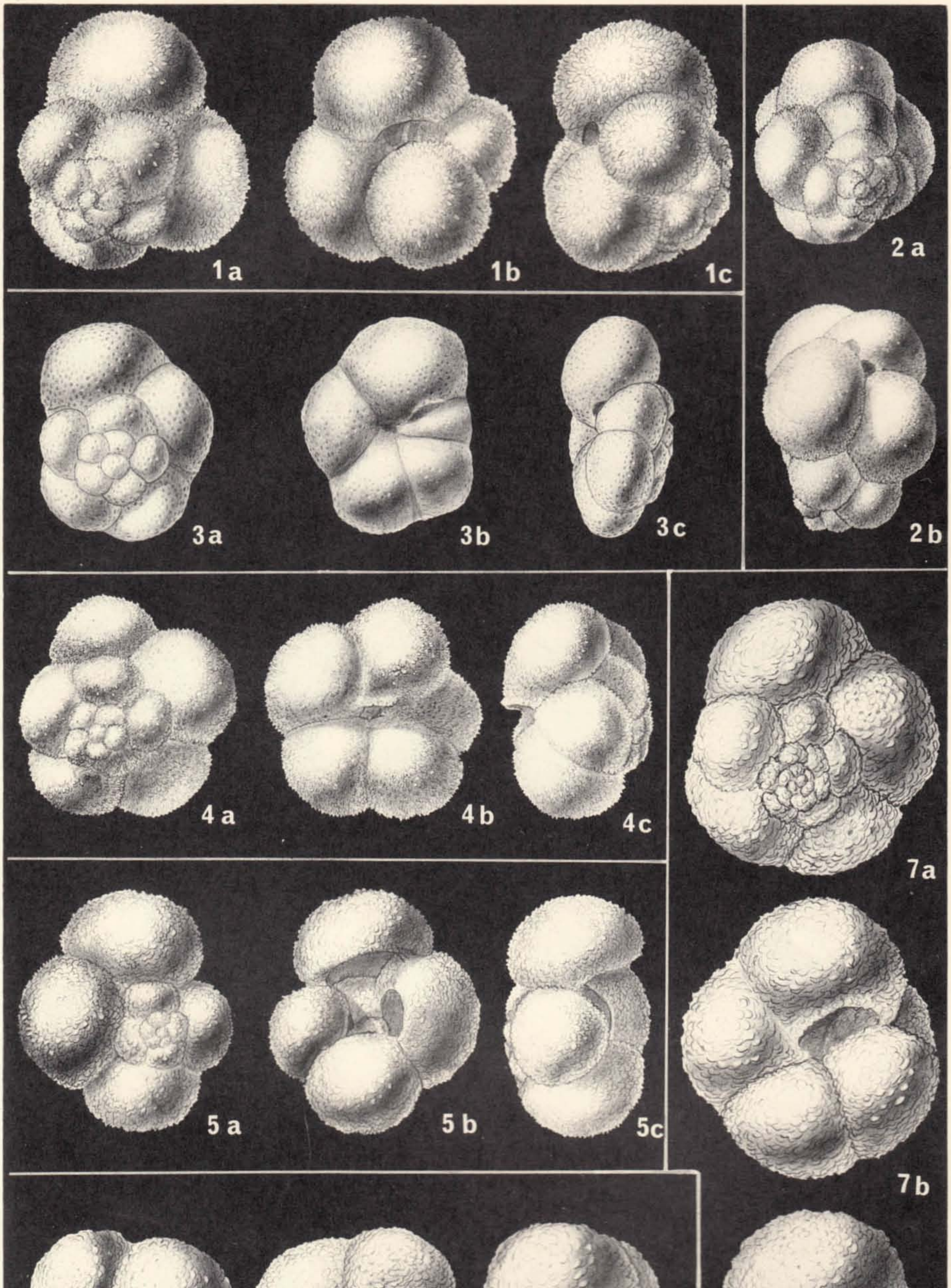
Remarks.—This species is similar to *Bolivina midwayensis* Cushman (Cushman, U. S. Geol. Surv. Prof. Paper 232, p. 43, pl. 2, figs. 11, 12) but the latter has broader and more numerous chambers and a bolivine aperture. *Loxostomum serrulum* Bandy differs in having spine-like projections on the lower chamber margin. It closely resembles *Coryphostoma plaitum* (Carsey) with which it occurs, but the latter has more chambers, lacks the strongly oblique and curved sutures, and the aperture does not extend to the base of final chamber.

Occurrence.—Holotype from UCLA fossil locality 5324, paratypes from UCLA fossil localities 5322, 5324.

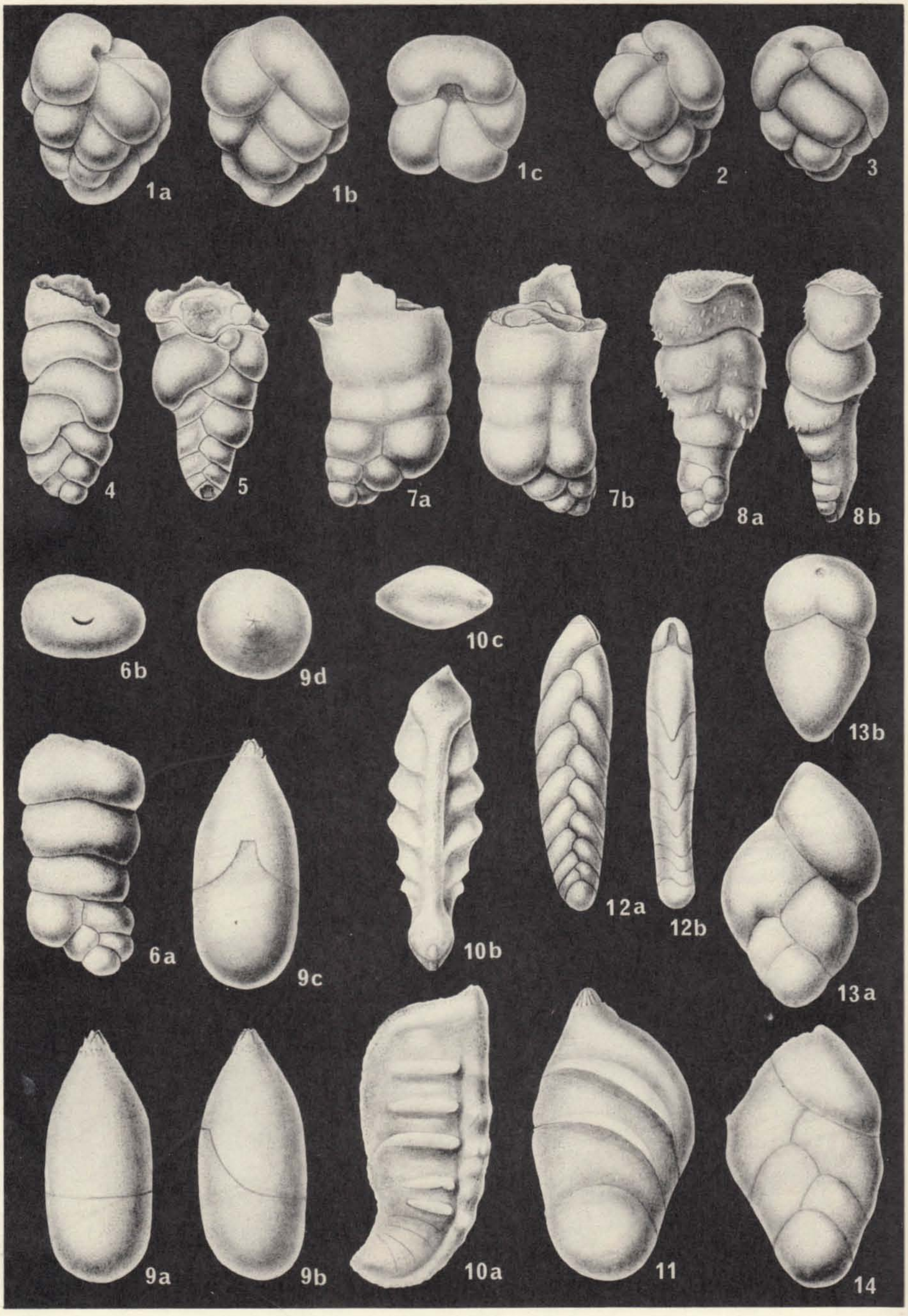
EXPLANATION OF PLATE 9

Planktonic foraminifera from the Okhotsk Sea. All figured specimens from surface sediment of core 33. (a. spiral view, b. umbilical view, c. edge view unless otherwise noted.)

FIGS.		PAGE
1.	*Globigerinita glutinata* (Egger). UCLA 34169, × 220.	131
2.	*Globigerinita uvula* (Ehrenberg). UCLA 34173, × 160. a. spiral view, b. edge view.	131
3.	*Turborotalia scitula* (Brady). UCLA 34174, × 160.	131
4.	*Globigerina quinqueloba* Natland. UCLA 34171, × 160.	133
5.	*Globigerina bulloides* d'Orbigny. UCLA 34168, × 75.	132
6.	*Globigerina eggeri* Rhumbler. UCLA 34169, × 105.	132
7.	*Globigerina pachyderma* (Ehrenberg). UCLA 34170, × 150.	132



Lipps and Warme: Okhotsk Sea Planktonic Foraminifera



Akpati: California Paleocene Foraminifera

Family PLEUROSTOMELLIDAE Reuss, 1860
Genus **Ellipsopolymorphina** Silvestri, 1910
Ellipsopolymorphina trinitatensis (Cushman and Renz)

Plate 10, figures 13a-c

Loxostomum trinitatensis CUSHMAN and RENZ, 1946, Cushman Lab. Foram. Res. Special Pub. no. 18, p. 39, Pl. 6, figs. 24, 25 (Lizard Springs Formation, Paleocene, Trinidad, W.I.).

Test free, about twice as long as broad, slightly compressed, periphery slightly lobate; chambers biserial, few, rather inflated, rapidly increasing in size; sutures distinct, depressed; wall smooth, finely perforate; aperture rounded, terminal on the protruding final chamber.

Hypotype: Length 0.442 mm., width on broadest side 0.255 mm.

Remarks.—This species resembles *Pleurostomella brevis* Schwager in general appearance but differs in having smaller and more compressed chambers.

Occurrence.—This species occurred in UCLA fossil locality 5324.

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EXPLANATION OF PLATE 10

FIGS. PAGE

1, 2, 3. *Quadratobuliminella pseudopyramidalis* n. sp. 135
1, Holotype (UCLA 5324). × 100; a. Front view, b. rear view, c. apertural view.
2, 3, paratypes (UCLA 5324). × 90.

4, 5, 6. *Yneziella salisipuedensis* n. sp. 137
6, Holotype (UCLA 5324). × 100; a. side view, b. apertural view.
4, 5, paratypes (UCLA 5324). × 90.

7. *Yneziella loeblichae* n. sp. 137
Holotype (UCLA 5324). × 90; a. side view; b. opposite view.

8. *Yneziella sliteri* n. sp. 137
Holotype (UCLA 5324). × 70; a. side view; b. edge view.

9. *Dentalina lippsi* n. sp. 137
Holotype (UCLA 5324). × 70; a. back view of suture, b. edge view showing sloping suture, c. front view of arched suture, d. apertural view.

10, 11. *Vaginulina anitana* n. sp. 138
10, Holotype (UCLA 5324); a. side view, b. edge view, apertural view.
11, paratype (UCLA 5322). Both × 34.3.

12. *Coryphostoma paleocenica* n. sp. 138
Holotype (UCLA 5324). × 90; a. side view, b. edge view.

13, 14. *Ellipsopolymorphina trinitatensis* (Cushman and Renz). 139
13, Holotype (UCLA 5324). a. side view, b. apertural view.
14, Hypotype (UCLA 5324). Both × 90.

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323. *ARCANISPIRA DEPRESSA* N. SP. FROM THE FLORIDA MIOCENE CHIPOLA FORMATION

C. W. POAG
Chevron Oil Company, New Orleans, Louisiana

ABSTRACT

Arcanispira depressa n. sp., from the type locality of the Miocene Chipola Formation of northwestern Florida, is described and illustrated, and its possible stratigraphic value is suggested. A direct evolutionary linkage is proposed between **A. depressa** n. sp. and **A. bacata** Poag of the eastern Mississippi Paynes Hammock Formation.

INTRODUCTION

A new species of *Arcanispira* Poag is described from the type locality of the Chipola Formation in northwest Florida. This is the second species of the genus to be described, the first having been recorded from the Paynes Hammock Formation of eastern Mississippi (Poag, 1966). *Arcanispira depressa* n. sp. is easily recognized and is fairly abundant, and may prove useful as an aid in correlation among the complex sedimentary facies of the Florida panhandle.

The writer wishes to thank the following persons for their help in the preparation of this paper: Mssrs. W. H. Akers, A. F. Barrelle, P. E. Koeppel, R. F. McClish, G. S. Robinson, and W. P. S. Ventress of Chevron Oil Company; Dr. Alan H. Cheetham of Louisiana State University; and Dr. H. V. Andersen of Louisiana State University who called the writer's attention to this new species and kindly provided samples from the Chipola type locality. The Chevron Oil Company has kindly granted permission to publish.

The holotype (No. 8392) and figured paratype (No. 8393) are deposited in the H. V. Howe Collection at Louisiana State University. Unfigured paratypes (No. 984) are deposited in the Louisiana State University Geology Department Museum Collection. Additional specimens and oriented thin sections are retained in the author's personal collection. Thin sections and camera lucida illustrations were prepared by the author.

LOCATION OF OUTCROP

The samples were collected from the bank of Ten Mile Creek, under the bridge on the Marianna-Clarkville road (State Hwy. 73), 2376 feet S. of N.W. cor. Sec. 12, T. 1 N., R. 10 W., 22 miles south of Marianna, Calhoun County, Florida (Puri, 1953; Puri and Vernon, 1964).

GEOLOGIC SETTING

The Chipola Formation, as exposed in the banks of Ten Mile Creek, consists of six feet of gray, calcareous, sandy clay, containing abundant microfossils and megafossils, overlain by about eight feet of sparsely fossiliferous clayey sand. Fifty-three species of Foraminiferida, twenty species of Ostracoda, and numerous molluscan species have been recorded from the Chipola Formation (Puri, 1953; Puri and Vernon, 1964). The Florida Geological Survey considers the Chipola Formation to be of Middle Miocene age, unconformably overlying the Lower Miocene Chattahoochee Formation (Tampa Stage) at Ten Mile Creek.

Puri (1953) reports a Chipola foraminiferal assemblage dominated by miliolids (33%) and suggests that the maximum water depth during deposition was sixty fathoms. The two samples examined by the writer reflect maximum water depth closer to fifteen fathoms, with an association of *Amphistegina, Elphidium, Rosalina,* miliolids, and *Globigerina* dominant in frequency of specimens encountered. Abundant ostracod, mollusk, and echinoid remains are also present.

PHYLOGENY OF *ARCANISPIRA*

The composition of the observed *Arcanispira* population from Chipola samples suggests a direct phylogenetic development from *Arcanispira bacata* Poag of the Paynes Hammock Formation (Poag, 1966). The observed *Arcanispira* population in the Paynes Hammock samples consists entirely of the species *A. bacata* (53 specimens; with conical spire, raised sutures and umbo on convex side; plate 11, fig. 7). Of forty specimens from the Chipola samples, two belong to the species *A. bacata* and the remaining thirty-eight belong to *A. depressa* (with flattened spire, depressed sutures and umbo on convex side; plate 11, figs. 1-6). Since the Chipola Formation overlies beds equivalent in age to the Paynes Hammock Formation (*i.e.* the Chattahoochee Formation; Butler, 1963; Puri and Vernon, 1964; Poag, 1966), a direct line of evolution from *A. bacata* to *A. depressa* can be reasonably surmised. The presence in the Chipola samples of low frequencies of *A. bacata,* indicates that this species was approaching extinction, but had not yet been completely replaced by *A. depressa.*

It is to be expected that *A. bacata* is present in the Chattahoochee Formation, and that *A. depressa* may be found in Chipola equivalents of the northern Gulf Coast Province, although neither occurrence has been reported to date.

SYSTEMATIC DESCRIPTION

Order FORAMINIFERIDA

Family ROTALIIDAE Ehrenberg, 1839

Genus **Arcanispira** Poag, 1966

Arcanispira depressa Poag, n. sp.

Plate 11, figures 1-6

Material.—Thirty-eight specimens from the type locality of the Chipola Formation.

Diagnosis.—Test medium, plano- to concavo-convex, of radially fibrous calcite; septa secondarily double; periphery acute, keeled; outline generally lobate, especially in final 2-3 chambers; convex side involute, flattened in center and generally depressed at umbo, chambers inflated; flat side involute; coiling trochospiral, each succeeding whorl completely enveloping the previous whorl; 2½-3 whorls in entire test, composed of 17-19 chambers, generally 6-6½ chambers in final whorl; sutures on flat side gently curved, radiate, slightly depressed; sutures on convex side distinctly depressed, strongly curved, with sigmoidal tendencies, especially in final suture of some specimens; indistinct knob sometimes present in depressed umbo of convex side; center of flat side contains several pillars which project as flattened circular or irregular knobs; additional ornamental pustules and radiating elongate ridges extend distally from central pillars; wall coarsely perforate on both sides of test, typically pustulose on convex side, but sometimes nearly smooth (30 of 38 specimens distinctly pustulose); pustules on convex side sometimes forming ridges parallel to sutures; reentrant of sutures on flat side contains tubular invagination of wall which is connected through internal cavity of chamber to periphery of previous coil; tube apparently does not have an opening into previous coil or into open chamber cavity; external opening of tube often obscured by pustular ornamentation; aperture a narrow areal slit on flat side near periphery, just above final suture, completely surrounded by thickened lip.

Dimensions of holotype.—Height 0.47 mm; width 0.43 mm.; thickness 0.23 mm.

Remarks.—*Arcanispira depressa* differs from *A. bacata* in having fewer chambers in the final whorl, a flattened spire with depressed sutures and umbo on the convex side, generally a higher degree of ornamentation on both sides of the test, a less pustulose keel, and the opening into the tubular apparatus seems consistently at a greater distance from the primary aperture.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVII, PART 4, OCTOBER, 1966

324. TWO NEW MIDDLE ALBIAN SPECIES OF FORAMINIFERA FROM SASKATCHEWAN

PAUL GULIOV
Department of Mineral Resources, Regina, Saskatchewan, Canada

INTRODUCTION

While engaged in a biostratigraphic study of the Middle Albian Joli Fou Formation from several localities in Saskatchewan, the writer collected a new species of *Ammodiscus* and one of *Ammomarginulina*.

ACKNOWLEDGEMENTS

The writer is indebted to Dr. W. G. E. Caldwell and Dr. W. Braun of the Department of Geology, University of Saskatchewan, Saskatoon, and to B. R. North (Mrs. W. G. E. Caldwell) of the Saskatchewan Research Council, Saskatoon, for their assistance and technical advice, and to his colleagues in the Department of Mineral Resources, Regina, for their assistance and co-operation.

SYSTEMATIC DESCRIPTION

Order FORAMINIFERIDA

Family AMMODISCIDAE

Ammodiscus anthosatus sp. nov.

Plate 12, figures 1-5

Description.—Test free, planispirally coiled, evolute, disc shaped, usually with broad shallow umbilical depression on both sides; four or five closely appressed whorls visible in adult, earliest portion of test indistinct, fused along spiral suture; last three whorls each divided into about four elongate tubular sections by slight constrictions of the test wall giving the periphery a broadly lobate character, whorls increasing gradually in diameter distally; wall arenaceous, fine grained, usually white; cement siliceous, abundant especially in early portion; surface slightly rough; aperture a rounded opening at end of last volution.

Dimensions.—Maximum diameter of holotype 0.57 mm.; minimum diameter of holotype 0.49 mm.; thickness of holotype 0.12 mm.; maximum diameters of paratypes range from 0.29 mm. to 0.76 mm.; minimum diameters of paratypes range from 0.25 mm. to 0.62 mm.

Types.—All types are deposited in the type collection of the Geological Museum of the University of Saskatchewan (abbreviated G.M.U.S.). Holotype G.M.U.S. Pf 46 was taken from the Alwinsal Sarcee 4-28 borehole in Lsd. 4, Sec. 28, Twp. 33, R. 23 W2nd meridian, which is to be regarded as type locality, 24 to 31 feet above the base of the Joli Fou Formation, or 1419 to 1426 feet below the Kelly bushing elevation of 1771.3 feet above sea level. Nine paratypes are established and range in number from G.M.U.S. Pf 47 to G.M.U.S. Pf 55. All were collected from the International Yarbo 17S borehole in Lsd. 1, Sec. 24, Twp. 20, R. 33 W1st meridian.

Discussion.—Approximately one hundred specimens were collected from five localities. About half of these were preserved well enough for adequate examination.

The transverse growth constrictions of the tubular chamber give the test a chambered appearance whereas a close examination reveals no internal partitions. The agglutinated character of the test wall confirms the assignment of this species to *Ammodiscus* rather than to *Involutina.*

The presence of *Inoceramus* cf. *I. comancheanus* Cragin in the Joli Fou shale of Saskatchewan points to an upper Middle Albian age.

The specific name of the new species is derived from the Greek *anthos-* = flower and *-atus* = having the nature of.

Family LITUOLIDAE

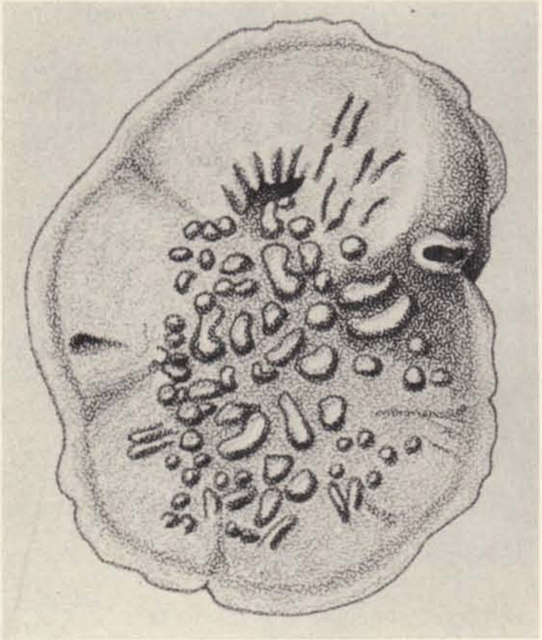
Ammomarginulina asperata sp. nov.

Plate 12, figures 6-9

Description.—Test free, large, initially planispiral,

EXPLANATION OF PLATE 11

FIGS.		PAGE
1-3.	*Arcanispira depressa* Poag, n. sp., holotype, × 130. 1, flat side; 2, edge view; 3, convex side.	141
4.	*Arcanispira depressa* Poag, n. sp., paratype, × 130. Convex side showing pustular ornamentation.	141
5.	*Arcanispira depressa* Poag, n. sp., × 430. Transverse section (part) showing double septum.	141
6.	*Arcanispira depressa* Poag, n. sp., × 150. Axial section showing test outline, central pillars and fibrous, lamellar walls.	141
7.	*Arcanispira bacata* Poag, × 100. Axial section showing test outline, central pillars, fibrous lamellar walls, and tubular invagination of wall in last chamber of flat side.	140



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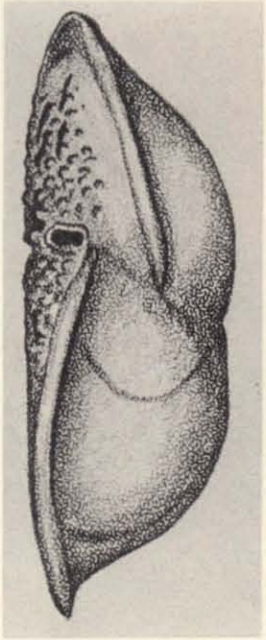

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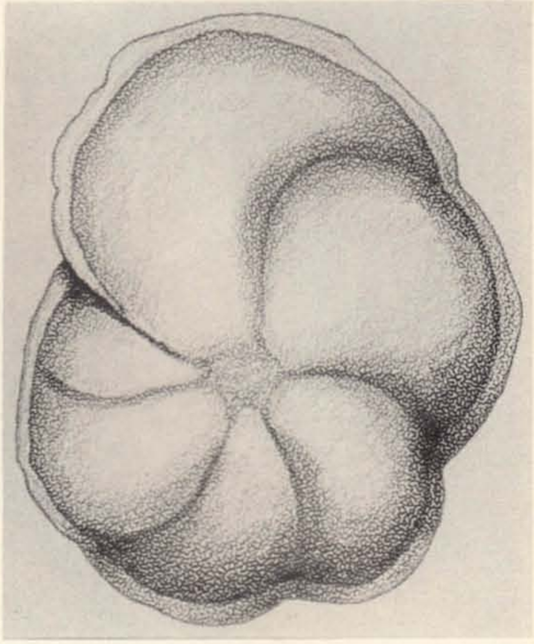

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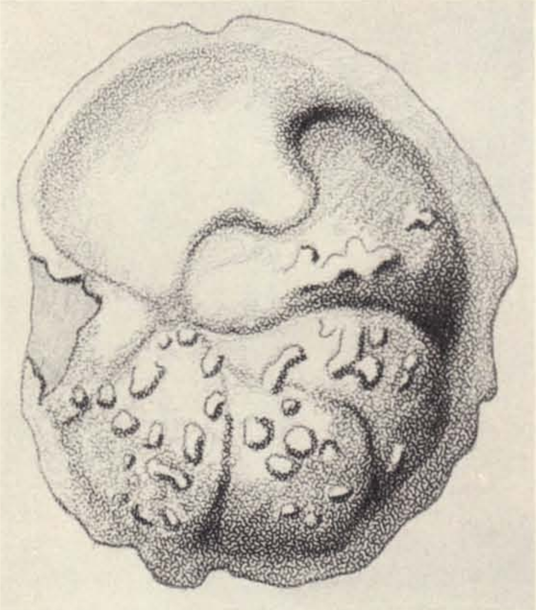

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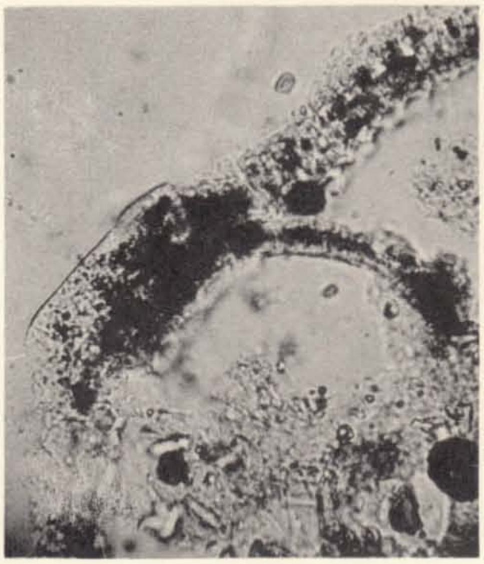

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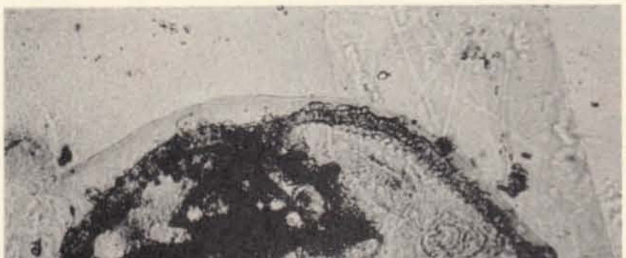

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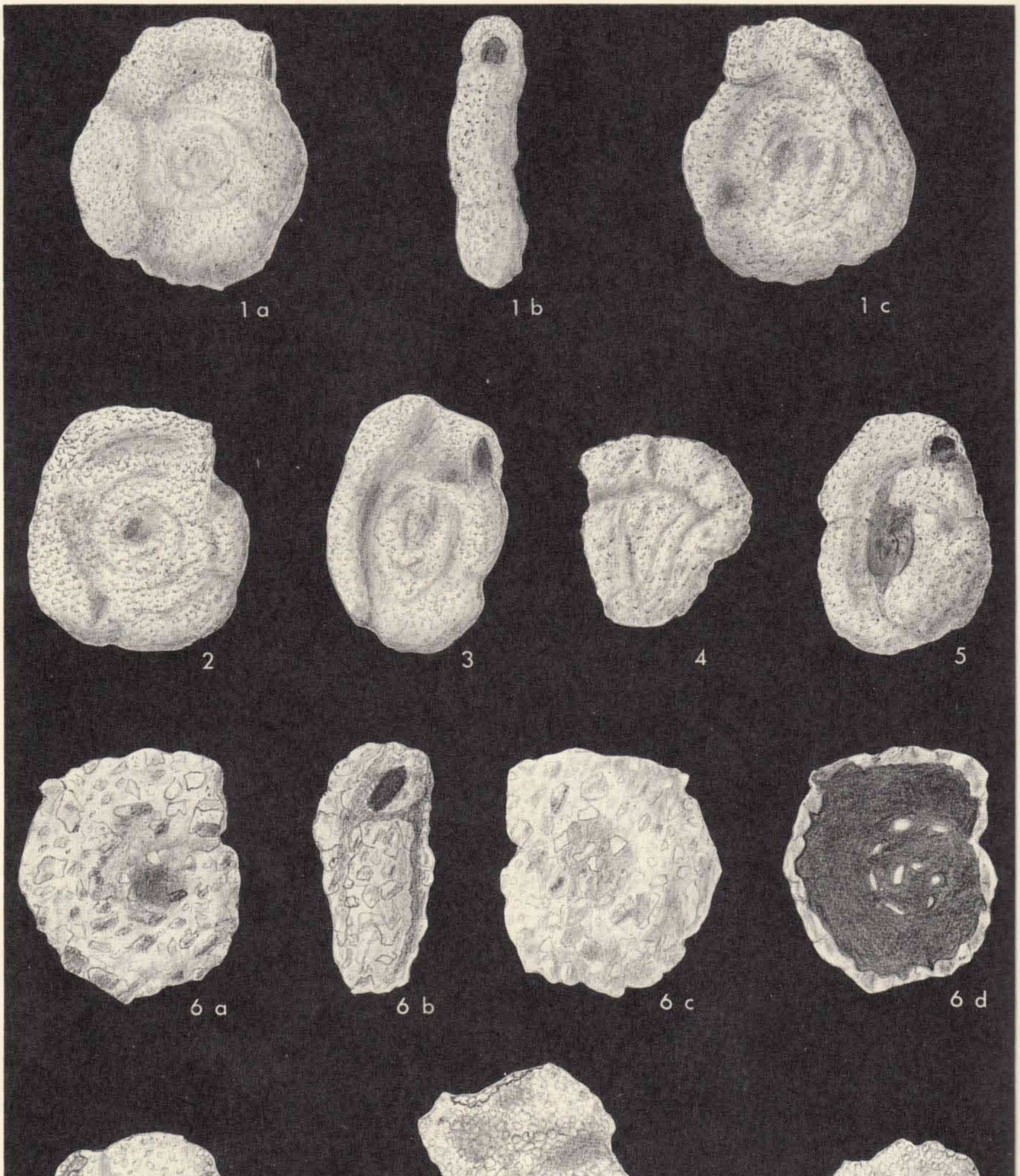
Poag: New *Arcanispira* from Florida Miocene



Guliov: Albian Foraminifera from Saskatchewan evolute, later portion uniserial but often not well developed, compressed; periphery narrowly rounded, weakly lobate; whorls 2 to 2½ in number; chambers weakly to moderately inflated in coiled portion, 5 to 7 in ultimate whorl, increasing rapidly in size; 2 to 3 chambers in uniserial portion, initial one usually considerably larger than last one in coiled portion; sutures broad, depressed, distinct in more inflated forms, indistinct in compressed forms; umbilicus rather narrow and moderately deep in more inflated forms, broad and shallow in compressed forms; test wall arenaceous, very coarse to medium grained, roughly finished; grains up to 0.21 mm. in diameter; cement abundant, brownish; aperture a terminal elongate opening in uniserial forms, a simple rounded or elongate opening at distal end of chamber in form without uniserial development, a peripheral opening in forms with incipient uniserial development.

Dimensions.—Maximum diameter of coiled portion of holotype 0.82 mm. Minimum diameter of holotype 0.70 mm. Thickness of holotype 0.33 mm. Maximum and minimum diameters of the coiled portion of the paratypes are from 0.45 mm. to 0.90 mm. and 0.41 mm. to 0.74 mm. respectively.

Types.—Holotype G.M.U.S. Pf 56 was taken from the International Yarbo 17S borehole, which is to be regarded as type locality, 1226-1228 feet below the Kelly bushing elevation of 1893 feet above sea level or 20 to 22 feet above the base of the Joli Fou Formation. Nine paratypes are established and range in number from G.M.U.S. Pf 57 to G.M.U.S. Pf 65. Paratypes G.M.U.S. Pf 57 to 61 and G.M.U.S. Pf 64 and 65 were collected from the International Yarbo 17S borehole from a depth of 1226 to 1228 feet below the Kelly bushing. Paratypes G.M.U.S. Pf 63 and 62 were collected respectively from the Potash Company of America Saskatoon No. 2 borehole in Lsd. 6, Twp. 16, Sec. 36, R. 3 W3rd meridian from a depth of 1588 to 1590 feet below the Kelly bushing elevation of 1740 feet above sea level, and from the Saskatchewan Power Corporation Regina 9-27 borehole in Lsd. 9, Twp. 27, Sec. 16, R. 20 W2nd meridian from a depth of 2483 to 2490 feet below the Kelly bushing elevation of 1893 feet above sea level.

Discussion.—*Ammomarginulina asperata* strongly resembles *Ammobaculites texanus* Cushman (1946). However the former is evolute throughout its early stage whereas the latter becomes evolute only in the late stage of coiling. The former is generally much smaller than the latter. *Ammobaculites texanus* is a much later (Maastrichtian) species than *Ammomarginulina asperata.*

Ammobaculites subplanatus Cushman and Deaderick (1942, p. 52, pl. 9, figs. 10, 11) resembles the new species in general appearance and size, but it is less strongly evolute and does not display the abrupt increase in chamber size in the initial part of the uniserial portion. *Ammobaculites subplanatus* was recovered from rocks of Santonian age.

Ammobaculites goodlandensis Cushman and Alexander (1930, p. 8, pl. 2, figs. 7, 8), an Albian species from Oklahoma, bears some resemblance in general appearance to the new species. It differs in that it is less inflated, with a larger number of chambers in the last whorl, more broadly umbilicate, more closely coiled, and finer grained.

Ammomarginulina asperata is characteristic of the lower part of the Joli Fou Formation. The holotype was found in direct association with *Inoceramus comancheanus* thus supporting a late Middle Albian age. About one hundred and twenty specimens were collected and examined. The specific name of the new species is derived from the Latin *asperata* = made rough — a reference to the common appearance of the test wall.

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EXPLANATION OF PLATE 12

FIGS.		PAGE
1.	*Ammodiscus anthosatus* Guliov n. sp. Holotype G.M.U.S. Pf 46. a, side view; b, apertural view; c, side view, × 65.	142
2-5.	*Ammodiscus anthosatus* Guliov n. sp. Paratypes. 2, side view of specimen G.M.U.S. Pf 48, × 69; 3, side view of specimen G.M.U.S. Pf 51, × 54; 4, side view of specimen G.M.U.S. Pf 54 × 66; 5, side view of specimen G.M.U.S. Pf 55, × 62.	142
6.	*Ammomarginulina asperata* Guliov n. sp. Holotype G.M.U.S. Pf 56. a, side view; b, apertural view; c, side view; d, side view in transmitted polarized light, × 43.	142
7-9.	*Ammomarginulina asperata* Guliov n. sp. Paratypes. 7, side view of specimen G.M.U.S. Pf 62, × 50; 8, side view of specimen G.M.U.S. Pf 63, × 43; 9, side view of specimen G.M.U.S. Pf 59, × 43.	142

Figures are camera lucida drawings by author.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
Volume XVII, Part 4, October, 1966

325. UNRECORDED FORAMINIFERA FROM THE LITTORAL OF PUERTO DESEADO[1]

Esteban Boltovskoy[2] and Haydée Lena[3]

ABSTRACT

The Foraminifera were studied from very rich material collected during four years from the intertidal zone of Deseado Harbor. Thirty-two species, each represented by very few specimens, were identified in addition to the 44 from the same area described in the senior author's preceding paper (Boltovskoy, 1963). Representatives of eight species contained protoplasm.

Three years ago Boltovskoy (1963) published a paper on the littoral foraminiferal biocoenoses of Deseado Harbor (Patagonia, Argentina) in which several biological, zoogeographical and taxonomical conclusions were drawn. It was the result of a study of 42 bottom samples collected in the intertidal zone in the vicinity of Deseado Harbor. Forty-four species were identified, representations of 28 of them containing protoplasm and presumably alive when collected. Since then very rich additional material of the following origin and nature has also been studied by us:

a) For two years (1961-1963) samples of about 700-725 grams of bottom sediments gathered near the "Dos Hermanas" rocks were obtained weekly for a study of seasonal variations in the foraminiferal population (Boltovskoy, 1964). Although the known species were initially studied in this material, each time an unknown foraminifer was found it was set aside for the present study.

b) During 1964-1965 bottom samples were collected each week from another locality ("Isla Quinta") to carry out the same study with other foraminiferal species. The material was thoroughly checked and all species previously unrecorded were also reserved for the present study.

c) Finally, large quantities of material were collected by students who came in February every year to participate in a course in marine biology. All this material was carefully checked by us for the same purpose.

The abundance of samples obtained after the first account was published explains why we were able to discover 32 additional species, thereby enlarging the total list of the foraminifera of Deseado Harbor to 76 species. The 32 additional species are represented only by isolated specimens not previously encountered. Only two species, namely *Glomospira perplexa* and *Ovammina sp. "A,"* were represented by more or less sizable numbers of specimens, but each has a very distinctive biotope, the first species being found only near "Isla Quinta," the second almost exclusively in tidal pools situated near Cavendish Rocks. The small number of specimens found also explains the small percentage of species containing protoplasm, only the following 8 out of the 32: *Bolivina striatula, Glomospira perplexa, Guttulina problema, Haplophragmoides weddellensis, Nodosaria calomorpha, Ovammina sp. "A," Trochammina* cf. *T. helgolandica* and *Tubinella funalis.*

It is interesting to note that a study of the additional material enabled us to check all the previous identifications, which were found to be correct with but a single exception. The species determined in the preceding paper by Boltovskoy (1963) as *Trochammina macrescens* should be considered as *Jadammina polystoma.* This error is explained by the fact that among the population of *Jadammina polystoma* of Deseado Harbor there are some specimens which do not possess the supplementary apertures. A specimen found in that condition was the one described in the preceding paper.

Since this communication should be considered as a supplement to the paper published in 1963, we have given neither a description of the species nor an extensive synonymy of them. Only the original reference for each species and, where necessary, some brief notes have been included. A single exception was made for *Trochammina sp. "A"* and for *Avammina sp. "A,"* since these probably represent new species.

The following species, alphabetically listed, are not found in the previous paper by Boltovskoy (1963):

1. *Ammodiscus gullmarensis* Höglund, 1947. Plate 13, figure 1.

    1947 *Ammodiscus planus* Höglund, Gullmar, p. 123, pl. 8, figs. 2, 3, 8; pl. 28, figs. 17, 18; textfigs. 85-89, 105, 106, 109 [emend Höglund, 1948].

2. *Ammovertella* cf. *A. persica* Oberhauser, 1960. Plate 13, figure 23.

    cf. 1960 *Ammovertella persica* Oberhauser, Trias Persien, p. 14, pl. 6, figs. 20-22.

    The spire is not as regular as the description and figure of *A. persica* given by Oberhauser suggest. This circumstance forced us to identify the foraminifer only tentatively.

---

[1] Contribution N° 32 of the Puerto Deseado Marine Biological Station.

[2] Museo Argentino de Ciencias Naturales "B. Rivadavia," Buenos Aires, and Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina.

[3] Museo Argentino de Ciencias Naturales "B. Rivadavia."

3. *Bolivina difformis* (Williamson), 1858. Plate 13, figure 2.
   1858 *Textularia variabilis* var. *difformis* WILLIAMSON, Foram. Brit., p. 77, pl. 6, figs. 166, 167.

4. *Bolivina striatula* Cushman, 1922. Plate 13, figure 3.
   1922 *Bolivina striatula* CUSHMAN, Tortugas, p. 27, pl. 3, fig. 10.

5. *Cassidulina crassa* d'Orbigny, *forma minuta* Cushman, 1933. Plate 13, figure 5.
   1933 *Cassidulina minuta* CUSHMAN, New Rec. Foram. Tropic. Pacif., p. 92, pl. 10, fig. 3.

6. *Cibicides altocameratus* (Heron-Allen and Earland), 1922. Plate 13, figure 33.
   1922 *Truncatulina tenuimargo* Brady var. *alto-camerata* HERON-ALLEN and EARLAND, Terra Nova, p. 209, pl. 7, figs. 24-27.

7. *Cornuspira planorbis* Schultze, 1854. Plate 13, figure 6.
   1854 *Cornuspira planorbis* SCHULTZE, Organ. Polyth., p. 40, pl. 2, fig. 21.

8. *Cribrostomoides columbiense robustum* (Cushman and McCulloch), 1939. Plate 13, figure 34.
   1939 *Haplophragmoides columbiense* Cushman var. *evolutum* CUSHMAN and MCCULLOCH, Allan Hancock Exp., p. 73, pl. 5, figs. 11, 12; pl. 6, fig. 2 [emend Cushman and McCulloch, 1948].

9. *Discorbis valvulatus* (d'Orbigny), 1840.
   1840 *Rosalina valvulata* D'ORBIGNY, Cuba, p. 103, pl. 3, figs. 21-23.

10. *Fissurina laureata* (Heron-Allen and Earland), 1932. Plate 13, figure 4.
    1932 *Lagena laureata* HERON-ALLEN and EARLAND, Discovery, p. 382, pl. 11, figs. 37-40.

11. *Glomospira perplexa* Franke, 1936. Plate 13, figure 17.
    1936 *Glomospira perplexa* FRANKE, Deutschen Lias, p. 18, pl. 1, fig. 12.

The specimens found appear to fit Franke's description and figure very well, although this species was originally described from the Lias.

12. *Guttulina problema* d'Orbigny, 1826. Plate 13, figure 10.
    1826 *Guttulina problema* D'ORBIGNY, Tabl. Méth., p. 266, No. 14.

13. *Haplophragmoides weddellensis* Earland, 1936. Plate 13, figure 9.
    1936 *Haplophragmoides weddellensis* EARLAND, Weddell Sea, p. 33, pl. 1, figs. 15, 16.

This species seems to be identical with the type, except in size; our specimens are somewhat coarsely agglutinated.

14. *Heronallenia kempii* (Heron-Allen and Earland), 1929.
    1929 *Discorbis kempii* (HERON-ALLEN and EARLAND), New Foram. S. Atlant., p. 332, pl. 4, figs. 40-48.

Only young and isolated specimens have been encountered.

15. *Jadammina polystoma Bartenstein* and Brand, 1938. Plate 13, figures 20, 21.
    1938 *Jadammina polystoma* BARTENSTEIN and BRAND, Jade-Gebiet, p. 381, Text-figs. 1-3.
    1963 *Trochammina macrescens* Brady, BOLTOVSKOY, Puerto Deseado, p. 64, pl. 7, fig. 21.

The walls of the majority of specimens found were collapsed, but in several they were not. Another interesting feature observed in some tests is the presence of a lobe, in the last chamber, which covers the umbilicus. The supplementary apertures on the septal face are not only rather different in size, place and number, but are sometimes completely lacking.

16. *Lagena aspera* Reuss, 1861. Plate 13, figure 7.
    1861 *Lagena aspera* REUSS PALÄONT. Beitr., p. 305, pl. 1, fig. 5.

17. *Lagena striata* (d'Orbigny), 1839. Plate 13, figure 13.
    1839 *Oolina striata* D'ORBIGNY, Amér. Mérid., p. 21, pl. 5, fig. 12.

18. *Nodosaria calomorpha* Reuss, 1865. Plate 13, figure 11.
    1865 *Nodosaria calomorpha* REUSS, Foram. Anthoz. Bryoz., p. 129, pl. 1, figs. 15-19.

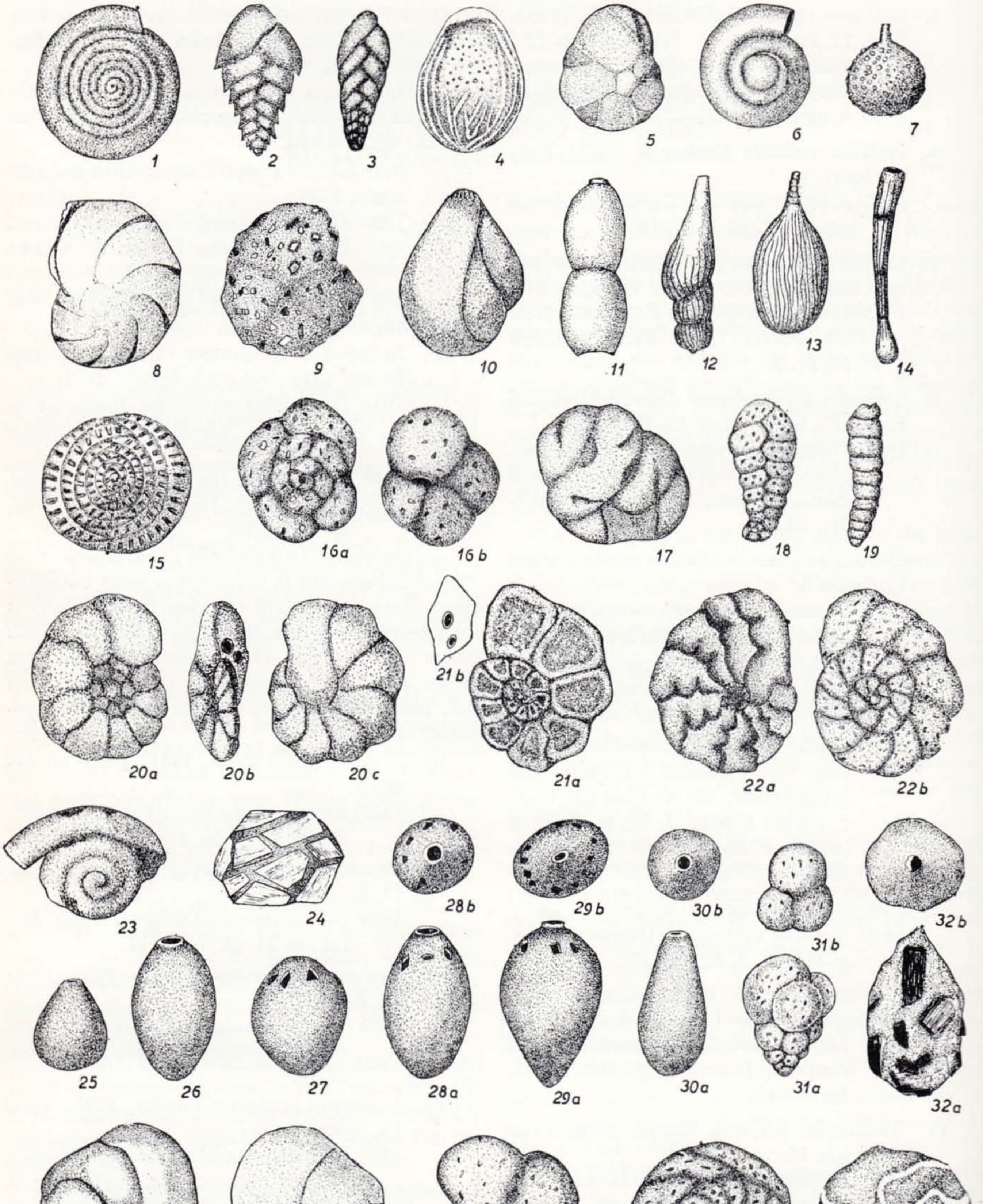
19. *Nodosaria scalaris* (Batsch), 1791. Plate 13, figure 12.
    1791 *Nautilus (Orthoceras) scalaris* BATSCH, Concyl. Seesand., No. 4, pl. 2, fig. 4.

Only one single abnormal depauperate test —similar to those found in the gulf of San Jorge (Boltovskoy, 1954, p. 146, pl. 5, figs. 14-17)—has been found.

20. *Notorotalia clathrata* (Brady), 1884.
    1884 *Rotalia clathrata* BRADY, Challenger, p. 709, pl. 107, figs. 8, 9.

21. *Ovammina sp. "A."* Plate 13, figures 25-30.

A monothalamous foraminifer with a shell that is soft when moistened, but that does not col-



Boltovskoy and Lena: Argentinian Littoral Foraminifera lapse at drying. Shape irregularly ovoid (Plate 13, fig. 29), fusiform (Plate 13, figs. 26, 28) or sometimes nearly droplike (Plate 13, figs. 25, 30); in cross section circular (Plate 13, figs. 28b, 30b) or somewhat ovoidal (Plate 13, fig. 29b). Walls single-layered, poreless, very finely agglutinated, white-grayish, without calcareous cement. Aperture a simple rounded orifice without apertural apparatus, but some specimens with a very short collar (Plate 13, fig. 20). Several specimens with numerous (usually 6-12) irregular large pores situated around the aperture (Plate 13, figs. 27-29). [According to Dahlgren (personal communication), these pores occur only in connection with gametogenesis, and, consequently, could be observed only on gamonts and on those which are going to produce gametes.] Length, 0.24-0.50 mm.

The taxonomic position of this species is not completely clear to us. The nearest species is undoubtedly *Ovammina opaca* Dahlgren. However, the character of the aperture of our specimens, as well as their single-layered walls restrain us at present from considering our specimens as belonging to this species. We sent several specimens to Dr. Dahlgren and he very kindly agreed to compare them with his material, to study them and, if possible, to determine their taxonomic position.

Ovammina sp. "A" has been found living mainly in the tidal pools near Cavendish Rocks. In the same pools many specimens of *Pyrgo quadrata* (Heron-Allen and Earland) and small irregular Miliolidae have also been found. Moreover, some isolated specimens of *Ovammina sp. "A"* were found elsewhere. The most characteristic ecological feature of the tidal pools mentioned is their rapid change, particularly as regards temperature and pH; owing to evaporation, their salinity is sometimes much higher than normal.

22. *Patellina corrugata* Williamson, 1858. Plate 13, figure 15.

1858 *Patellina corrugata* WILLIAMSON, Foram. Brit., p. 46, pl. 3, figs. 86-89.

EXPLANATION OF PLATE 13

(The size of each hypotype is given in parentheses)

FIGS.		PAGE
1.	*Ammodiscus gullmarensis* Höglund (0.19 mm.).	144
2.	*Bolivina difformis* (Williamson) (0.25 mm.).	145
3.	*Bolivina striatula* Cushman (0.49 mm.).	145
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23. *Psammosphaera bowmanni* Heron-Allen and Earland, 1912. Plate 13, figure 24.
    1912 *Psammosphaera bowmanni* HERON-ALLEN and EARLAND, Goldseeker, p. 385, pl. 62, figs. 5, 6; pl. 6, fig. 5.

24. *Robulus rotulatus* (Lamarck), 1804. Plate 13, figure 8.
    1804 *Lenticulites rotulata* LAMARCK, Fossil. Envir. Paris, p. 188, No. 3, pl. 62, fig. 11.

25. *Saccammina decorata* (Earland), 1933. Plate 13, figure 32.
    1933 *Proteonina decorata* EARLAND, S. Georgia, p. 62, pl. 1, figs. 28, 29.

26. *Spiroplectammina biformis* (Parker and Jones), 1865. Plate 13, figure 18.
    1865 *Textularia agglutinans* d'Orbigny var. *biformis* PARKER and JONES, N. Atlant. Arct., p. 370, pl. 13, figs. 23, 24.

27. *Trochammina* cf. *T. helgolandica* Rhumbler, 1938. Plate 13, figure 22.
    cf. 1938 *Remaneica helgolandica* RHUMBLER, Helgoland, p. 195, figs. 38-45.

28. *Trochammina plana discorbis* Earland, 1934. Plate 13, figure 16.
    1934 *Trochammina discorbis* EARLAND, Falkland Sect. Antarct., p. 104, pl. 104, figs. 28-31.

We interpret this foraminifer as a subspecies of *T. plana* Egger, found by Boltovskoy and Theyer (in press) on the other side of the South American Continent in Chilean waters.

29. *Trochammina sp. "A."* Plate 13, figure 35.

This is probably an undescribed foraminifer, but we prefer not to advance a new name until more material is available and studied. However, it is of interest to describe and illustrate it for future reference.

Test of median size, thin, plano-convex or trochospiral. The spire is very low and consists of 2.5-3 volutions, the last one with 10-13 chambers. Periphery carinate; chambers bent, elongate, trapezoidal. Sutures of the dorsal side plain or only slightly depressed. The ventral side is distinctive owing to radial ribs that connect the circular and deeply depressed umbilicus with the periphery. Near the periphery the ribs sometimes ramify irregularly or possess knots. Maximum diameter between 0.26 and 0.38 mm.

This species is very similar to *T. multiloculata* Höglund in chamber number, height of spire, and general outline, but differs in having the peculiar ribs on the ventral side.

30. *Tubinella funalis* (Brady), 1884. Plate 13, figure 14.
    1884 *Articulina funalis* BRADY, Challenger, p. 185, pl. 13, figs. 6-11.

31. *Turritellella shoneana* (Siddall), 1878. Plate 13, figure 19.
    1878 *Trochammina shoneana* SIDDALL, River Dee, p. 46, figs. 1, 2.

32. *Valvulina conica* (Earland), 1934. Plate 13, figure 31.
    1934 *Trochammina conica* EARLAND, Falklands Sect. Antarct., p. 10, pl. 3, figs. 47-49.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVII, PART 4, OCTOBER, 1966

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ALIJULLA, KH. O Sostojanii Izuchennosti Semejstva Heterohelicidae i Puti ego Dal'nejshego Izuchenija.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 215-228, 1 pl., text figs. 1-4 (phylogenetic chart, drawings).—Four species and 2 subspecies, all new.

AOKI, NAOAKI. Pliocene and Pleistocene Foraminifera from along the Yoro River, Boso Peninsula. Vertical faunal change.—Sci. Repts. Tokyo Kyoiku Daigaku, sec. C, v. 8, No. 78, June 25, 1963, p. 203-227, text figs. 1-6 (maps, columnar section, frequency charts, graphs), table 1.—Occurrence and abundance of nearly 300 benthonic and 25 planktonic species are indicated in 99 samples along the river. The section is subdivided into 16 zones that are described in terms of their Foraminifera species.

BACH, ILSE. Mikrofauna und Stratigraphie der Unterkreide im Gebiet des Kleinen Fallsteins bei Osterwieck.—Geologie, Zeitschr. Gesamtgebiet Geol. Wissenschaft., Berlin, Jahrg. 14, Beih. 51, Dec. 1965, p. 1-65, pls. 1-9, text figs. 1-3 (map, graphs), tables 1, 2.—Based on boring samples of Hauterivian, Barremian, Aptian, Albian, and early Cenomanian age. Chart shows occurrence and abundance of about 110 species of Foraminifera (of which 28 are illustrated).

BALAKHMATOVA, V. T. Novye Paleogenovye Foraminifery iz Severnoj Turkmenii.—Russia Vses. geol. instit., Trudy, n. ser., tom 115, Biostratigraficheskij Sbornik, vyp. 1, 1965, p. 126-134, pls. 1-3.—Six species (5 new) and 2 new subspecies and 1 new variety.

BARKER, R. WRIGHT. Notes on Miogypsinidae in the Gulf of Mexico region.—Dr. D. N. Wadia Commemorative Volume, Min., Geol. & Metall. Instit. India, Feb. 1965, p. 306-342, pls. 1-6, 2 text figs.—Includes an interesting historical summary of the family. Fourteen out of 21 American species are valid; 11 of them are present in the Gulf of Mexico region. A new species, *Miogypsina* (*Miogypsina*) *colei*, is described from the subsurface Anahuac formation of Louisiana.

BARR, F. T. The foraminiferal genus *Bolivinoides* from the Upper Cretaceous of the British Isles. —Palaeontology, v. 9, pt. 2, July 1966, p. 220-243, pls. 34-38, text-figs. 1-8 (zonation chart, map, columnar section, distrib. chart, phylogenetic diagram, graphs, drawings).—Nine species (3 new) are described and illustrated from Santonian to lower Maestrichtian. A lectotype is proposed for *B. decorata*.

BARTENSTEIN, HELMUT. Taxionomische Revision und Nomenklator zu Franz E. Hecht "Standard-Gliederung der Nordwest-deutschen Unterkreide nach Foraminiferen" (1938). Teil 4: Alb.—Senckenbergiana lethaea, Band 46, Nr. 4/6, Dec. 27, 1965, p. 327-366, text figs. 1-7 (drawings), tables 1-3.—A new genus is described: *Pseudosigmoilina* (type species *Quinqueloculina infravalanginiana* Bartenstein, 1962), and a new species: *Hedbergella aptiana*.

BERGER, W. H. Distinguishing juvenile Foraminifera in plankton samples by using biological dyes.—Jour. Paleontology, v. 40, No. 4, July 1966, p. 975-976.—Methylene blue added to wet samples tends to stain different species in different ways and to stain closely related species similarly.

BERGQUIST, HARLAN R. Micropaleontology of the Mesozoic rocks of northern Alaska.—U. S. Geol. Survey Prof. Paper 302-D, June 27, 1966, p. 93-227, pls. 13-24 (bar charts, correl. diagrams, stratig. distrib. tables), figs. 33-49 (map, photomicrographs, outcrop photo, correl. diagram), tables 1-16.—Summary of microfaunal examination of more than 15,000 samples (outcrop and subsurface). Six microfaunal zones are described: 2 in Albian, 1 in Cenomanian, 2 in Turonian, and 1 in Senonian. Details of distribution and abundance in over 40 test wells are tabulated. For 12 of the more significant species, variation within species and effects of deformation of specimens are well illustrated in photomicrographs of large groups.

BLONDEAU, ALPHONSE. Étude biométrique et statistique de *Nummulites laevigata* Bruguière dans les bassins de Paris et du Hampshire. Implications stratigraphiques.—Bull. Soc. Géol. France, ser. 7, tome VII, No. 2, 1965 (April 1966), p. 268-272, pl. 4, text figs. 1-3 (graphs).

BOLLI, HANS M. Zonation of Cretaceous to Pliocene marine sediments based on planktonic Foraminifera.—Bol. Informativo, Asoc. Venez. Geol., Min. y Petrol., v. 9, No. 1, Jan. 1966, p. 3-32, tables 1-4 (correl. charts, range chart). —Sixty planktonic zones between Aptian and Pliocene are useful in warm marine sediments,

and the restricted ranges of the 60 species are indicated.

BORSETTI, A. M. Una microfauna a *Globotruncana* del Flysch alloctono di Castel di Casio (Bologna).—Ann. Mus. Geol. Bologna, ser. 2, v. 32, fasc. 2, 1964, p. 667-685, pl. 79, text figs. 1-15, range chart.—Thirteen species of *Globotruncana* place the fauna in the Maestrichtian.

Microfaune del Langhiano Superiore nel "Macigno" di Lizzano in Belvedere (Appennino Bolognese).—Ann. Mus. Geol. Bologna, ser. 2, v. 33, fasc. 1, 1965, p. 131-142, pls. 13, 14, text fig. 1 (map).—Eleven planktonic species illustrated in thin section.

BROGLIO LORIGA, C., and MANTOVANI, M. G. Le biofacies del Cretacico della Valle del Vaiont (Belluno).—Riv. Ital. Pal. Stratig., v. 71, No. 4, Dec. 1965, p. 1225-1248, pls. 110-114, text figs. 1, 2 (photos).—Planktonic forams illustrated in section from 10 faunizones mostly in the Upper Cretaceous.

BRÖNNIMANN, PAUL, and ZANINETTI, LOUISETTE. Note sur *Lituola salsa* (Cushman et Brönnimann) 1948, un Foraminifère de la Mangrove de l'île de la Trinité, W. I.—Archives des Sciences, v. 18, fasc. 3, Sept.-Dec. 1965, p. 608-615, figs. 1-3 (drawings).—To transfer the species from *Haplophragmium* to *Lituola*.

BUGROVA, E. M. O Stroenii Stenki Rakovin Roda *Karreria* Rzehak.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 212-214, 1 pl., text fig. 1 (drawing).—On wall structure of *Karreria*.

BUKALOVA, G. V. Verkhneal'bskie Otlozhenija Mezhdurech'ja Beloj i Kubani, *in* Fauna Mezozoja i Kainozoja Evropejskoj Chasti SSSR i Srednej Azii, edited by N. T. SAZONOVA and E. K. SHUTHKOJ.—Moscow Vses. nauchnoissl. geol. neft. instit. (VNIGNI), Trudy, vyp. 44, 1965, p. 148-156, pl. 1.—Seven species and 1 subspecies of Lageninae from the upper Albian, all new.

BUTT, AFTAB A. Foraminifera of the type Turonian.—Micropaleontology, v. 12, No. 2, April 1966, p. 168-182, pls. 1-4, text figs. 1-5 (map, columnar sections), tables 1-3.—Fifteen species (2 new) and the new genus *Orostella* (type species *O. turonica* n. sp.) described.

BUZAS, MARTIN A. The discrimination of morphological groups of *Elphidium* (foraminifer) in Long Island Sound through canonical analysis and invariant characters.—Jour. Paleontology, v. 40, No. 3, May 1966, p. 585-594, pls. 71, 72, text fig. 1 (graph).—Canonical analysis of the external morphology of 4 groups of specimens of *Elphidium*—*E. incertum, E. incertum* of Cushman (not Williamson), *E. clavatum,* and *E. subarcticum*—suggests they fall into only 3 species (with *E. incertum* of Cushman being identical with *E. clavatum*). Presence or absence of 3 invariant characters—inner lining, radial wall and granular wall—also points to the existence of only 3 species.

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CASSITY, PAUL E., and LANGENHEIM, R. L., Jr. Pennsylvanian and Permian fusulinids of the Bird Spring Group from Arrow Canyon, Clark County, Nevada.—Jour. Paleontology, v. 40, No. 4, July 1966, p. 931-968, pls. 110-114, text figs. 1-6 (geol. map, columnar sections, zone chart), tables 1-29 (measurements).—Descriptions and illustrations of 32 species (8 new) and 1 subspecies from Atokan, Desmoinesian, Missourian, Virgilian, and Wolfcampian rocks.

CAVELIER, CLAUDE, and LE CALVEZ, YOLANDE. Présence d'*Arenagula kerfornei* (Allix), Foraminifère "biarritzien," à la partie terminale du Lutétien supérieur de Foulangues (Oise).—Bull. Soc. Géol. France, ser. 7, tome VII, No. 2, 1965 (April 1966), p. 284-286, text fig. 1 (geol. section).

CHAROLLAIS, JEAN, and BRÖNNIMANN, PAUL. Première note sur les Foraminifères du Crétacé inférieur de la région genevoise. *Sabaudia* Charollais et Brönnimann, n. gen.—Archives des Sciences, v. 18, fasc. 3, Sept.-Dec. 1965, p. 615-624, pls. 1-3, figs. 1-4 (drawings and thin section photo).—Type species *Textulariella minuta* Hofker, 1965. Genus closely related to *Pseudotextulariella* but differing in having a hyaline wall around the trochospire.

CHAROLLAIS, J., BRÖNNIMANN, P., and NEUMANN, M. Deuxième note sur les Foraminifères du Crétacé inférieur de la région genevoise. Signification stratigraphique et extension géographique de *Sabaudia minuta* (Hofker).—Archives des Sciences, v. 18, fasc. 3, Sept.-Dec. 1965, p. 624-642, figs. 1-4 (maps, columnar sections), table.—Occurrence of *S. minuta* in pelagic as well as in reefal environments aids in correlation between the two facies.

CIRY, RAYMOND, and AMIOT, MAURICE. Sur quelques Foraminifères Permiens d'Asie Centrale.

—Ital. Exped. to the Karakorum (K^2) and Hindu Kush, Sci. Repts., IV, 1965, p. 127-133, pl. 19.—Seven fusulinids, none new.

CITA, MARIA BIANCA. Jurassic, Cretaceous and Tertiary Microfacies from the southern Alps (northern Italy).—Internat. Sedimentary Petrographical Ser., vol. VIII, 1965, p. 1-99, pls. 1-117, text figs. 1-17 (local. maps, geol. maps, time scale, columnar sections, correl. tables, geol. sections) (available from E. J. Brill, publisher, Leiden, 110 guilders, cloth).—Book includes over 225 photomicrographs illustrating microfacies, many having specifically identified Foraminifera. Continuing the high quality of this series, the author discusses the stratigraphy and paleogeography of the region.

CONATO, VITTORIO. *Loxostoma beccarii,* nuova specie dell Pliocene Nord Appenninico.—Boll. Soc. Geol. Ital., v. 84, fasc. 2, 1965, p. 43-55, pl. 1, map.

CRESCENTI, UBERTO, and FOLLADOR, UMBERTO. Il Pleistocene a *Hyalinea balthica* (Schroeter) nella parte orientale dell'Italia centro-meridionale.—Boll. Soc. Geol. Ital., v. 84, fasc. 2, 1965, p. 57-59, fig. 1 (map).—Siz zones based on Foraminifera in the Plio-Pleistocene.

DESIO, A., CITA, M. B., and PREMOLI SILVA, I. The Jurassic Karkar Formation in north-east Afghanistan.—Riv. Ital. Pal. Stratig., v. 71, No. 4, Dec. 1965, p. 1181-1222, pls. 102-109, text figs. 1-5 (map, columnar sections, geol. section, drawings).—Includes 3 species of *Trocholina.*

DOLITHKAJA, I. V., and NIKITINA, JU. P. Sostojanie Izuchennosti i Puti Dal'nejshikh Issledovanij Semejstva Anomalinidae.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 198-211, text figs. 1-4 (phylogenetic charts, diagram, graph), 1 table.—Comparison of classifications of the family Anomalinidae.

DOUGLAS, ROBERT, and SLITER, WILLIAM V. Regional distribution of some Cretaceous Rotaliporidae and Globotruncanidae (Foraminiferida) within North America.—Tulane Studies in Geol., v. 4, No. 3, June 11, 1966, p. 89-131, pls. 1-5, text fig. 1 (map), tables 1, 2 (range chart, occurrence table).—Twenty-eight species (1 new and 2 indeterminate) described and illustrated, with their stratigraphic and geographic ranges indicated.

EL-NAGGAR, Z. R. Stratigraphy and classification of type Esna Group of Egypt.—Am. Assoc. Petroleum Geologists Bull., v. 50, No. 7, July 1966, p. 1455-1477, figs. 1-8 (maps, strat. sections, correl. chart, outcrop photos), table 1.—Planktonic zones used in subdivision of the Esna Group into a lower formation (Maestrichtian) and an upper formation (Paleocene).

FARINACCI, A. "Laffitteina marsicana," nuova specie di rotalide nel calcare Maastrichtiano a "Rhapydionina liburnica" di M. Turchio (Marsica).—Riv. Ital. Pal. Stratig., v. 71, No. 4, Dec. 1965, p. 1251-1262, pls. 115-117, text fig. 1 (drawings).

GAWOR-BIEDOWA, EUGENIA. The Upper Albian and Upper Cretaceous deposits of the Szczecin Synclinorium in the light of micropalaeontological examinations (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., tom 9, No. 4, 1965, p. 791-814, text figs. 1-3 (map, range charts).—Eighteen zones based on Foraminifera between upper Albian and upper Maestrichtian.

GOLEV, B. T. Zur Frage der Morphologie und Systematik der Unterfamilie Nummulitinae.—Zeitschr. Deutschen Geol. Gesellschaft, Jahrg. 1964, Band 116, Teil 2, Hannover, Oct. 1965, p. 521-543, pls. 1-3, text figs. 1-5.—Detailed morphology of *Operculina, Nummulites,* and *Assilina* is shown diagrammatically.

GRETCHISHNIKOVA, E. V. Foraminifery iz Kampanskikh i Maastrikhtskikh Otlozhenij Nizov'ev Amu-Dar'i, *in* Fauna Mezozoja i Kainozoja Evropejskoj Chasti SSSR i Srednej Azii, edited by N. T. SAZONOVA and E. K. SHUTHKOJ.—Moscow Vses. nauchno-issl. geol. neft. instit. (VNIGNI), Trudy, vyp. 44, 1965, p. 160-177, pls. 1-6.—Sixteen species (1 new) and 3 subspecies from Campanian and Maestrichtian.

GUHA, D. K., MOHAN, MADAN, KUMAR, P., IYENGAR, KM. R., and RAJU, D. S. N. Marine Neogene microfauna from Karikal, South India.—Bull. Geol., Min. and Metall. Soc. India, No. 34, Sept. 1965, p. 1-13, pls. 1-3, text fig. 1 (map).—Illustration of Burdigalian and Aquitanian smaller and larger Foraminifera and ostracodes.

GUILLAUME, SOLANGE, and SIGAL, JACQUES. Le stratotype du Barremien. II. Les Foraminifères.—Mem. Bureau de Recherches Géol. et Min., No. 34, Colloque Crétacé inférieur (Lyon, Sept. 1963), 1965, p. 117-129, text fig. 4 (zone chart), tables 1, 2 (illustrated range charts).—Ranges of numerous species in two sections that extend from upper Hauterivian through Barremian into Bedoulian are represented diagrammatically and the species are illustrated.

GULJAEV, P. V. O Mineralogicheskom Sostave i Strukture Stenki Rakovin Thiklammin.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 83-88, pls. 1-3, 1 table.—On mineralogy of *Cyclammina.*

GUNG FU-SHEN. Neskol'ko Novykh Vidov Fuzulinid iz Verkhnej Permi Ganthze Uezda Pintan Prov. Gujchzhou (in Chinese with Russian summary).—Acta Palaeont. Sinica, v. 14, No. 1, Feb. 1966, p. 80-90, pl. 1.—Five new fusulinid species from the Upper Permian. *Haoella* n. gen. (type species *H. sinensis* sp. nov.) erected in the Staffellinae.

HAMAOUI, M. Biostratigraphy of the Cenomanian type Hazera Formation.—Israel Geol. Survey, Stratigraphic sections No. 2b, 1965, p. 1-27 (mimeo.), pls. 1-15, charts 1-4 (distrib. and abund. charts, range chart, correl. chart).—Seven biostratigraphic units are distinguished by their fossil remains (mostly Foraminifera). Many Foraminifera are illustrated, some as free individuals and some in thin section; mostly identified only to genus. A few new genera and new species are named: *Biconcava bentori* nov. gen., nov. sp.; *Biplanata* nov. gen.; *Deuterospira pseudodaxia* nov. gen., nov. sp.; *Laterostoma* nov. gen.; *Merlingina cretacea* nov. gen., nov. sp.; *Pterammina israelensis* nov. gen., nov. sp.; *Spirolinoides* nov. gen.; and *Trochospira avnimelechi* nov. gen., nov. sp. In addition, 3 new species are named.

HEDLEY, R. H. Appendix [to paper by K. B. LEWIS]. Cytological notes on *Syringammina tasmanensis*.—New Zealand Jour. Sci., v. 9, No. 1, March 1966, p. 123-124, fig. 1 (photo of thin section).—Protoplasm was observed in a slender organic tube found inside the agglutinated tube. Pockets of waste material (stercomata) are stored within the agglutinated tube, plastered against its inner wall. Undecomposed protoplasm was observed within captured planktonic foraminifers that had been recently incorporated into the test wall.

HEEZEN, BRUCE C., GLASS, BILL, and MENARD, H. W. The Manihiki Plateau.—Deep-Sea Research, v. 13, No. 3, June 1966, p. 445-458, text figs. 1-12 (map, profiles, diagrams, graphs, sea-floor photographs, core photographs), tables 1-3.—Extinction of *Globigerinoides sacculifera fistulosa* in 4 cores from the plateau, at 550 to 710 cm. below the surface.

HIGUCHI, YU. On some new species of fossil Foraminifera from the boring cores in the gas field in Chiba Prefecture, Japan.—Trans. Proc. Palaeont. Soc. Japan, new ser., No. 60, Dec. 20, 1965, p. 178-181, pl. 21, fig. 1 (map).—Four new species described and illustrated from the Pliocene.

HO JAN, HU LAN-IN', and WANG KE-LJAN. Chetvertichnye Foraminifery Vostochnoj Chasti Provinthii Thzjansu Kitaja (in Chinese with Russian summary).—Mem. Instit. Geol. Paleont., Acad. Sinica, No. 4, 1965, p. 51-162, pls. 1-16.—Illustrated systematic catalog includes 154 species (20 new and 15 indeterminate and 1 given a new name) and 9 subspecies (6 new) from the Quaternary of the eastern part of Kiang-su province. Two new genera are erected: *Stomoloculina multangula* gen. et sp. nov. in the Nonionidae and *Rectoelphidiella lepida* gen. et sp. nov. in the Elphidiidae.

HUANG, TUNYOW. *Asanonella shojii* n. gen., n. sp. (fam. Discorbidae) from Tokunoshima, Kagoshima Prefecture, Japan.—Trans. Proc. Palaeont. Soc. Japan, new ser., No. 60, Dec. 20, 1965, p. 166-171, pl. 20, fig. 1 (map).—From the Plio-Pleistocene, similar to "*Truncatulina tubulifera*" in having dorsal tubules, but differing in having an apertural tooth.

IRELAND, H. A. Silurian arenaceous Foraminifera from subsurface strata of northeastern Kansas.—Micropaleontology, v. 12, No. 2, April 1966, p. 215-234, pl. 1, text figs. 1, 2 (map, diagrams), tables 1-5.—Foraminifera and acid residues of oil well samples are used to extend correlation northward and westward, to divide the Hunton group into 2 Devonian and 5 Silurian zones, and to recognize unknown faults. Twenty species (2 new) and the new genus *Hyperbathoides* (type species *H. schwalmi* n. sp.) are described from the Niagaran part of the Silurian.

JENKINS, D. GRAHAM. Planktonic foraminiferal zones and new taxa from the Danian to lower Miocene of New Zealand.—New Zealand Jour. Geology and Geophysics, v. 8, No. 6, Dec. 1965, p. 1088-1126, text figs. 1-15 (map [1], range and correl. chart [2], pls. of drawings [3-15]).—Fourteen planktonic zones between Danian and lower Miocene are set up for the New Zealand section and correlated with the Trinidad zonation. Ranges in New Zealand are shown for 103 planktonic species. Twelve species (11 new) and 3 subspecies are described and illustrated. The new genus *Pseudogloboquadrina* (type species *Globoquadrina primitiva* Finlay) is regarded as a middle Eocene homeomorph of the Miocene *Globoquadrina*.

KAHLER, FRANZ and GUSTAVA. Fusulinida (Foraminiferida), Teil 1.—Fossilium Catalogus. 1: Animalia, Pars 111, s'Gravenhage, March 15, 1966, 254 p.

KALMYKOVA, M. A. Revizija Grupp *Pseudofusulina vulgaris* i *Pseudofusulina kraffti* (po topotipicheskim materialam).—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 111-128, pls. 1-4, map, 1 table.—Five species of *Pseudofusulina*.

KAUFFMAN, A. E., and ROTH, R. I. Upper Pennsylvanian and Lower Permian fusulinids from north-central Texas.—Spec. Publ. No. 8, Cushman Found. Foram. Res., June 17, 1966, p. 1-49, pls. 1-11, text figs. 1, 2 (map, columnar sections), table 1 (check list).—Twenty-nine species (14 new and 3 indeterminate) and 2 new subspecies.

KENNETT, JAMES P. The *Globorotalia crassaformis* bioseries in north Westland and Marlborough, New Zealand.—Micropaleontology, v. 12, No. 2, April 1966, p. 235-245, pls. 1, 2, text figs. 1-10 (map, graphs, drawings), tables 1-6.—*Globorotalia conomiozea* n. sp. connects *G. miozea* with *G. crassaformis* in an upper Miocene to Pliocene bioseries.

Foraminiferal evidence of a shallow calcium carbonate solution boundary, Ross Sea, Antarctica. —Science, v. 153, No. 3732, July 8, 1966, p. 191-193, figs. 1, 2 (percentage charts).—Most calcareous faunas are restricted to depths shallower than 550 meters and the dominantly noncalcareous faunas to depths deeper than 430 meters.

KORCHAGIN, V. I. Vidy Roda *Nonionella* iz Verkhnemelovykh Otlozhenij Tadzhikskoj Depressii. —Akad. Nauk Tadzhikskoi SSR, Otdel. Fiziko-Tekhnicheskikh i Khimicheskikh Nauk, Izvestiia, No. 2 (18), 1965, p. 78-90, pl. 1.—A new species of *Valvulineria*? and 6 of *Nonionella* (4 new) from the Upper Cretaceous.

LEVEN, EH. JA. O Statigraficheskom Znachenii Roda *Polydiexodina* Dunbar et Skinner, 1931. —Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 129-146, pls. 1-6, text figs. 1, 2 (sketch, columnar sections), tables 1-3.—Twenty-one fusulinid species (4 new and 6 indeterminate).

LEWIS, K. B. A giant foraminifer: a new species of *Syringammina* from the New Zealand region. [See also Appendix to this paper by R. H. HEDLEY.]—New Zealand Jour. Sci., v. 9, No. 1, March 1966, p. 114-123, figs. 1-8 (photos, drawings, and diagrams of specimens). —Six specimens dredged from Challenger Plateau; size up to 44 mm. A fragile hemispherical mass of anastamosing tubes made up mostly of cemented-together tests of pelagic foraminifers.

LIDZ, LOUIS. Planktonic Foraminifera in the water column of the mainland shelf off Newport Beach, California.—Limnology and Oceanography, v. 11, No. 2, April 1966, p. 257-263, text figs. 1-7 (local. map, distrib. maps).—*Globigerina bulloides* and *G. quinqueloba* predominate (more than 90%), but are accompanied by rare specimens of dextral *G. pachyderma* and living *Bolivina vaughani*, both probably related to upwelling. A greater total of planktonic tests coincides with the area of upwelling from the Newport Submarine Canyon and the Orange County Sewer outfall.

LIDZ, LOUIS, and LIDZ, BARBARA. Foraminiferal biofacies of Veracruz reefs.—Am. Assoc. Petroleum Geologists Bull., v. 50, No. 7, July 1966, p. 1514-1517, figs. 1, 2 (maps).—A mixture of two assemblages: *Ammonia beccarii* group and *Elphidium*-miliolid group.

LOEP, KENNETH J. A study of ecology and distribution of Recent Foraminifera in the northwest Gulf of Mexico.—Trans. Gulf Coast Assoc. Geol. Soc., v. 15, 1965, p. 167-177, text figs. 1-3 (map, graph, profiles), tables 1, 2.—Based on 8 samples from beach and nearshore environments, continental shelf, Stetson Bank, and continental slope.

MARGEREL, JEAN-PIERRE. Les petits Foraminifères des sables du Bois-Gouët (Loire-Atlantique). —Bull. Soc. Sci. Nat. Ouest France, tome 63, 1966, p. 13-21, pls. 1-3.—A list of 147 species from the upper Lutetian. Ten are illustrated; 4 are new.

MAYNC, WOLF. Microbiostratigraphy of the Jurassic of Israel.—Israel Geol. Survey Bull. No. 40, March 1966, p. 1-56, pls. 1-15 (1-8, forams; 9, 10, ostracodes; 11-15, rock classification table, correl. charts), tables 1-3.—Foraminifera listed and illustrated in thin section and as free specimens from 6 zones between Domerian and upper Oxfordian.

MCLEAN, JAMES D., JR. Miocene and Pleistocene Foraminifera and Ostracoda of southeastern Virginia.—Virginia Div. Min. Res., Rept. Invest. 9, 1966, p. 1-79, text figs. 1-7 (correl. diagrams, check lists), local. map, tables 1-5 [Part 1—Text]; p. 1-123, pls. 1-19 [Foraminifera], 20-23 [Ostracoda], table 1 [Part 2—Taxonomy and fossil plates].—The study is based on material from numerous wells and outcrops. The Foraminifera section includes over 125 species and subspecies (2 species and 2 subspecies new and 27 indeterminate), and most are illustrated. Species useful in recognition of the Miocene formations—Yorktown, St. Marys, Choptank, and Calvert—are recorded.

MEHES, K. *Orbitolina* studies in Hungary (English summary of Hungarian text).—Ann. Rept. Hungarian Geol. Instit. of 1963, 1965, p. 95-106, pls. 8-13, text fig. 1 (diagram), 4 tables.—Illustrations of 8 species.

MIKLUHKO-MAKLAI, K. V. O Nekotorykh Osobennostjakh Foraminifer Kraevoj Chasti Kazanskogo Bassejna.—Russia Vses. geol. instit., Trudy, n. ser., tom 115, Biostratigraficheskij

Sbornik, vyp. 1, 1965, p. 114-121, pls. 1, 2, tables 1-3.—Includes thin-section illustrations of uniserial species.

MINATO, M., and HONJO, S. On *Colania kwangsiana* Lee.—Jour. Fac. Sci. Hokkaido Univ., ser. IV, Geol. & Min., v. 13, No. 1, Nov. 1965, p. 1-5, pl. 1, text fig. 1 (phylogenetic diagram).

MURRAY, J. W. The Foraminiferida of the Persian Gulf. Part 1. *Rosalina adhaerens* sp. nov. —Ann. Mag. Nat. Hist., ser. 13, v. 8, No. 86, Feb. 1965 (Dec. 31, 1965), p. 77-79, pl. 1, text figs. 1, 2 (graphs, map).

The Foraminiferida of the Persian Gulf. 2. The Abu Dhabi region.—Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier Publ. Co., Amsterdam, v. 1, No. 4, Dec. 1965, p. 307-332, text figs. 1-4 (maps, aerial mosaic, graph), tables 1-6.—A preliminary quantitative study based on 116 samples from an area of carbonate sedimentation: a hypersaline lagoon connected by a tidal channel to an oolith bank facing a deeper nearshore shelf. Though empty tests are abundant, live specimens are scarce and have restricted areas of occurrence. Many live attached to weeds and are thus not found in sediment samples.

The Foraminiferida of the Persian Gulf. 3. The Halat al Bahrani Region.—Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier Publ. Co., Amsterdam, v. 2, No. 1, March 1966, p. 59-68, figs. 1-3 (maps, graph), table 1.—Preliminary quantitative study based on 82 samples from an area of carbonate sedimentation around a barrier island and coral banks. Environments, populations (miliolids and peneroplids), and scarcity of living specimens are similar to those described in part 2.

MYERS, DONALD A. *Oketaella earglei,* a new fusulinid species, from the Adams Branch Limestone Member of the Graford Formation of Late Pennsylvanian age, Brown County, Texas. —U. S. Geol. Survey Prof. Paper 550-B, p. B47-B50, figs. 1, 2 (map, thin sections), table 1.

NORVANG, AKSEL. *Textilina* nov. gen., *Textularia* Defrance, and *Spiroplectammina* Cushman, (Foraminifera).—Biol. Skrifter Kon. Danske Vidensk. Selskab, Bind 15, nr. 3, 1966, p. 1-16, pls. I, II.—Because the type species of *Textularia* (*T. sagittula*) differs from almost all other species of *Textularia, Textilina* (type species *Textularia stricta* Cushman, 1911) is proposed for those having a perforated wall and an adventitious chamber adjoining the proloculus. The neotype selected for *T. sagittula* has an imperforate wall and a planispiral initial end. *Spiroplectammina* (type species *Textularia agglutinans* var. *biformis* Parker and Jones, 1865) differs from both *Textilina* and *Textularia* in having an arenitic rather than calcarenitic wall, and its relationship to *Bolivinopsis* still remains to be determined.

OMARA, S., and KENAWY, A. Upper Carboniferous microfossils from Wadi Araba, Eastern Desert, Egypt.—Neues Jahrb. Geol. Paläont. Abhandl., Stuttgart, Band 124, heft 1, March 1966, p. 56-83, pls. 8-11, text figs. 1-3 (maps, outcrop sketch).—Descriptions and illustrations of 36 species (9 new and 11 indeterminate) of mostly smaller Foraminifera, indicating correlation with the American upper Missourian-lower Virgilian.

PAPP, ADOLF. Discocyclinen von Holy vrch bei Kurdejov (Zdanice-Zone)—CSSR.—Vestnik Ustred. Ustavu Geol., roc. 41, cis. 3, 1966, p. 195, 196, map, diagram.

PHLEGER, FRED B. Patterns of marsh Foraminifera, Galveston Bay, Texas.—Limnology and Oceanography, v. 10, Supple., Nov. 1965, p. 169-184, text figs. 1-8 (maps, distrib. chart), tables 1, 2.—Based on 115 samples taken in 12 traverses in 6 marsh areas. About 20 species are involved and distinctive assemblages are found in 8 different environments. Living populations range from very small to very large, but living/total population rates are large.

PIRINI, C. Presenza di *"Orbitopsella praecursor"* (Gümbel) nella zona di Monte Marsicano (Abruzzo).—Riv. Ital. Pal. Stratig., v. 71, No. 4, Dec. 1965, p. 1169-1178, pls. 100, 101.

PISHVANOVA, L. S. New microfaunistic zone in Front-Carpathians (in Russian).—Bull. Moscow Soc. Naturalists, Geol. Ser., v. 41, pt. 2, 1966, p. 94-97, text figs. 1, 2.—*Globigerina bollii* zone recognized.

POJARKOV, B. V. Sistematika i Filogenija Roda *Mediocris* Rozovskaja, 1961—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 89-110, 1 pl., text figs. 1-6 (graphs, phylogenetic diagram), tables 1-7.—Seven species and 4 subspecies (2 new).

PRONINA, T. V., and CHUVASHOV, B. I. Ehvoljuthionnoe Razvitie, Sistematika, Paleoehkologija i Stratigraficheskoe Znachenie Semejstva Parathuramminidae.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 71-82, phylogenetic diagram.

RAT, PIERRE. Essai sur la répartition stratigraphique des divers types architecturaux du genre *Orbitolina* s.l.—Mém. Bureau de Recherches Géol. et Min., No. 34, Colloque Crétacé inférieur (Lyon, Sept. 1963), 1965, p. 531-532, diagram.—Progression toward a low flat form.

RAUZER-CHERNOUSOVA, D. M. Phasing and periodicity in the evolution of fusulinids.—Doklady Acad. Sci. USSR, Earth Sci. Sec., v. 160, Nos. 1-6, Am. Geol. Instit., translations, Nov. 1965, p. 57-59.

REITLINGER, E. A. Razvitie Foraminifer v Pozdnepermskuju i Rannetriasovuju Ehpokhi na Territorii Zakavkaz'ja.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 45-70, pls. 1, 2, text figs. 1-4 (diagrams), tables 1, 2. —From Late Permian and Early Triassic, 4 new genera: *Neoendothyra* (type species *N. reicheli* sp. nov.) in the Endothyridae; *Dagmarita* (type species *D. chanakchiensis* sp. nov.) and *Paraglobivalvulina* (type species *P. mira* sp. nov.) in the Biseriamminidae; and *Baisalina* (type species *B. pulchra* sp. nov.) in the Miliolidae.

RESIG, J. M. Foraminifera, Table VIII, *in* An Oceanographic and biological survey of the southern California mainland shelf.—California State Water Quality Control Board, Publ. No. 27, 1965, appendix, p. 340-350.—Species recorded by percentage from many stations taken on 9 shelf areas.

ROCHA, A. TAVARES, and UBALDO, M. LOURDES. Note on the Recent Foraminifera from the beach sands of Jampor (Damão) and Baga (Goa) (in Portuguese with English synopsis). —Garcia de Orta, Lisboa, v. 12, No. 4, 1964, p. 645-649, pls. 1, 2, text fig. 1 (map), check list.—Illustrations of 25 species, none new.

ROMANOVA, V. I. Paleontologicheskoe Obosnovanie Raschlenenija Verkhnejurskikh Otlozhenij Pripoljarnogo Urala.—Russia Vses. geol. instit., Trudy, n. ser., tom 115, Biostratigraficheskij Sbornik, vyp. 1, 1965, p. 105-113, map. —Foraminifera zones in the Upper Jurassic.

ROMEO, M. "Globigerina multiloba" nuova specie del Messiniano della Calabria e Sicilia.—Riv. Ital. Pal. Stratig., v. 71, No. 4, Dec. 1965, p. 1265-1268, pl. 118.—A minute (0.2 mm.) and many-chambered species.

SAIDOVA, KH. M. Foraminiferal bottom fauna of the Pacific (English summary of Russian text). —Okeanologija, tom 6, vyp. 2, 1966, p. 276-284, text figs. 1, 2 (graphs).

SAURIN, E. Foraminifères Namuriens de Tan-Lam (Province de Quang-Tri, Centre Viêt-Nam).—Vietnam Service Géol., Archives Géol. du Viêt-Nam, No. 6, 1964, p. 37-74, pls. 1-7.—About 60 species (3 new and 23 indeterminate).

SCHROEDER, ROLF. Les connaissances acquises sur les Orbitolinidae rencontrés dans le Crétacé inférieur du sud-ouest de l'Europe.—Mém. Bureau de Recherches Géol. et Min., No. 34, Colloque Crétacé inférieur (Lyon, Sept. 1963), 1965, p. 525-530, text fig. 1 (drawings).—Ranges indicated for 12 species and 2 subspecies in France and Spain.

SCHUTZKAJA, E. K. Filogeneticheskie Vzaimootnothenija Vidov Gruppy *Globorotalia compressa* Plummer v Datskom Veke i Paleothenovoj Ehpokhe.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 173-188, 1 pl., text figs. 1-5 (drawings), 1 table.—Five species (1 new) and 1 new subspecies of *Globorotalia* in the Danian and Paleocene.

SCHUTZKAJA, E. K., SCHVEMBERGER, JU. N., and CHASINA, G. I. Uploshchennye Globorotalii iz Verkhnepaleothenovykh i Nizhneeothenovykh Otlozhenij Kryma, Predkavkaz'ja i Zakaspija, *in* Fauna Mezozoja i Kainozoja Evropejskoj Chasti SSSR i Srednej Azii, edited by N. T. SAZONOVA and E. K. SHUTHKOJ.—Moscow Vses. nauchno-issl. geol. neft. instit. (VNIGNI), Trudy, vyp. 44, 1965, p. 192-202, pls. 1-4.—Seven species (2 new) and 2 subspecies of *Globorotalia* in the upper Paleocene and lower Eocene.

SCHVEMBERGER, JU. N. O Znachenii Napravlenija Navivanija u Rannepaleogenovykh Globorotalij Severnogo Kavkaza.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 189-197, text figs. 1, 2 (graphs), tables 1-3.—Species of *Globorotalia* in the Paleocene to middle Eocene.

SEIGLIE, GEORGE A. Notas sobre las familias Pegidiidae y Siphoninidae (Foraminiferida). Genero y especie nuevos.—Caribbean Jour. Sci., v. 5, No. 1-2, March-June 1965, p. 9-14, 1 pl.—One new genus (*Siphonidia* [type species *S. aurantiata* n. sp.]) and 3 new species from Los Testigos reefs are described and illustrated.

SIGAL, JACQUES. Présence d'un Foraminifère pélagique *Hedbergella washitensis* (Carsey) du domaine Méditerranéen dans l'Albien du bassin de Paris.—Mém. Bureau de Recherches Géol. et Min., No. 34, Colloque Crétacé inférieur (Lyon, Sept. 1963), 1965, p. 289-292.

État des connaissances sur les Foraminifères du Crétacé inférieur.—Mém. Bureau de Recherches Géol. et Min., No. 34, Colloque Crétacé inférieur (Lyon, Sept. 1963), 1965, p. 489-502, range chart.—Includes a chart showing ranges of 79 species.

Bibliographie sur les Foraminifères du Crétacé inférieur.—Mém. Bureau de Recherches Géol. et Min., No. 34, Colloque Crétacé inférieur (Lyon, Sept. 1963), 1965, p. 503-512.

SOLOVJEVA, N. N., and KRASHENINNIKOV, V. A. Nekotorye Obshchie Osobennosti Kompleksov Foraminifer i Stratigrafii Srednego Karbona

Afrikanskoj i Russkoj Platform.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 3-44, pls. 1-3, range chart, correl. table.—Twenty-nine Lower Carboniferous species (7 new).

SOSNINA, M. I. Nekotorye Permskie Fuzulinidy i Lagenidy Sikhote-Alinja.—Russia Vses. geol. instit., Trudy, n. ser., tom 115, Biostratigraficheskij Sbornik, vyp. 1, 1965, p. 142-159, pls. 1-5, 1 text fig.—Thirteen species of fusulinids, 2 of *Nodosaria* and 1 of *Dentalina,* all new, from the Permian.

SOUAYA, FERNAND JOSEPH. Miocene Foraminifera of the Gulf of Suez region, U.A.R. Part 3—Biostratigraphy.—Micropaleontology, v. 12, No. 2, April 1966, p. 183-202, text figs. 1-4 (correl. chart, map, distrib. and abund. chart, columnar sections).—In a study of smaller Foraminifera in 500 samples from 4 sections, 7 assemblage zones, 5 subzones and 10 zonules are defined and correlated with Burdigalian, Helvetian, and Tortonian.

Sakesaria cotteri, an early Eocene foraminifer from Egypt.—Jour. Paleontology, v. 40, No. 4, July 1966, p. 859-866, pl. 100, text-figs. 1-3 (map, columnar section, graphs).—First report from Egypt; described and illustrated.

STYK, OLGA. The Triassic foraminifers and ostracods in the southern part of the Swiety Krzyz Mts. (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., tom 9, No. 4, 1965, p. 737-744, tables 1, 2.

TAKAYANAGI, YOKICHI, and ŌBA, TADAMICHI. Stratigraphic change and significance of planktonic Foraminifera from the Oga Peninsula (in Japanese with English abstract).—Jour. Geol. Soc. Japan, v. 72, No. 1, Jan. 1966, p. 35-47, figs. 1-4 (maps, columnar sections, graphs), table 1. —Warm and cold alternations and tectonic changes of depth of deposition in the upper Miocene and Pliocene are recognized. Beds containing dextral *Globigerina pachyderma* indicate the influence of warm currents.

TER-GRIGORJANZ, L. S. Nekotorye Kharakternye Vidy Agglutinirovannykh Foraminifer iz Pogranichnykh Sloev Eothena i Oligothena Stavropol'ja, *in* Fauna Mezozoja i Kainozoja Evropejskoj Chasti SSSR i Srednej Azii, edited by N. T. SAZONOVA and E. K. SHUTHKOJ.—Moscow Vses. nauchno-issl. geol. neft. instit. (VNIGNI), Trudy, vyp. 44, 1965, p. 212-232, pls. 1-5, tables 1-3.—Twenty species (11 new) and 1 new variety of agglutinated genera in the Eocene and Oligocene.

TODD, RUTH, and LOW, DORIS. Foraminifera from the Arctic Ocean off the eastern Siberian coast. —U. S. Geol. Survey Prof. Paper 550-C, Aug. 9, 1966, p. 79-85, text fig. 1 (map), tables 1-4. —Based on 105 dredged samples from the shallow continental shelf (depths beween 10 and 55 meters), an impoverished fauna is reported. The distribution and abundance of about 60 species is shown in the Chukchi, East Siberian, and Laptev Seas. Brackish species are found off the mouths of large rivers.

TRIFONOVA, EK. *Nodosaria ordinata* sp. nov. from the Upper Triassic in Bulgaria.—Review Bulgarian Geol. Soc., v. 26, pt. 2, 1965, p. 213-216, pl. 1.—Constituting almost the entire association.

TRUNKO, LASZLO. Geologische Untersuchungen am Doberg bei Bünde und die Foraminiferen des Doberges bei Bünde und von Astrup (Cassidulinidae bis Nummulitidae).—Beih. geol. Jahrb., Hannover, Band 60, 1965, p. 7-42, 121-206, pls. 1, 2, 13-19 (outcrop photos, foram photos, geol. map, occur. and abund. chart), text figs. 1-10, 15-20 (geol. sections, graphs, foram drawings).—Occurrence and abundance in about 80 upper Oligocene samples are indicated for 60 species and subspecies (7 species and 4 subspecies new). Most are described and illustrated.

UJIIÉ, HIROSHI. Shell structure of Japanese smaller Foraminifera. Part 1. *Ammonia tochigiensis* (Uchio, 1951).—Trans. Proc. Palaeont. Soc. Japan, new ser., No. 60, Dec. 20, 1965, p. 156-165, pls. 18, 19, figs. 1-3 (graph, map, drawings).—A species closer to *Ammonia* than to the allied genus *Pseudorotalia.*

Shell structure of Japanese smaller Foraminifera. Part 2. *Pararotalia nipponica* (Asano, 1936). —Trans. Proc. Palaeont. Soc. Japan, new ser., No. 61, April 10, 1966, p. 191-200, pls. 24, 25, text figs. 1-3 (diagrams).

VANGEROW, E. F. Möglichkeiten Ökologischer und Paläogeographischer Untersuchungen im Oberkarbon des Ruhrgebietes Anhand von Foraminiferen.—Geol. Rundschau, Stuttgart, Band 54, heft 2, 1964 (Nov. 1965), p. 645-650, text fig. 1 (graph).

VOLOSHINA, A. M. Sostojanie Izuchennosti Nekotorykh Rodov Podsemejstva Ataxophragmiinae.—Akad. Nauk SSSR, Voprosy Mikropaleont., vyp. 9, 1965, p. 147-156, text figs. 1, 2 (drawings).—*Arenobulimina* and *Ataxophragmium* subdivided into 5 and 3 subgenera respectively. Six new subgenera named.

WEZEL, FORESE CARLO. Geologia della tavoletta Mirabella Imbàccari (Prov. di Catania, Caltanissetta ed Enna, F. 272, I-NE).—Boll. Soc. Geol. Ital., v. 84, fasc. 7, 1965, p. 3-136, text figs. 1-55 (map, columnar section, outcrop photos, thin sections, graph, drawings, diagram, distrib. chart, geol. section), pl. 2 (geologic profiles).—Four groups of significant planktonic Foraminifera are illustrated, one from a mixture of Albian to lower Eocene, another from a formation of Oligocene-Helvetian age, another from the Tortonian, and the fourth from the Trubi marls of lower to middle Pliocene.

WILLIAMS, THOMAS ELLIS. Fusulinidae of the Hueco Group (Lower Permian), Hueco Mountains, Texas.—Peabody Mus. Nat. Hist., Yale Univ., Bull. 18, 1963, p. 1-122, pls. 1-25, text figs. 1-10 (geol. map, index map, illustr. columnar section, diagram, charts, stratigraphic sections, geol. section), tables 1-26.—Twenty-six species, 5 new.

YABE, HISAKATSU. *Lepidolina* problem; supplementary notes.—Proc. Japan Acad., v. 42, No. 2, Feb. 1966, p. 141-145.

ZANINETTI, LOUISETTE, and BRÖNNIMANN, PAUL. Etude morphologique et stratigraphique de l'espèce type du genre *Aulotortus* Weynschenk, 1956.—Archives des Sciences, v. 18, fasc. 3, Sept.-Dec. 1965, p. 699-705, pl. 1, fig. 1 (thin section).—The holotype of *A. sinuosus* Weynschenk, 1956, is redescribed and illustrated; the genus is considered "nomen dubium" in Foraminifera.

RUTH TODD
U. S. Geological Survey
Washington, D. C.