CONTRIBUTIONS FROM THE CUSHMAN ~~FOUNDATION~~
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382. COMPARISON OF *GLOBIGERINA PACHYDERMA* (EHRENBERG) IN ARCTIC AND ANTARCTIC AREAS

JAMES P. KENNETT
Florida State University, Tallahassee, Florida 32306

ABSTRACT

Populations of **Globigerina pachyderma** in Arctic bottom sediments exhibit distinct morphological differences from those in Antarctic bottom sediments. Arctic populations are less heavily encrusted, more lobulate, have a higher arched aperture, and have a dominance of 4½-chambered forms (umbilical view), compared with a dominance of 4-chambered forms in Antarctic populations. Both are dominated by sinistrally coiling forms and they have similar size characteristics. Because of a shortage of morphological data on **G. pachyderma** in subArctic and northern hemisphere subtropical areas, it is not possible to determine whether these morphological differences result from phenotypic variation or subspeciation.

Characteristic ranges of variation of **G. pachyderma** from both areas are illustrated by scanning-electron micrographs.

INTRODUCTION

Globigerina pachyderma is the only species of planktonic foraminifera found in both Arctic and Antarctic water masses, so it is of special interest in studies of faunal-floral bipolarity. Despite this, populations of this species in the two polar areas have not been compared in detail until now. Shchedrina (1964), in a discussion of bipolarity of foraminifera, stated that *G. pachyderma* is the only species that can be called identical in both areas. During examination of both Arctic and Antarctic foraminiferal faunas, I noticed, on the contrary, that distinct differences do occur in *G. pachyderma* from the two areas. The purpose of this paper is to describe these differences and to discuss briefly their possible significance.

Arctic samples examined were obtained by dredge and bottom trawls from ice islands (Arlis II; Fletcher's Ice Island-T-3) from 1962-1965 in the central Arctic Ocean and the northern Beaufort Sea (Table 1). Antarctic samples have been examined from numerous cores collected during operations of National Science Research Vessel *Eltanin* in the Antarctic area (Kennett, 1968). For both Arctic and Antarctic areas, many thousands of specimens of *G. pachyderma* have been examined in order to make the comparisons. Arctic samples were supplied by Dr. J. Mohr and Mr. S. Geiger as part of the Arctic Drift Station Biology Program. The scanning electron micrographs (Plates 8 and 9) were taken by R. Parker, using a Cambridge stereoscan, mark II-A, in the Biology Department, Florida State University. This research was supported by Nonr 228(19) and NR 307-270 (Arctic Biology, University of Southern California) and N.S.F. GA-4002 (Antarctic foraminifera, Florida State University).

MORPHOLOGICAL DIFFERENCES BETWEEN ARCTIC AND ANTARCTIC POPULATIONS

The following comparisons are tabulated between *G. pachyderma* populations in the Antarctic area (A), and populations in Arctic areas (B).

A. CHARACTERISTICS OF **G. PACHYDERMA** IN ANTARCTIC AREAS (KENNETT, 1968)	B. CHARACTERISTICS OF **G. PACHYDERMA** IN ARCTIC AREAS
1. Dominated by forms with 4 chambers (umbilical view). Four-chambered forms constitute 54 - 80% of *G. pachyderma* samples, with an average of 66%.	1. Dominated by forms with 4½-5 chambers (umbilical view). 4½-5 chambered forms constitute 56-36% of *G. pachyderma* samples with an average of 59%.
2. Test highly thickened, heavily pitted, compact, and only slightly lobulate.	2. Test less thickened, less heavily pitted, less compact and rather lobulate.
3. Aperture usually relatively low, narrow arch; lip thickened.	3. Aperture usually higher arched, more open; lip less thickened.
4. Sinistrally coiled forms dominate (greater than 97%).	4. Sinistrally coiled forms dominate (greater than 95%).
5. Large size. Median diameter increases southwards from about 160μ near the Antarctic convergence to 200μ near the Antarctic continent.	5. Large size. Median diameter 180-187μ.

Arctic populations of *G. pachyderma* (Plate 8), are readily distinguished from Antarctic populations (Plate 9) because they are less heavily encrusted, more lobulate, generally have a more highly arched, more open aperture, and are dominated by forms with 4½ to 5 chambers (umbilical view), while those in Antarctic populations are dominated by 4-chambered forms (Table 1). Indeed, Arctic populations have more in common with subAntarctic populations than with Antarctic populations (Kennett, 1968). It is important to note that the Arctic forms described in this paper are mature, relatively thickly encrusted forms, and should not be confused with thin-shelled, immature forms characteristic of relatively shallow Arctic waters (Bé, 1960). All of the Arctic samples used in this study were from depths greater than 1300 m., which is substantially deeper than the critical depth (200 m.) below which more typical *G. pachyderma* populations, characterized by crystalline thickening of the test wall (Bé, 1960), are found.

DISCUSSION

The morphological differences between Arctic and Antarctic populations of *G. pachyderma* can be accounted for in two possible ways:

1. Subspeciation resulting from geographic isolation of the two forms.
2. Phenotypic variation reflecting differences in the environment of Arctic and Antarctic water masses.

In present-day seas, *G. pachyderma* is essentially restricted to water masses as far north as 25° S in the southern hemisphere and as far south as 25° N in the northern hemisphere (Parker, 1962). It is possible that the present-day equatorial water masses form a barrier to the migration of *G. pachyderma* between the northern and southern hemispheres. On the other hand, significant oceanic cooling associated with the Pleistocene glacial stages possibly enabled the latitudinal range of *G. pachyderma* to be extended close to the equator in some areas, enabling the reasonably free interchange of northern and southern hemisphere populations, thereby preventing subspeciation.

An alternative explanation is that subspeciation has occurred independently within northern hemisphere populations, and that the Arctic form has evolved as the result of subspeciation in the relative isolation of the Arctic Ocean.

Environmentally-controlled changes in coiling direction in *G. pachyderma* are well known (Bandy, 1960; Ericson, 1959). Other gradational morphological changes possibly under environmental control have been described for forms from the South Pacific (Kennett, 1968). It is conceivable that distinct Arctic and Antarctic forms have arisen as phenotypic variations reflecting environmental differences in the two oceans. If this is the case, it is difficult to explain why the Arctic form of *G. pachyderma* is more like the subAntarctic form, since Arctic water masses are more like those of the Antarctic than the subAntarctic.

Unfortunately, since little is known about *G. pachyderma* in other northern hemisphere areas, it is not possible to determine at this time whether the distinct Arctic and Antarctic forms represent subspeciation or are merely an expression of phenotypic variation.

REFERENCES

BANDY, O. L., 1960, The geologic significance of coiling ratios in the foraminifera *Globigerina pachyderma* (Ehrenberg): *Jour. Pal.*, vol. 34, no. 4, pp. 671-681, text-figs. 1-7.

BÉ, A. W. H., 1960, Some observations on Arctic planktonic foraminifera: *Contr. Cushman Found. Foram. Research*, vol. 11, pt. 2, pp. 64-68.

ERICSON, D. B., 1959, Coiling direction of *Globigerina pachyderma* as a climatic index: *Science* vol. 130, no. 3369, pp. 219-220, text-fig. 1.

KENNETT, J. P., 1968, Latitudinal variation in *Globigerina pachyderma* (Ehrenberg) in surface sediments of the southwest Pacific Ocean: *Micropaleontology*, vol. 14, no. 3, pp. 305-318, pl. 1.

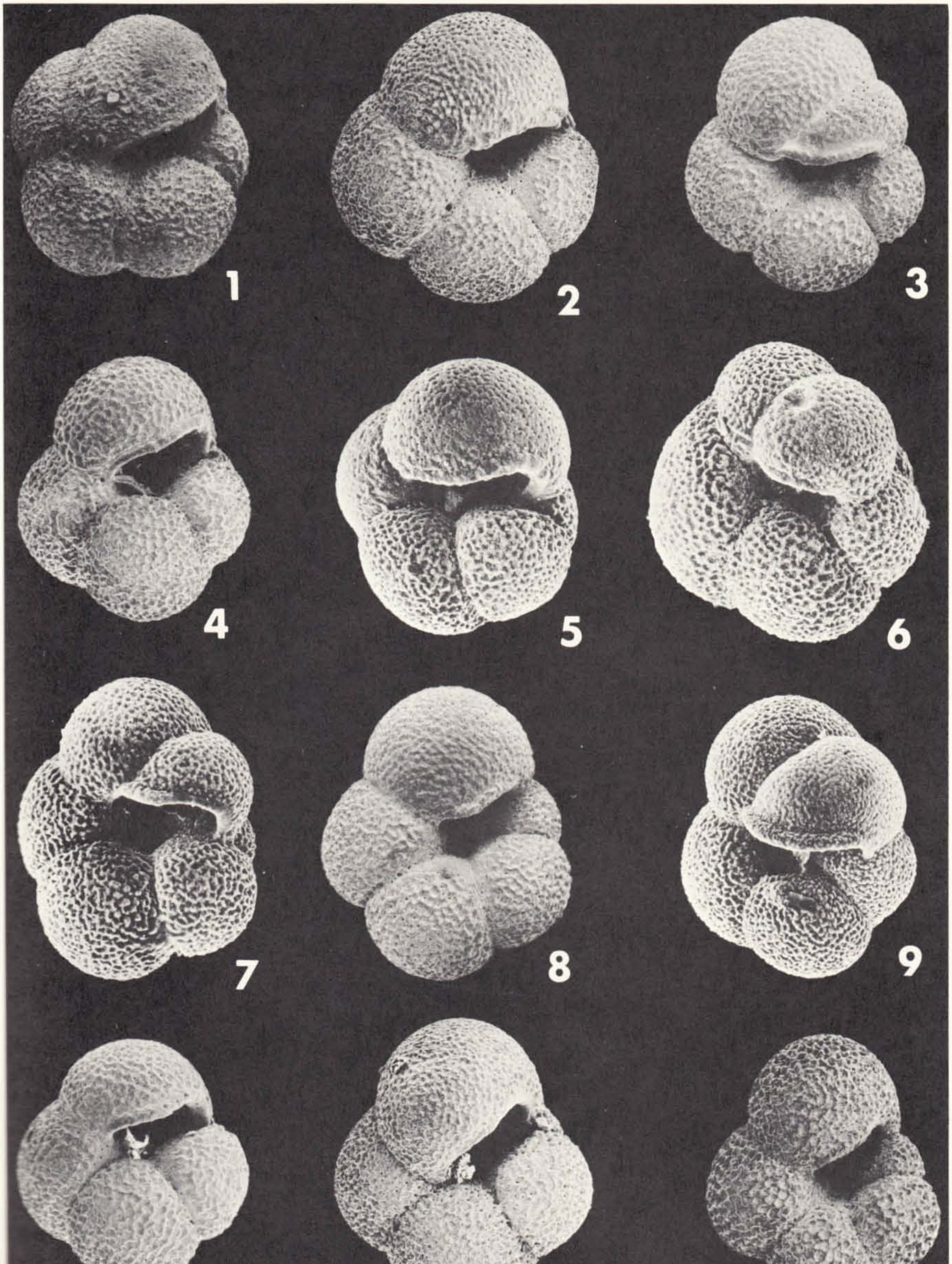
PARKER, F. L., 1962, Planktonic foraminiferal species in Pacific sediments: *Micropaleontology*, vol. 8, no. 2, pp. 219-254, pls. 1-10.

SHCHEDRINA, Z. G., 1964, The foraminiferen fauna of the eastern sector of the Antarctic: *in Soviet Antarctic Expedition, Information Bull.*, v. 1, pp. 125-127, Elsevier Publ. Co.

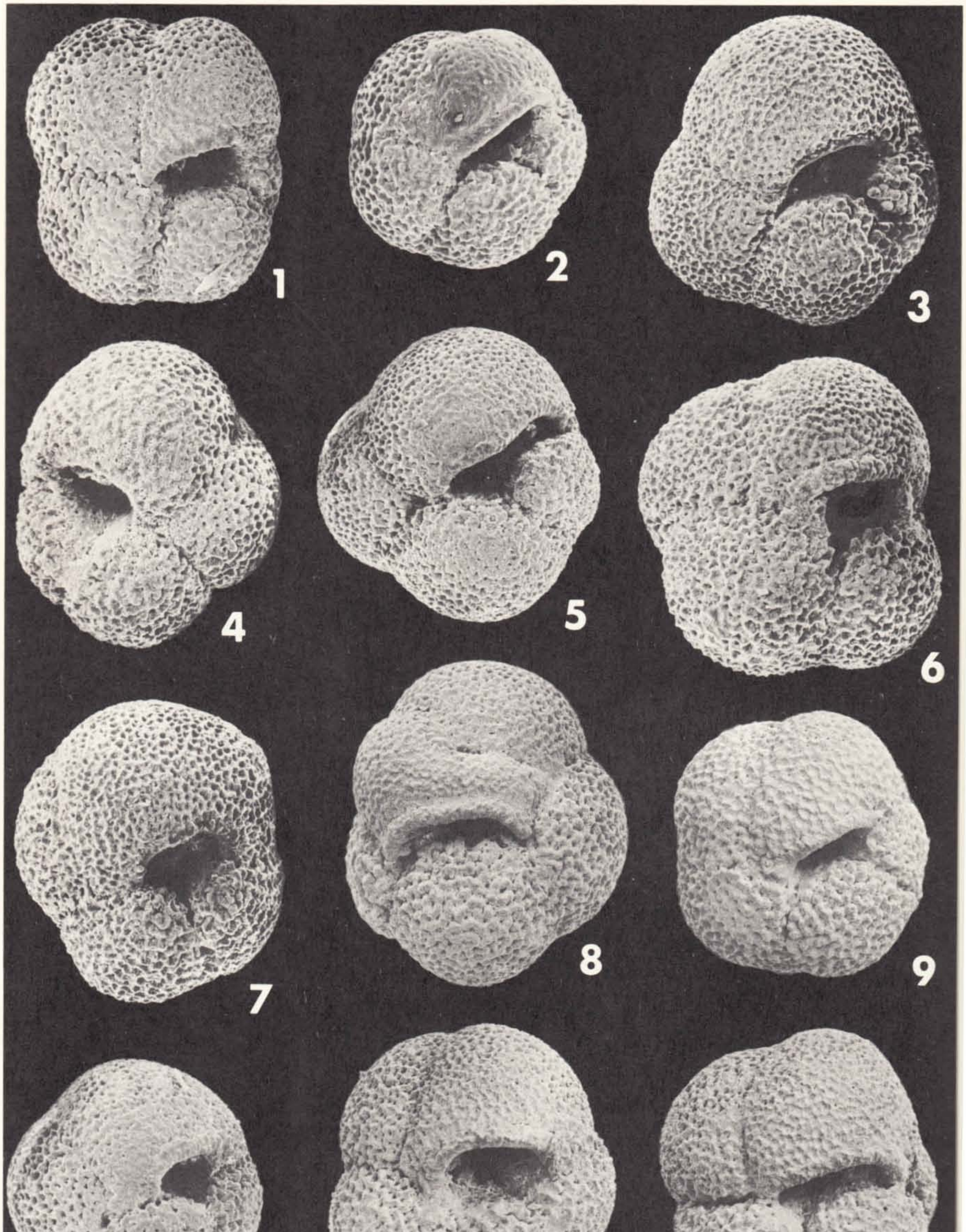
SHARP, W. E., and POW-FOONG FAN, 1963, A sorting index: *Jour. Geol.*, vol. 71, no. 1, pp. 76-84.

EXPLANATION OF PLATE 8

Morphological variation in mature specimens of *Globigerina pachyderma* (Ehrenberg) from Arctic surface sediments. Sample 298a. All figures ×120 48



Kennett: Arctic and Antarctic *Globigerina pachyderma.*



Kennett: Arctic and Antarctic *Globigerina pachyderma.*

TABLE 1

Sample No.	Location—Latitude	Location—Longitude	Depth (m.)	% of sample	% of Sinistrally Coiling forms	% with 4 chambers (umbilical view)	% with 4½-5 chambers (umbilical view)	Maximum diameter (μ)	Median diameter (μ)	Sorting index (%)
98	87°12′N	64°06′W	1340	100	97	38	62	432	180	65
298a	84°22′N	169°48′E	3175	100	96	43	57	504	180	70
22	76°11′N	141°56′W	3700	100	95	37	63	360	185	68
73c	74°28′N	141°58′W	3650	100	97	44	56	450	187	67

Data for *Globigerina pachyderma* from Arctic samples. Each parameter determined from counts of more than 200 specimens. The sorting index is explained by Sharp and Pow-Foong Fan (1963). An increase in percentage of sorting indicates greater numbers of specimens within a narrower size range.

EXPLANATION OF PLATE 9

Morphological variation in mature specimens of *Globigerina pachyderma* (Ehrenberg) from Antarctic surface sediments. Sample *Eltanin* 27-22; 8-10 cm.; 64°58′S; 160°37′E; 2920 m. All figures ×120. 48

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383. ANNOTATED BIBLIOGRAPHY OF PALEOZOIC NONFUSULINID FORAMINIFERA, ADDENDUM 7

DONALD FRANCIS TOOMEY
Pan American Petroleum Corporation, Research Center, Tulsa, Oklahòma
and
B. L. MAMET
Department of Geology, University of Montreal, Montreal, Canada

ABSTRACT

This addendum includes 109 annotated references pertaining to Paleozoic nonfusulinid Foraminifera, and can be considered reasonably complete through the year of 1968. As in previous bibliographies, (Toomey, 1959, 1961, 1963, 1965, 1966, and Toomey and Mamet, 1967, 1968 and 1969),[1] the aims are unchanged: (1) to summarize briefly the pertinent data contained in each article, (2) to list all new genera and species described therein, and (3) to denote, within brackets, all taxonomic changes noted from current and subsequent publications, and to include pertinent comments when possible, thus making the bibliography a more useful working tool.

INTRODUCTION

This annotated bibliography consists of 18 references containing original descriptions of genera and species and taxonomic nomenclature of Paleozoic nonfusulinid Foraminifera. An additional 91 references that utilized smaller foraminifers in stratigraphic subdivision and that mention incidental occurrences are also included for completeness.

The 109 references have been annotated by the compilers. These annotations include geologic age, geographic locality, type of illustrations, original language, new forms described, and comments in brackets on taxonomic changes from the annotated article or noted from subsequent publications. It should be noted that Professor Mamet is actively engaged in research on the Lower Carboniferous smaller foraminifers of the world, hence, many of the notations enclosed within the brackets, particularly in reference to Lower Carboniferous articles, are comments made by him based upon his considerable experience working with these forms.

This bibliography may be considered to be reasonably complete through the year 1968. Including this addendum, the total number of annotated Paleozoic nonfusulinid foraminiferal references has reached 1190. The compilers would greatly appreciate the effort and cooperation of all Paleozoic foraminiferal workers in keeping them current on all new works that appear by sending pertinent reprints and separates when available.

[1] Contr. Cushman Found. Foram. Research, v. 10, p. 71-105; v. 12, p. 33-46; v. 14, p. 77-94; v. 16, p. 1-21; v. 17, p. 46-66; v. 18, p. 55-83; v. 19, p. 41-69; v. 20, p. 45-64.

LITERATURE TRENDS

Text fig. 1 is an attempt to show chronologically the distribution of articles relating to Paleozoic nonfusulinid Foraminifera within designated geographic regions. The inclusion of the present 109 references and the 116 references from Addendum 6 (total 225) again points out the pronounced increase of foraminiferal literature from Europe, Africa, and the Middle East (column C), and the continued additions made by Soviet workers (column A). The substantial increase in both of these regions is primarily due to the ever increased usage of the endothyroid smaller foraminifers in biostratigraphically subdividing the Lower Carboniferous sequence on a worldwide basis. Workers in North America continue to keep pace with the remainder of the world (column B), but little in the way of monographic taxonomic works have been forthcoming in spite of an incipient massive and ever-present potential. The Australasian region (column D) is beginning to show signs of increasing awareness; the potential for this region is great.

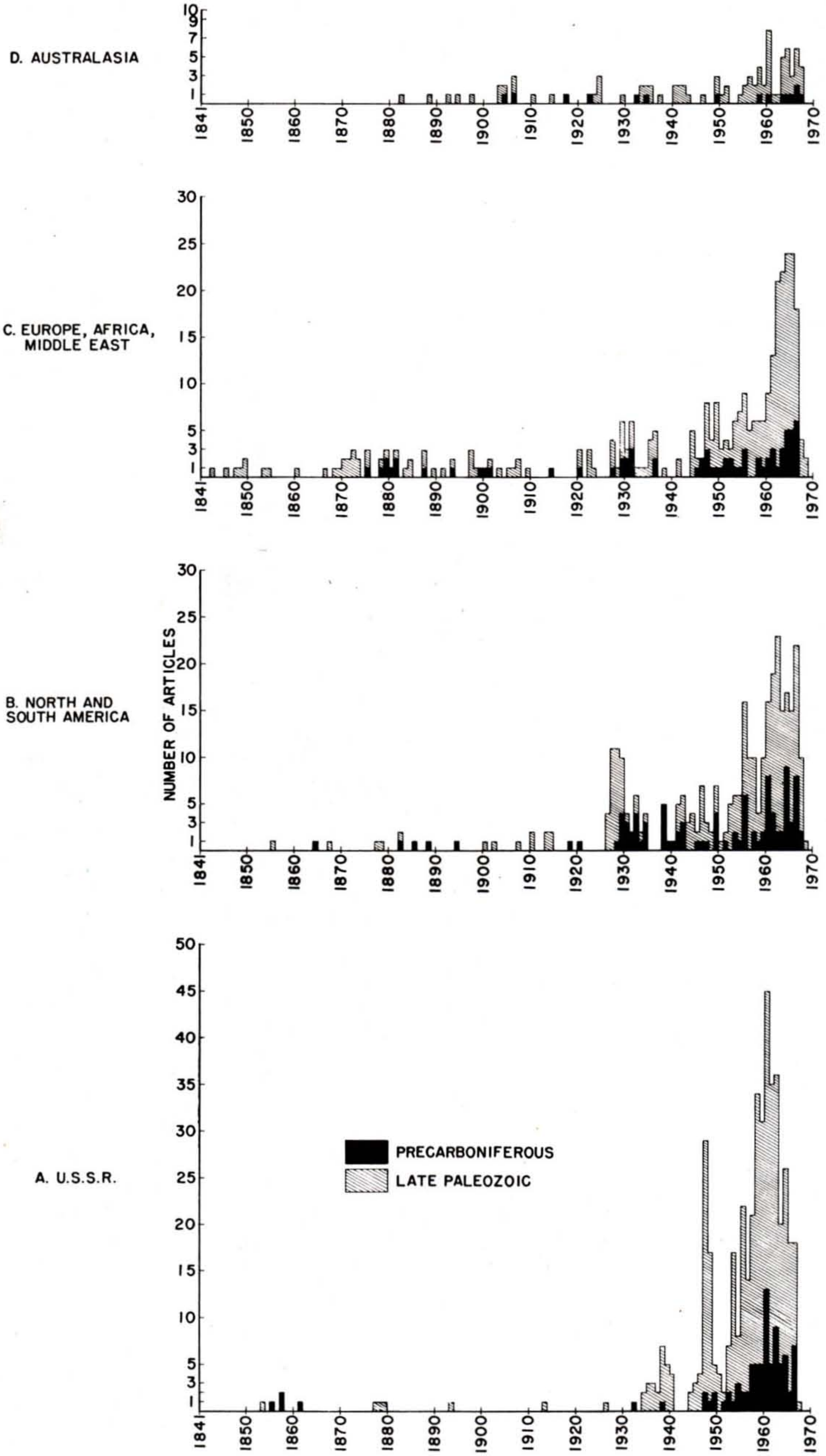
In text fig. 2 the output of foraminiferal literature has been plotted according to geologic age. The basic overall trend shown in previous bibliographies remains essentially unchanged and, again, is a reflection of the intense work currently being done on Lower Carboniferous microfaunas, as noted above.

ANNOTATED BIBLIOGRAPHY

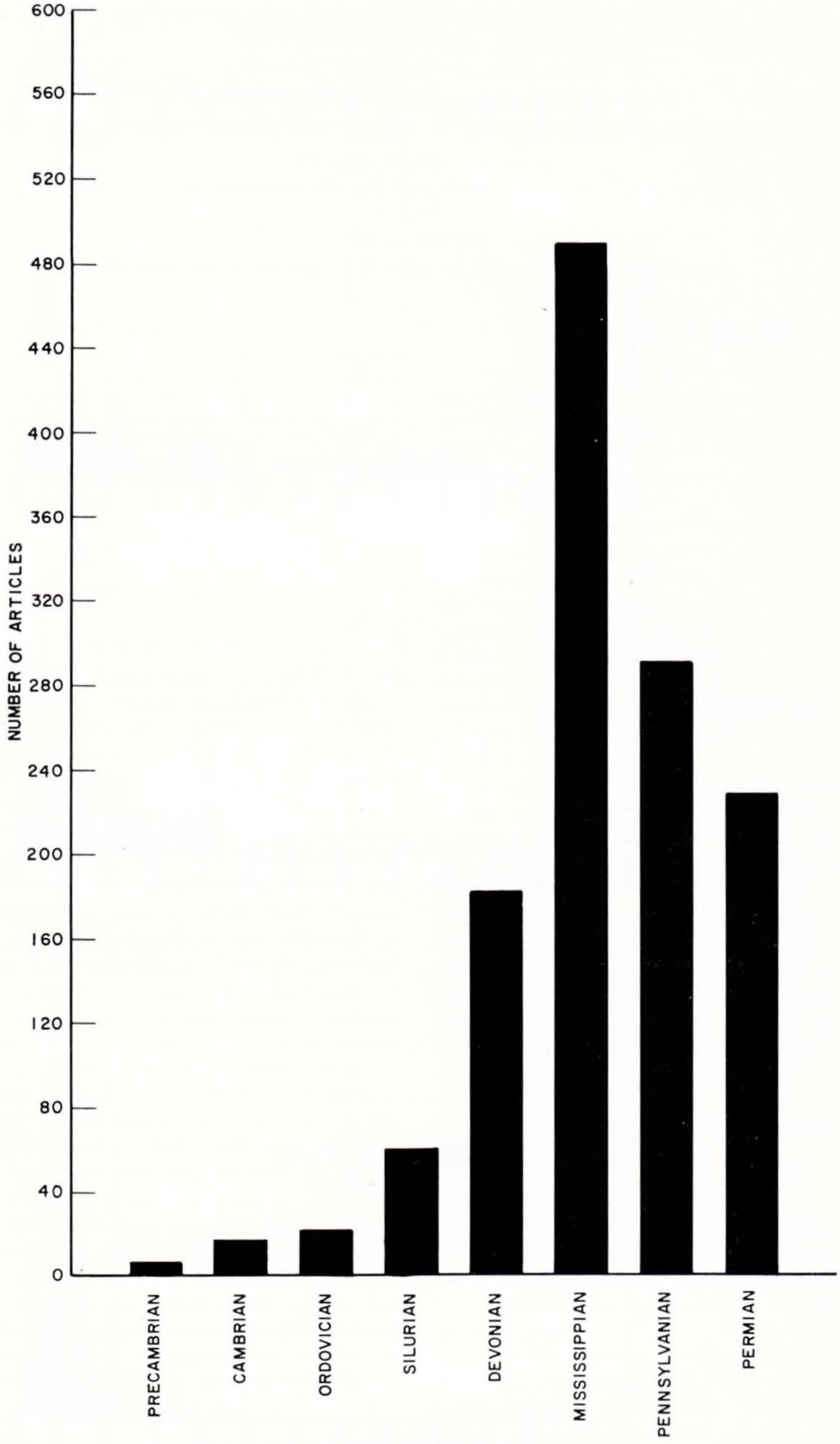
A. *PRECARBONIFEROUS FORAMINIFERA*

1. ARONOVA, S. M., *ET AL.*, 1967, Devonian of the Russian Platform. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 1, p. 379-396, 8 text-fig., 3 tables.

   On the Russian Platform, U.S.S.R., Devonian rocks are more widely distributed than those of any other Paleozoic system. The writers list on table 1 previously described characteristic guide fossils, including smaller foraminifers, for the Middle and Upper Devonian and Lower Carboniferous regions of the Russian Platform.



TEXT FIGURE 1
Geographic Distribution of Paleozoic Foraminiferal Literature



TEXT FIGURE 2
Geological Distribution of Paleozoic Foraminiferal Literature

2. BULTYNCK, P. L., 1967, Description revisée de la Coupe Type du Couvinien à Couvin. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 2, p. 421-440, 4 text-fig., 3 tables [in French with English abstract].

The writer presents a detailed revision of the Middle Devonian (Couvinian) type section at Couvin, Belgium. An ecological study of the section was undertaken concurrently with stratigraphical revision, for which conodonts, supplemented by other microfaunas, including smaller foraminifers, were particularly valuable. Table 3 shows the stratigraphic position of 13 foraminifers within the Couvinian sequence. This revision allowed the writer to suggest stratigraphic correlation with the Couvinian of Western Germany and to discuss the lower and upper limits of the Couvinian. Comparisons are made with the Middle Devonian of the United States.

3. CHAPMAN, F., 1907, On the relationship of the genus *Girvanella* and its occurrence in the Silurian limestones of Victoria: Rept. Australasian Assoc. Adv. Sci., v. 10, p. 377-386, 3 pl.

The writer presents a lucid discussion on the affinities of *Girvanella,* and offers comparison of this form with the foraminifer *Hyperammina vagans*. The writer concludes that Brady, Nicholson and Etheridge were mistaken in suggesting that *Girvanella* has foraminiferal affinities. The present writer suggests that *Girvanella* is an alga and probably should be assigned to the blue-green algae.

4. CONKIN, J. E., and CONKIN, B. M., 1968, A revision of some Upper Devonian Foraminifera from Western Australia: Palaeontology, v. 11, pt. 4, p. 601-609, pl. 114-117, 1 text-fig.

Agglutinated Foraminifera described by Crespin (1961) from the Upper Devonian Virgin Hills and Gogo Formations of the Fitzroy Basin of Western Australia are revised and redescribed by the present writers. In the foraminiferal assemblage 4 genera and 8 species are recognized; these include *Oxinoxis* Gutschick 1962 and *Sorosphaeroidea* Stewart and Lampe 1947, which were previously recorded only from the Middle Paleozoic of the United States. The similarity of these foraminifers to Upper Devonian microfaunas in the United States is noted and described. In addition, several new occurrences of agglutinated foraminifers are reported from the Silurian and Devonian of New South Wales, Victoria, and Tasmania. All of the foraminifers are illustrated by whole-specimen photomicrographs.

5. DANNER, W. R., 1967, Devonian of Washington, Oregon and western British Columbia. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 1, p. 827-842, 16 text-fig.

In western Washington, Whatcom County, the writer reports the occurrence of the encrusting foraminifer *Wetheredella* sp. from what are apparently Devonian reef complexes. It is also noted that an earlier investigator (Enbysk, 1956) reported the occurrence in northeastern Washington (Limestone Hill locality) of a Middle Devonian genus of foraminifer related to *Endothyra* [probably *Nanicella*] from a supposed reef sequence. [Figure 11 shows a photomicrograph of calcisphere limestone from an outcrop on the northwest side of Black Mountain, Whatcom County, Washington; these are probably umbellinids.]

6. ENBYSK, B. J., 1956, Additions to the Devonian and Carboniferous faunas of northeastern Washington (abstract): Geol. Soc. America, Bull., v. 67, no. 12, p. 1766.

The writer reports the occurrence in northeastern Washington (limestone exposure northwest of Metoline Falls) of a probable Middle Devonian (Onondagan) biota containing a foraminifer related to *Endothyra* [probably *Nanicella*].

In addition, the first record of Pennsylvanian smaller foraminifers from this region (southeastern Stevens County) is also reported. These include forms referred to the genera *Rhabdammina, Ammobaculites, Endothyra, Globivalvulina, Trochammina,* and the fusulinid genus *Millerella*.

7. GOLOUBTSOV, V. K., KEDO, G. I., KRYLOVA, A. K., LUTKEVITCH, E. M., and MAKHNATCH, A. S., 1967, Le Devonien de la Bielorussie. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 1, p. 367-377, 1 text-fig., [in French with English abstract].

Devonian deposits (Givetian, Frasnian, and Famennian Stages) are widespread in Byelorussia, U.S.S.R., where their thickness is from some tens of metres up to 5000 metres. From the Upper Devonian Frasnian Stage (Evlanian Horizon) the writers note that the following smaller foraminifers are characteristic: *Archaesphaera minima* Suleimanov, *A. grandis* Lipina, *Parathurammina* ex. gr. *sulbasta* Bykova, and *Vicinisphaera* ex. gr. *squalida* Antropov.

8. GUTSCHICK, R. C., and MOREMAN, W. L., 1967, Devonian-Mississippian boundary relations along the cratonic margin of the United States. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H.,

Ed., Alberta Soc. Petroleum Geologists, v. 2, p. 1009-1023, 6 text-fig.

The writers present and fully discuss the Devonian - Mississippian boundary relationships along the cratonic margin of the continental United States. Their study indicates that available evidence supports placing the boundary at the base of the Louisiana-uppermost Severton biota, which includes brachiopods, conodonts, foraminifers, corals, and goniatite cephalopods. This biota has wide distribution and is found in the upper part of the black shales and in the transitional beds. Numerous biostratigraphic sections from key areas are included; a few of these are subdivided on the basis of previously described Upper Devonian-Lower Mississippian smaller foraminifers.

9. Hizhnyakov, A. V., and Pomyanovskaya, G. M., 1967, Devonian of the Volyno-Podolian margin of the Russian Platform. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 1, p. 359-366, 2 text-fig.

The writers list the occurrence of a limited number of previously described smaller foraminifers from the Upper Devonian sequence at the Volyno-Podolian margin of the Russian Platform, U.S.S.R. From the Frasnian, the forms *Umbellina* aff. *U. baschkirica* Bykova, *Bisphaera parva* Bykova, and *Maravammina* sp. (*sic*). From the Famennian Stage, it is noted that intercalations of limestone carry *Umbellina* sp., *Bisphaera* sp., and ostracodes in this region.

10. Krylova, A. K., Malitch, N. S., Menner, V. V., Obrutchev, D. V., and Fradkin, G. S., 1967, Devonian of the Siberian Platform. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 1, p. 473-482, 2 text-fig.

On the Siberian Platform U.S.S.R., Devonian deposits are developed in the Tunguska and Vilui Synclines, as well as in depressions along the southern, northern and eastern boundaries of the platform. The writers note that the uppermost horizon of the Middle Devonian, the Yukhta, contains the smaller foraminifers *Vicinesphaera squalida* Antropov, and *Archaesphaera* sp. In the Upper Devonian of the Tunguska syncline, in the Calargon Suite the following smaller foraminifers are found: *Moravammina* sp. cf. *M. fragilis* Bykova, *Paracalligella* sp., *Nodosinella* sp., *Umbellina* ex. gr. *bella* Maslov, and *U.* ex. gr. *bykovae* Reitlinger. It is further noted that in the boreholes which penetrated below Tournaisian limestones in the Khatanga Trough rare Famennian foraminifers (*Hyperammina minima* Birina and *H. elegans* Rauser) also occur.

11. Leavitt, E. M., 1968, Petrology, palaeontology, Carson Creek North Reef Complex, Alberta: Bull. Canadian Petroleum Geol., v. 16, no. 3, p. 298-413, 22 pl., 15 text-fig., 3 tables.

In a subsurface study of the Swan Hills Formation of the Beaverhill Group (Carson Creek North Reef Complex of probable late Middle and early Upper Devonian age) of westcentral Alberta, Canada, the writer reports that smaller foraminifers are present in the off-reef and back-reef facies (see text-fig. 10). On Plate 13 (fig. 41-42) are thin-section photomicrographs of *Parathurammina* sp. from the back-reef facies. [The form identified as *Tikhinella* appears to be a misidentification (see Plate 13, fig. 40).]

12. Lecompte, M., 1967, Le Devonien de la Belgique et le nord de la France. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 1, p. 15-52, 18 pl., [in French with English abstract].

The writer presents a brief description of the characteristics of the Devonian outcrops of Belgium and northern France, illustrated by a map including the published data of French oil companies and a brief summary of previous and current works. The structure and tectonic evolution of the region which appear to be responsible for the facies variations are also briefly described. A number of foraminiferal genera are listed on plates 16 and 17 for the Middle and Upper Devonian portion of the sequence; these include *Nanicella, Semitextularia, Pseudopalmula, Paratikhinella, Bisphaera, Umbellina, Parathurammina,* and *Moravammina.*

13. Liashenko, A. I., and Liashenko, G. P., 1967, Correlation of Devonian deposits of the Russian Platform and the western slopes of the Urals. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 2, p. 511-523, 1 table.

The writers report the occurrence of the smaller foraminifer *Eonodosaria evlanensis* Lipina from the Upper Devonian (Frasnian) Evlan Horizon from the central area of the Russian Platform. This species is also reported from the eastern part of the Russian Platform.

From the Upper Devonian (Famennian), principally the central part of the platform, the following smaller foraminifers are reported: (a) the Ozersko-Khovansk Horizon carries *Septatournayella rauserae* Lipina and others; (b) the Zavolzhye Horizon contains *S. rauserae* Lipina, *Quasiendo-*

thyra communis Raus., and *Q. kobeitusana* Raus., and corresponds to the Ozersko-Khovansk Horizon; (c) in the southern Timan the Zelenetsk Limestone contains *Q. communis* and *Septatournayella rauserae* Lipina, while the Newmylg Limestone with *Q. kobeitusana* Raus. and *Q. communis* Raus. seems to correspond to the Ozersko-Khovansk Horizon.

14. LOEBLICH, A. R., JR., and TAPPAN, HELEN, 1964, Foraminiferal classification and evolution: Geol. Soc. India, Jour., v. 5, p. 1-40, 1 text fig.

The writers present a lucid discussion of the development of foraminiferal classificatory schemes from the time of Linné (1758) up to, and including, the usage of a comprehensive scheme for the *Treatise On Invertebrate Paleontology* (1964). The reasons and the morphologic documentation for the different genera are included, and much discussion is given to the basis for subordinal and suprafamilial organization, and their implication as to relationships and ancestries within the Foraminifera.

It is thought that the pseudochitinous Lagynacea gave rise separately to agglutinated, microgranular calcareous, and hyaline calcareous Foraminifera. A hypothetical phylogeny is presented (text-fig. 1) for the Parathuramminacea, Endothyracea, and Fusulinacea. Developmental trends from simple to compound walls, from unilocular to septate forms and subdivided chambers, and from free-living to attached habit appear to have occurred independently in various lineages.

15. MAMET, B. L., 1967, The Devonian-Carboniferous boundary in Eurasia. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 2, p. 995-1007, 4 text-fig.

The writer notes that the Devonian-Carboniferous boundary has been the subject of much controversy since the creation of both systems, as the boundary is distinctly transitional. Fortunately, foraminiferal zones have been a great help in deciphering this troublesome interval. Rapid evolution of the Endothyridae and Tournayellidae allows recognition of four significant zones which have been of great correlative value in Europe and Asia. These zones are characterized by: (1) appearance of the Endothyridae *sensu stricto* (*Quasiendothyra bella* and *Latiendothyra*), (2) appearance of *Quasiendothyra communis* (*Septatournayella rauserae* Zone *pars*), (3) acme of *Quasiendothyra communis* (appearance of *Quasiendothyra kobeitusana* or *Q. mirabilis*), and (4) extinction of the Quasiendothyridae and outburst of the tournayellid *Chernyshinella*. The first two zones are Upper Devonian (upper Famennian) in the type region, the third one appears at the base of the Etroeungt Limestone (as emended) and the final one is practically coincident with the disappearance of clymenids (lower Tn2a).

This zonation has proved to be reliable in many of the basins of Eurasia.

16. MOUND, M. C., 1968, Arenaceous Foraminiferida and zonation of the Silurian rocks of northern Indiana: Dept. Nat. Res. Geol. Survey Bull. 38, 126 p., 7 pl., 6 text-fig., 1 table.

The writer describes 82 species representing 31 genera of Silurian agglutinated foraminifers recovered from acid residues of cores from 5 deep wells and drill holes in Allen, Delaware, Howard, Marion, and Newton Counties, northern Indiana. Four species are described as new, these are: *Ammodiscus constrictodilatus, Lituotuba recurva, Tholosina phrixotheca,* and *Psammonyx ceratospirillus.* All forms are illustrated by whole-specimen photomicrographs; a few are illustrated by line drawings. *Metamorphina* is used for those forms previously assigned to *Webbinella* Rhumbler that cannot properly be included in either *Webbinelloidea* Stewart and Lampe or *Hemispherammina* Loeblich and Tappan.

Silurian rocks of the area are pre-Cayugan in age and assigned to 3 biostratigraphic zones: (1) the *Turritellella* Assemblage Zone, (2) the *Ammodiscus-Thurammina* Assemblage Zone, and (3) the *Ammodiscus-Lituotuba* Assemblage Zone. The *Turritellella* Assemblage Zone is restricted to the lowermost part of the Salamonie Dolomite in northwestern and northcentral Indiana and to the lowermost part of the Salomonie and the underlying Brassfield Limestone in eastcentral and southeastern Indiana. The *Ammodiscus-Thurammina* Assemblage Zone includes the middle and upper parts of the Salomonie Dolomite, as represented in the drill hole in Marion County. The *Ammodiscus-Lituotuba* Assemblage Zone includes the Louisville Limestone and the Wabash Formation. The Salina Formation, here represented by the Kokomo Limestone Member and other Salina strata, contains only sparse ammodiscids and astrorhizids; these are not assigned to any zone.

One preferential rock type for large foraminiferal assemblages is granular, relatively pure, biofragmental limestone or dolomite, i.e., the Salamonie Dolomite, which has been interpreted as representing optimum conditions for shallow marine invertebrate species. Generally, foraminifers are either sparse or lacking in cherty and argillaceous rocks of the Wabash Formation and in reef sections.

Common associates of the Silurian foraminifers are sponges, scolecodonts, brachiopods, ostracodes, graptolites, and conodonts.

Numerous taxonomic changes are also included in this report.

[It is noted that the writer refers many of his Silurian species to supposed similar Recent species, a practice not followed by most workers on Middle Paleozoic agglutinated foraminifers.]

17. PLAYFORD, P. E., and LOWRY, D. C., 1966, Devonian reef complexes of the Canning Basin, Western Australia: Geol. Survey Western Australia, Bull. 118, 150 p., 7 pl. (as supplementary atlas), 48 text-fig.

The writers have studied a series of Upper Devonian (principally Famennian) reef complexes exposed along the northern margin of the Canning Basin in the Kimberley Division of Western Australia. Mention is made of smaller foraminifers occurring in the following formations:

Back Reef Facies:

Pillara Limestone—*Quasiendothyra communis* and *Umbellina* sp.

Fore Reef and Inter-reef Facies:

Napier Formation—*Nodosinella* sp. cf. *N. cylindrica*

Virgin Hills Formation—agglutinated foraminifers described by Crespin (1961)

Piker Hills Formation—*Quasiendothyra communis, Tornayella* [*sic*] sp., and *Nodosinella* sp. cf. *N. tatarstanica*.

The post-reef Fairfield Formation which ranges in age from Upper Devonian (Famennian) to Lower Carboniferous (Tournaisian) contains *Umbellina* sp.

18. REITLINGER, E. A., and JARZTEVA, M. V., 1958, The new charophytes of the upper Famennian layers in the Russian Platform: Akad. Nauk S.S.S.R., Doklady, v. 123, no. 6, p. 1113-1116, 1 pl., [in Russian].

The writers describe and illustrate 4 new species of charophytes from the Upper Devonian (Famennian) Lebediansk Formation of the Russian Platform. It is noted that this formation is characterized by the smaller foraminifers *Archaesphaera* sp., *Parathurammina* sp., *Bisphaera* sp., *Nanicella* sp., and *Endothyra*? sp. [The wall structure of the above charophytes is strikingly different from that reported for the problematical form *Umbella/Umbellina*, which has been classified as both a charophyte and a foraminifer.]

19. ROBERTS, J., JONES, P. J., and DRUCE, E. C., 1967, Palaeontology and correlations of the Upper Devonian of the Bonaparte Gulf Basin, Western Australia and northern territory. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 2, p. 565-577, 2 text-fig., 1 table.

The writers report that in the Bonaparte Gulf Basin of Western Australia generically indeterminate fragments of agglutinated foraminifers are found in the Upper Devonian (Frasnian) Westwood Member of the Cockatoo Formation, together with *Nanicella* sp. cf. *N. gallowayi* (Thomas).

20. SERGUNKOVA, O. I., 1965, Devonian System. *IN*: Sergunkova, O. I., Stratigraphy of the Uzbek S.S.R., Pt. 1, Paleozoic: Akad. Nauk Uzbek S.S.R., Tashkent, Instit. Geol.-Geoph., p. 83-154, 1 text-fig., 2 tables, [in Russian].

The writer presents a compendium of micro- and macrofaunal elements present in various Upper Devonian (Famennian) horizons in Uzbekstan, U.S.S.R. Previously described smaller foraminifers are noted from most intervals. The most widespread monolocular foraminifers are *Radiosphaera* and *Vicinesphaera*, whereas the most widespread plurilocular forms are *Tikhinella* and *Eogeinitzina*. [The report of *Nodosinella* in rocks of middle Famennian age is probably erroneous; the foraminifer in question would be more aptly placed under the genus *Eonodosaria*.]

21. TIKHOMIROV, S. V., 1967, Stages of sediment accumulation in the Devonian of the Russian Platform: Izd. "Nedra," 267 p., 43 text-fig., [in Russian].

The writer presents a synopsis of biostratigraphic correlations presently recognized in the Devonian sediments of the Russian platform, U.S.S.R. It is noted that there are 27 biostratigraphical horizons which enable workers to reconstruct precise paleogeographic maps. Brachiopods appear to be the most useful guide fossils in the Lower and Middle Devonian sequence, whereas foraminifera appear in sufficient quantities in the Upper Devonian (Frasnian) to be useful as reliable markers. Eighteen smaller foraminiferal assemblages based upon previously described species are listed from the Frasnian and Famennian portions of the Devonian. The writer considers the *Endothyra* ex. gr. *communis* [now *Quasiendothyra*] Zone as uppermost Famennian in age and the *Endothyra kobeitusana* Zone as lowermost Carboniferous.

22. TOOMEY, D. F., 1968, Middle Devonian (Eifelian) Foraminifera from Padaukpin, northern Shan States, Burma (abstract): Geol. Soc. America, Program Ann. Meetings, Mexico City, p. 299.

The writer reports the occurrence of a relatively abundant foraminiferal assemblage in the

Middle Devonian (Eifelian) Padaukpin "limestone" of the northern Shan States, Burma. The microfauna consists of *Minammodytes* sp., *Hyperammina*?-like sp., *Hemisphaerammina* sp. cf. *H. bradyi* Loeblich and Tappan, 1957, *Metamorphina* sp. cf. *M. tholsus* (Moreman), *Thurammina*?-like sp., *Nanicella* sp., and *Semitextularia* sp. cf. *S. thomasi* Miller and Carmer, 1933.

Paleoecologically, this assemblage is unique in that it is principally an encrusting microfauna. It is believed that the foraminifers must have been attached to perishable supports, that is, marine grasses. This assemblage is primarily agglutinated, but this is prejudiced by sample preparation method (acid residues). Nonetheless, the presence of a limited number of pyritized steinkerns of originally calcareous forms such as *Nanicella,* and possibly *Semitextularia,* suggests that originally both agglutinated and calcareous forms comprised the microfauna.

Comparable species of some of the Padaukpin forms have previously been recorded from rocks as old as Middle Silurian (Wenlockian). This microfauna is the first abundant Middle Devonian foraminiferal assemblage reported from the Asian mainland.

23. TRIFONOVA, E., 1964, Foraminifera from the pebbles included in the Early Palaeozoic breccia conglomerates in northwestern Bulgaria: Rev. Bulgarian Geol. Soc., v. 25, pt. 2, p. 117-127, 2 pl., [Bulgarian text with good English summary].

The writer reports and describes an assemblage of what appears to be Upper Devonian foraminifers found in limestone pebbles of Upper Carboniferous (Stephanian) and Lower Permian breccia conglomerates of northwestern Bulgaria. The assemblage consists of 9 foraminifers which are either referred to previously described taxa or identified only to species. These are: *Pseudoastrorhiza* sp., *Sorosphaera papilla* Gutschick and Treckman, *Saccammina* sp., *Thurammina sphaerica* Ireland, *Parathurammina micropapilata* Blumenstengel, *P. suleimanovi* Lipina, *Bisphaera irregularis* Birina, *Tikhinella* aff. *T. measpis* Bykova, and *Semitextularia* sp. The microfauna is illustrated by whole-specimen and thin-section photomicrographs of both calcareous and agglutinated forms. Parts of *Hyperammina,* calcispheres, algae, bryozoa, ostracodes, and conodonts are found associated with the forams.

24. WETZEL, O., 1940, Mikropaläontologische Untersuchungen an eozoischen und paläozoischen Kieselgesteinen aus Nordamerika: Zbl. Miner. Geol. und Pal., Abt. B, p. 60-86, 2 text-fig., [in German].

The writer reports and illustrates by drawings a number of problematical forms from the Precambrian Beltain Series of Montana; a few of these *problematica* may be smaller foraminifers, [See Pflug, 1965, for a pertinent discussion of similar forms.].

25. WINDER, C. G., 1967, Micropaleontology of the Devonian in Ontario. *IN*: Internat. symposium on the Devonian System, Calgary, Alberta, Oswald, D. H., Ed., Alberta Soc. Petroleum Geologists, v. 2, p. 711-719, 12 text-fig.

The writer reports the occurrence of specimens of the agglutinated foraminifer *Tolypammina* sp. [probably *Minammodytes* sp.] from outcrops in the Ipperwash Limestone, uppermost unit of the Middle Devonian Hamilton Formation and just below an unconformity. A whole-specimen photomicrograph of this smaller foraminifer is given in text-fig. 4.

B. *LATE PALEOZOIC FORAMINIFERA*

26. ARMSTRONG, A. K., 1965, The stratigraphy and facies of the Mississippian strata of southwestern New Mexico: Guidebook New Mexico Geol. Soc. 16th. Field Conference, p. 132-140, 5 text-fig., 1 table.

The writer reports the presence of species of *Endothyra, Plectogyra,* and *Paramillerella* from the Mississippian (Osage-Chester) Escabrosa Group of southwestern New Mexico and southeastern Arizona. The stratigraphic position of the above foraminifers is shown on range charts.

27. BAARS, D. L., and SEE, P. D., 1968, Pre-Pennsylvanian stratigraphy and paleotectonics of the San Juan Mountains, southwestern Colorado: Geol. Soc. America, Bull., v. 79, no. 3, p. 333-350, 5 pl., 11 text-fig.

The writers note that endothyroid foraminifers are abundant at several Mississippian localities in the San Juan Mountains of Colorado. Only the upper member of the Leadville Formation contain these foraminifers in the outcrops, but the Ouray and lower Leadville are sparsely fossiliferous in the eastern Paradox Basin. In the San Juan Mountains the endothyroids occur in oolitic and pelletoidal grain-supported limestones. The best faunas were collected at Rockwood Quarry, Molas Lake, and Ouray in upper Leadville limestones. In each collection, the most common foraminifer is *Endothyra tuberculata* Lipina, but *E. spinosa* Chernysheva, *E. tumula* (Zeller), and *Septaglomospiranella dainae* Lipina are usually present. This assemblage is of middle Osagean age. [Foraminiferal identifications are by B. A. L. Skipp.]

28. BELFORD, D. J., 1968, Occurrence of the genus *Draffania* Cummings in Western Australia: Dept. Nat. Dev. Bur. Min. Res., Geol. & Geophysics, Bull. 92, Palaeontological Papers, 1966, p. 49-54, pl. 6, 2 text-fig.

Problematical microfossils referable to the genus *Draffania* Cummings have been found in core samples from a series of wells which penetrated the Lower Carboniferous rocks of Western Australia. The writer reports a foraminiferal microfauna occurring with *Draffania* which includes the genera *Endothyra, Haplophragmella, Stacheoides, Fourstonella, Archaediscus, Tetrataxis,* and *Valvulinella.* The smaller foraminifers indicate an age of Lower Carboniferous Viséan (V3b to lower V3c).

29. BETEKTINA, O. A., BOGUSH, O. I., and JUFEREV, O. V., 1967, Correlations of the Carboniferous and Permian of the Verkoyansk, Taimyr and Kussbass. *IN*: Stratigraphy of the Paleozoic of northern Siberia: Akad. Nauk S.S. S.R., Izdat. Nauka, p. 244-248, 1 table, [in Russian].

The writers present a stratigraphic subdivision of the Late Paleozoic rocks of three north-central and central Siberian regions, U.S.S.R. This subdivision is based upon previously described species of smaller foraminifers. The Etroeungt beds are considered Carboniferous and the *Quasiendothyra* zonation is extended into northern Siberia. The Tournaisian is zoned on Endothyridae, *e.g., Endothyra tuberculata.* The so-called "upper Tournaisian" of the Taimyr is shown to contain *Eoparastaffella* and is referred to the lowermost Viséan. The Viséan sequence is subdivided into three horizons, based mainly on species of *Archaediscus* and *Palanoarchaediscus.* The base of the Makarovsk Horizon is considered to be upper Viséan (first appearance of *Neoarchaediscus*), while the middle Namurian is zoned on *Asteroarchaediscus* and numerous species of *Neoarchaediscus.*

30. BOURRET, R., 1925, Etudes géologiques dans la région de Pak-Lay (Moyen-Laos): Serv. Géol. Indochine, Bull., v. 14, pt. 2, 178 p., 18 pl., 25 text-fig., 1 color map, [in French].

The writer reports the occurrence of the smaller foraminifers *Bigenerina, Endothyra,* and Textularidae from the Middle Carboniferous (Moscovian) cherts of French Indochina, southeast Asia. The foraminifers are illustrated by photomicrographs of randomly cut thin-sections. [Critical examination of the photomicrographs indicates the presence of *Bradyina, Palaeotextularia,* and encrusting foraminifers.]

31. CAROZZI, A. V., and TEXTORIS, D. A., 1967, Paleozoic carbonate microfacies of the eastern stable interior (U.S.A.): International Sedimentary Petrographical Series, v. 11, edited by J. Cuvillier and H. M. E. Schurmann, 41 p., 100 pl., 13 text-fig.

Primarily an atlas of various Paleozoic rock-type photomicrographs, illustrating carbonates from the eastern stable interior of the United States. A number of the Mississippian photomicrographs show smaller foraminifers (*Endothyra*), and some of the carbonates illustrated from the Pennsylvanian rocks are said to contain encrusting and arenaceous foraminifers.

32. CONIL, R., 1968, Le calcaire Carbonifère depuis le Tn1a jusqu'au V2a: Ann. Soc. Géol. de Belgique, v. 90, 1966-67, Bull. no. 8, p. 687-726, 10 text-fig., 2 charts, [in French].

A discussion of the micropaleontology (especially the smaller foraminifers) and a study of the rhythmic sedimentation affirms the time-stratigraphic subdivisions of the Dinantian sequence (Lower Carboniferous) of Belgium and has led to a revision of a portion of the Tournaisian sequence and the lower interval of the Viséan sequence. Evidence from measured sections in the Dinant region, obtained since 1965, has caused a revision of known stratotypes and parastratotypes, particularly in the six zones of the Tournaisian (Tn1), and the Waulsortian and its lateral equivalents. Also included is a pertinent discussion of the Tournaisian-Viséan and the V1a-V1b boundaries. One of the charts presents an excellent résumé of the known stratigraphic ranges of characteristic previously-described Tournaisian-Viséan smaller foraminifers, which are illustrated by representative line drawings.

33. CONIL, R., and PAPROTH, E., 1968, Mit Foraminiferen gegliederte Profile aus dem nordwestdeutschen Kohlenkalk und Kulm, with a paleontological appendix by CONIL, R., and LYS, M.: Decheniana, v. 19, pt. 1/2, p. 51-94, 6 pl., 3 text-fig., 4 tables, [in German].

Various algae and smaller foraminifers have been studied in thin-section from the carbonates of the Lower Carboniferous Kohlen and Kulm Limestones of West Germany. The writers have been able to demonstrate that the microfauna contained within these two units is widely distributed, and that there appears to be a close biostratigraphic relationship between the German and Belgian sections. Thirty species of smaller foraminifers, of which one is new, are illustrated by excellent thin-section photomicrographs. Most of the illustrated foraminifers are regarded as pertinent index markers. The new species is *Propermodiscus liebusi.* Table 3 presents an excellent compendium of the index fossils (conodonts, algae, smaller foraminifers, and cephalopods) commonly utilized in subdividing the Tournaisian and Viséan sequence of Germany and Belgium.

One important taxonomic change is noted: *Archaediscus convexus* var. *convexa* Grozdilova and Lebedeva in Conil and Lys, 1964 = *Archaediscus glomus* Ganelina.

34. CONKIN, J. E., CONKIN, B. M., and CANIS, W. F., 1968, Mississippian Foraminifera of the United States. Pt. 3—The limestones of the Chouteau Group in Missouri and Illinois: Micropaleontology, v. 14, no. 2, p. 133-178, 4 pl., 16 text-fig., 42 tables.

The agglutinated foraminiferal microfauna of the Compton, Sedalia, and Chouteau Limestones of the Lower Carboniferous (Mississippian-Kinderhookian) in Missouri and Illinois, described from 83 samples at 27 localities, consists of 42 species (including 5 new, 5 emended and 1 problematic species) belonging to 16 genera and 7 families. These 42 species, along with 7 others found in other Kinderhookian formations, constitute the known Kinderhookian agglutinated foraminiferal microfauna found to date in the United States. Approximately half of the Chouteau species occur in other Kinderhookian beds from Ohio and Kentucky westward to Oklahoma and Montana. Fourteen Kinderhookian species range downward into the Upper Devonian, and 28 range upward into the overlying Osagean interval. Seventeen species appear to be confined to the Kinderhookian, 8 of which occur widely enough to be regarded as reliable Lower Carboniferous (Kinderhookian) markers.

The new species are: *Saccammina howei, Oxinoxis swallowi, Ammovertella lisae, Tolypammina* [probably *Minammodytes*] *bransoni*, and *Sorosphaera*? *cooperensis*. All of the described species of the Chouteau microfauna are illustrated by whole-specimen photomicrographs. Pertinent taxonomic changes include the following: *Sorosphaera geometrica* Eisenack of Gutschick, Weiner and Young, 1961, (= *S*? *cooperensis* n. sp.); *Thurammina diforamens* Ireland, *T. quadritubulata* Dunn, and *T. furcata*, all of Gutschick and Treckman, 1959, (= *T.*? *triradiata* Gutschick and Treckman, 1959); *Ammodiscella*? sp. Conkin, Conkin, and Pike, 1965, (= *Ammovertella lisae* n. sp.); *Trepeilopsis spiralis* Gutschick and Treckman, 1959, (= *T. recurvidens* Gutschick and Treckman, 1959); and *Ammobaculites pyriformis* Gutschick and Treckman, 1959, (= *A. leptos* Gutschick and Treckman, 1959).

35. CRANE, M. J., and KELLY, W. A., 1956, A new occurrence of Mississippian Ostracoda in Michigan: Jour. Paleontology, v. 30, no. 4, p. 869-875, pl. 98.

The writers mention the occurrence of numerous *Paramillerella* [now *Eoendothyranopsis*] and *Plectogyra* [now *Endothyra* or *Globoendothyra*] in the Middle (?) Mississippian Bayport Limestone of Arenac County, Michigan.

36. DIBNER, A. F., 1967, The Upper Paleozoic of the Lene-Katang'sk Syncline. *IN*: Stratigraphy of the Paleozoic of northern Siberia: Akad. Nauk S.S.S.R., Sibirsk Otdel. Izdat. Nauka, p. 213-215, 1 table, [in Russian].

Four Permian stratigraphic subdivisions are recognized in the rocks of the Nordvinsk region of the Soviet Union. The subdivisions are based upon the ranges of previously described species of agglutinated and calcareous foraminifers. These divisions are tentatively correlated with the Sakmarian-Tatarian Stages of the original Permian System.

37. ECHOLS, J., 1968, Relation of microfaunal distribution to the Strawn-Canyon boundary, northcentral Texas: Compass, v. 45, no. 4, p. 202-211, 1 text-fig.

The writer observes that an analysis of the Middle Pennsylvanian microfauna from northcentral Texas—principally smaller foraminifers and ostracodes (excluding fusulinids)—reveals no significant faunal break that would indicate a disconformity at the Strawn-Canyon boundary. No definite boundary was observed. Microfaunal distribution appears to be related to ecology and not time. Samples containing megafossils have larger and more diverse microfaunas than those lacking megafossils. No zonation was possible, because of the lateral and vertical variation in the microfauna and the long stratigraphic ranges of the common species.

The most meaningful Desmoinesian-Missourian boundary is thought to be a lithologic unit, *i.e., a* time-stratigraphic boundary. However, the Desmoinesian-Missourian boundary could not be placed with confidence in the area of the present study.

38. EGIASAROI, V. X., LUNDO, O. P., ANUKEEVA, L. I., RUSAKOV, I. M., and DESMIARENKO, IU. P., 1965, Geology and fossils of the Koriahsk Mountains: Inst. Geol. Arktiki Trudy Nauk Issl., v. 148, 343 p., 19 text-fig., 1 correlation chart, 2 colored maps, 31 tables, [in Russian].

From the Koriahsk Mountains of northeastern Siberia, in the vicinity of the Bering Straits, U.S.S.R., the writers report the occurrence of four microfaunal assemblages ranging in age from Lower Carboniferous (lower Namurian) to Permian. All of the reported smaller foraminifers appear to have been previously described, with the exception of the genus *Paratuberitina* Reitlinger, which is, to the compilers' knowledge, a *nomen nudum*.

39. EICKHOFF, G., 1968, Morovamminidae (Foraminifera) aus dem Unterkarbon vom Hermannsholz bei Frankenberg an der Eder: Neues Jahrb. Geol. Paläont. Mh., v. 3, p. 129-142, 14 text-fig., [in German].

A well-preserved foraminiferal microfauna is recorded from the Lower Carboniferous marls and limestones of Frankenberg/Eder, West Germany. Five species are described and illustrated by thin-section and whole-specimen photomicrographs. One species, *Moravammina simplex,* is new. This marks the first time that a representative of this genus has been reported from rocks younger than Devonian. The remainder of the microfauna is referred to described species of *Earlandia* and *Lugtonia.*

40. EICKHOFF, G., 1968, Neue Textularien (Foraminifera) aus dem Waldecker Unterkarbon: Paläont. Zeit., v. 42, no. 3/4, p. 162-178, pl. 19-20, 6 text-fig., [in German with English and French summaries].

An outcrop of Lower Carboniferous rocks (Kohlenkalk von Schreufa) in the vicinity of Frankenberg, West Germany, has yielded a well-preserved microfauna of 5 species, of which 2 genera, 2 species, and one name are new. The new forms are: *Koskinotextularia cribriformis, Koskinobigerina breviseptata,* and *Cribrostomum curvatum* nom. nov. The microfauna is illustrated by line drawings and both thin-section and whole-specimen photomicrographs.

Pertinent taxonomic changes include the following: *Cribrostomum jeffersonensis* Harlton, 1927 (*pars*) = *Koskinotextularia cribriformis; Cribrostomum obliquum* Conil & Lys, 1964 = *Koskinotextularia obliqua* (Conil & Lys); and new name *C. curvatum* is proposed for the foraminifer *Cribrostomum eximium* Eichwald *sensu* Möller 1879, because *C. lecomptei* Conil & Lys 1964 cannot be accepted as a new name. The writer believes that there is too little correspondence with the description given by Möller. *Cribrostomum lecomptei* Conil & Lys, 1964, is described as a separate species.

41. ELLINGSON, J. A., 1969, Paleozoic sedimentary and metamorphic rocks in the southern Cascade Mountains, Washington: Geol. Soc. America, Abstracts With Programs for 1969, Pt. 3, Meeting In Eugene, Oregon, p. 15-16.

The writer reports that in the Russell Ranch Formation of the southern Cascade Mountains, Washington, large fragments of relatively undeformed oolitic pelletal limestone have nuclei of smaller foraminifers. L. Holcomb identified *Globivalvulina* sp., *Textularia* sp., and *Geinitzina*? sp. He concluded that these microfossils are definitely post-Mississippian and pre-Triassic in age and are probably Permian.

42. FIEBIG, H., and GREBE, H., 1956, Die fazielle und stratigraphische Bedeutung der Mikrofauna im Ruhrkarbon und ihr praktischer Wert für den Bergbau: Deutsche geol. Gesellschaft, Zeitschrift, Berlin, v. 107, p. 284-285, [in German].

In a study of the ostracodes present in the cyclic coal-bearing Middle Carboniferous (Westphalian) sediments of the Ruhr Valley, Western Germany, the writers note that ostracode occurrence is dependent upon environment. The marine facies is characterized by the occurrence of *Hollinella,* the brackish facies by *Jonesina,* and the nonmarine facies by *Carbonita.* Agglutinated foraminifers, present in this same sequence of strata, seem to adapt more readily to salinity changes and, hence, the foraminifers *Ammodiscus, Glomospira, Glomospirella,* and *Hyperammina* occur with little variation in their relative abundances in both marine and brackish-water realms.

43. GALITSKAIA-GLACHENKO, A. IA., 1958, On the stratigraphy of the Lower Carboniferous of the Djergalan and Tekes Rivers: Akad. Nauk Kirgiz S.S.R., Trudy, Inst. Geol. Bull. 10, p. 3-15, 2 text-fig., [in Russian].

The writer's usage of smaller foraminifers (previously described taxa of the Archaediscidae, Biseriamminidae, and Bradyinidae) helped in subdividing a thick (4,000 meters) section of arenites and shales into 4 stratigraphically recognizable foraminiferal assemblage zones in the region of the Djergalan and Tekes Rivers, U.S.S.R. These microfaunal assemblages range in age from Lower Carboniferous (uppermost Viséan or lowermost Namurian) to Middle Carboniferous (Bashkirian).

44. GANELINA, R. A., 1966, Tournaisian and lower Viséan foraminifers of some areas of the Kama-Kinel depression: Vses. Neft. Nauch-Issled. Geol. Instit. (V.N.I.G.R.I.), Trudy, Bull. 250, Microfauna U.S.S.R., Sbornik 14, p. 64-151, 12 pl., 1 text-fig., 1 table, [in Russian].

The writer lists the stratigraphic ranges of 235 species of smaller foraminifers present in the Lower Carboniferous (Tournaisian-Viséan) strata of the Kama-Kinel region, near Perm, U.S.S.R.

In addition to the redescription of numerous previously described taxa, 3 genera and 23 species are described as new and illustrated by excellent thin-section photomicrographs. The new forms include: *Glomospiranella annulata, G. venusta, Uvatournayella uva* (n. gen.), *U. astricta, U. annularis, U. pluvialis, Uviella aborigena* (n. gen.), *U. racemus, U. baculus, Tournayellina solida, Rectochernyshinella mutila, R. bifida, Lituotubella conferta, Corrigotubella posneri* (n. gen.), *Haplophragmella* *curta, Dainella amenta, D. cognata, D. manifesta, Paraendothyra ninae, Plectogyra (Latiendothyra) quaesita, P. (L.) notabilis, P. (L.) tortuosa,* and *Globoendothyra dilatata.* [The Viséan interval can be recognized by the first appearance of the Archaediscidae, *Dainella,* and *Globoendothyra*].

45. GOLUBSOV, V. K., 1962, The Carboniferous sediments in the Retchitsy region: Vesti Akad. Nauk, Biel. S. R., ser. fizika-tekhnichnykh nauk, Minsk, No. 3, p. 75-80, 2 text-fig., 1 table, [in Ukrainian].

The writer reports the occurrence of a microfauna of 36 previously described taxa from a condensed Lower Carboniferous (middle and upper Viséan) carbonate sequence encountered in a borehole taken in the Dneiper Valley region, U.S.S.R. The overlying Carboniferous units are zoned with fusulinids.

46. GORTANI, M., 1906, Contribuzioni allo studio del Paleozoico Carnico. Pt. 1 La Fauna Permocarbonifera: Palaeontographia Italica, v. 12, 84 p., 3 pl., 7 text-fig., 1 table, [in Italian].

The writer describes and illustrates with thin-section photomicrographs a few smaller foraminifers encountered in the Permo-Carboniferous rocks of the Carnic Alps. The microfaunal assemblage consists of: *Tetrataxis maxima, Bigenerina* sp., *Nodosaria*? sp., *Endothyra* sp. cf. *E. bowmani,* and *E.* sp. A few fusulinids are also described along with a rather large and diverse megafauna.

47. GROZDILOVA, L. P., 1966, Upper Carboniferous Foraminifera of northern Timan: Vses. Neft. Nauch-Issled. Geol. Instit. (V.N.I.G. R.I.), Trudy, Bull. 250, Microfauna U.S.S.R., Sbornik 14, p. 254-331, 15 pl., 2 tables, [in Russian].

Basically a monograph on the Upper Carboniferous (Ghzelian, Orenburgian, and Asselian Stages) Fusulinidae of northern Siberia; however, the writer gives the stratigraphic ranges of 16 significant smaller foraminifers (all previously described) and compares them to the standard fusulinid zonation of this region of the U.S.S.R.

48. GUBAREVA, V. S., and RAKHMANOVA, S. G., 1968, The Lower Carboniferous boundary: Akad. Nauk S.S.S.R., Doklady, v. 178, no. 6, p. 1374-1377, [in Russian; English translation *IN*: Doklady ESS, v. 178, p. 92-94, American Geol. Inst.].

The writers report that in a continuous succession of carbonate beds at the Devonian-Carboniferous boundary, in the Saratov region of the Soviet Union, boreholes have indicated that the *Quasiendothyra communis* microfauna is associated with a residual Upper Devonian assemblage. It is noted that the overlying *Quasiendothyra kobeitusana* assemblage is associated with Tournaisian forms such as *Chernyshinella*? and *Brunsiina uralica;* it should therefore be considered as the earliest zone of the Lower Carboniferous.

49. HENBEST, L. G., 1945, Unusual nuclei in oolites from the Morrow Group near Fayetteville, Arkansas: Jour. Sed. Petrology, v. 15, no. 1, p. 20-24, 6 text-fig.

The writer reports that the foraminifers *Endothyra* and *Millerella* often serve as constituents of oolite nuclei in the Lower Pennsylvanian limestones (Hale Formation), near Fayetteville, Arkansas.

50. IASKOVITCH, V. B., and KHALETCHAIA, O. N., 1965, Lower Carboniferous. *IN*: Sergunkova, O. I., Stratigraphy of the Uzbek S.S.R., Pt. 1, Paleozoic: Akad. Nauk S.S.R., Tashkent, Instit. Geol.-Geoph., p. 155-258, text-fig. 6-11, [in Russian].

The writers report that the Lower Carboniferous (Tournaisian and Viséan Stages) in the Tchatkalo-Kyraminsk Mountains, the Alaisk Range, and the Turkestan and Nuratinsk Ridges, of the Uzbek region (U.S.S.R.) are biostratigraphically subdivided into 15 micro- and macrofaunal zones based on ammonoids, brachiopods, and smaller foraminifers. The great precision of this zonation allows reconstruction of a series of paleogeographic maps for the entire Tian-Shian region (text-fig. 7-11). [All taxa (approximately 120) have been previously described, with the exception of *Hyperammina elegans* var. *crassa* Pojarkov and *Endothyra maljavkini* Mikliko-Maklai, which are to the compilers' knowledge both *nomina nuda.* It is also noted that these stratigraphic zones are not comparable to those used by European workers. For instance, the *Endothyra rauserae-Quasiendothyra* ex. gr. *communis* Zone is regarded as Lower Carboniferous (Tournaisian) by Soviet workers, whereas it is regarded as Upper Devonian (Famennian) in the type region of western Europe. In addition, the "upper Viséan" *Asteroarchaediscus-Globivalvulina* assemblage is only present in the typical early Namurian of England. Moreover, numerous discrepancies are observed between micro- and macrofaunal ages. For example, the presence of the brachiopod *Plicatifera humerosa* associated with a supposed typical microfauna certainly deserves reinvestigation.]

51. IU-IA LIVCHITZ, 1966, New data on the geological character of the Great Pyramid region (mountainous Spitzbergen): Nauch.-Issled.

Inst. Geol. Arktik., Uchenye Zapiski, Bull. 9, p. 35-56, 5 text-fig., 1 table, [in Russian].

The writer notes that in westcentral Spitsbergen the Lower Carboniferous sequence is entirely continental and no Foraminifera have been encountered. It is noted that the upper portion of the Late Paleozoic is a marine sequence, and the writer reports smaller foraminiferal assemblages (all previously described species) diagnostic of the lower Middle Carboniferous (*Planospirodiscus*), Moscovian (*Bradyina magna*), and of the Upper Carboniferous and Lower Permian (*Syzrania bella*). [It is noted that the *Bradyina-Climacammina gigas* assemblage is here reported as occurring with *Nodosaria netchajevi* in the questionable Lower Permian portion of the section.]

52. JUNG, J., 1928, Contribution à la géologie des Vosges hercyniennes d'Alsace: Serv. Géol. Als.-Loraine, Univ. Strasbourg Mém. No. 2, 481 p., 5 pl., 22 text-fig., 2 maps, [in French].

The writer mentions (p. 289) the presence of the smaller foraminifers: *Endothyra, Nodosinella, Valvulina, Tetrataxis, Trochammina* and *Saccammina,* in the Lower Carboniferous (Viséan) limestones near Willer and Tremont, France. Plate 5, figure 2 shows a photomicrograph of a thin section which contains an *Endothyra.*

53. KAMALETDINOV, M. A., KAMALETDINOV, R. A., and NADEZHKIN, A. D., 1967, Geology of the Bol'shoy Ik Basin, southern Urals: Akad. Nauk S.S.S.R., Doklady, v. 174, no. 4, p. 909-912, 2 text-fig., [in Russian; English translation *IN*: Doklady ESS, v. 174, p. 58-60, 2 text-fig., Amer. Geol. Inst.].

A drill core log and detailed geological surveys have shown that the Devonian reef massif of the Bol'shoy Ik Basin (the southern Urals, U.S.S.R.) was overthrust from the east onto Middle Carboniferous rock. The Middle Carboniferous age of this sequence is indicated by the occurrence within the cored sequence of previously described species of smaller foraminifers and fusulinids [foraminifers identified by A. Ya Vissarionova and A. Ya Nikol'skaya].

54. KHACHATRIAN, R. O., KRESTOVNIKOV, V. N., LIPINA, O. A., and ROSTOVCEVA, L. F., 1961, On some continuous Tournaisian-Viséan successions at the Rjauziak River (southern Urals): Akad. Nauk S.S.S.R., Doklady, v. 140, no. 4, p. 919-921, [in Russian].

The writers report the biostratigraphic zonation of five foraminiferal assemblages occurring in a thin but continuous Lower Carboniferous succession in the southern Urals, U.S.S.R. Approximately fifty smaller foraminifers, all previously described, enable recognition of rocks dated as middle Tournaisian, upper Tournaisian, lower Viséan, and middle Viséan. This report is of especial interest for its study of the Tournaisian-Viséan passage beds. The *Tetrataxis kiselicus-Palaeotextularia diversa-Plectogyra elegia* assemblage is considered to be at the boundary of the two stages, while the *Quasiendothyra* [now *Urbanella*] *urbana-Globoendothyra parva-Endothyra transita* assemblage appears to be characteristic of the lowermost Viséan.

55. KOGAN, V. D., ANDREYEVA, V. I., and KOLOMIYETS, YA. I., 1967, Coastal facies of the Bakhmut Sea and *Schwagerina*: Paleont. Zhur., No. 4, p. 35-41, 2 text-fig., [in Russian].

The writers note that in the Lower Permian Bakhmut Series of the Dneiper-Donets Basin, U.S.S.R., the sequence is divided into three rock suites: the Nikitova, Slavyansk, and Kramatorsk, in ascending order. The lower two are made up of interlayered calcareous rocks, clays, siltstones and evaporites. The upper suite is principally rock salt. The schwagerinid fusulinids are essentially restricted to the non-salt horizons (coastal or shelf facies). Associated with the schwagerinids are numerous (18) previously described species of smaller foraminifers, suggesting a "normal marine" depositional environment.

Significantly, the writers report that there is a definite inverse relationship between the occurrence of schwagerinids and representatives of the Lagenidae. The number of lagenids, particularly *Dentalina* and *Geinitzina,* sharply decreases in layers where schwagerinids are abundant.

56. LAPINA, N. N., 1967, The Lower Carboniferous carbonates of the Siberian Platform. *IN*: Stratigraphy of the Paleozoic of northern Siberia: Akad. Nauk S.S.S.R., Sibirsk Otdel. Izdat. Nauka, p. 194-196, [in Russian].

The writer notes there are two Lower Carboniferous (upper Tournaisian) foraminiferal horizons in northcentral Asia which have been helpful in subdividing the rocks of this region. The recognized forms are previously described taxa. Characteristic species of spores and brachiopods are also reported.

57. LAPINA, N. N., and TROSHINA, M. K., 1959, The Carboniferous deposits north of the Boljezimelsk Tundra: Akad. Nauk S.S.S.R., Doklady, v. 128, no. 2, p. 366-368, [in Russian].

The writers report the occurrence of five Lower Carboniferous foraminiferal assemblages from a clay-carbonate succession (550 meters thick) in the Boljezimelsk Tundra, northern U.S. S. R. The distribution of 35 previously described foraminiferal taxa enables recognition of the following Lower Carboniferous stages: (1) the early Tournaisian with abundant *Bisphaera*; (2) the late Tournaisian with *Spiroplectammina* [now *Palaeospiroplectammina*] *tschernyshinensis* and *Chernyshinella glomisformis* [this microfauna is characteristic of the middle Tournaisian in its type locality]; (3) the middle Viséan Tula Horizon with *Archaediscus convexus;* (4) the late Viséan Mikhailov Horizon with *Endothyra crassus intermedia* [now *Endothyranopsis*] and *Lituotubella glomospiroides;* and (5) the latest Viséan Venev Horizon with the fusulinid *Eostaffella ikensis.*

58. Lapparent, De, A. F., and Lys, M., 1966, Attribution au Permien supérieur du gisement à Fusulines et Brachiopodes de Kwaja Gar (Bamian, Afghanistan): Acad. Sci. Paris, C. R., v. 262, ser. D, p. 2138-2141, [in French].

The Kwaja Gar brachiopod beds of Afghanistan have in the past been assigned to various horizons within the Carboniferous or Permian Periods. Restudy of the microfauna of the type locality enables the present writers to established firmly an Upper Permian age for this rock sequence. A rich fusulinid sequence (*Polydiexodina* Assemblage) is abundantly represented along with the following smaller foraminifers: *Glomospira regularis, G.* sp., *Hemigordius* sp., *Cribrostomum* sp., *Spiroplectammina* sp. [now *Palaeospiroplectammina*], *Globivalvulina* sp., *Langella perforata* (Lange), and *Geinitzina* sp. The algae *Mizzia* and *Permocaculus,* along with characteristic Permian brachiopods, are also conspicuous within this interval.

59. Lebedeva, N. S., 1966, Foraminifera of the Middle Carboniferous of northern Timan: Vses. Neft. Nauch-Issled. Geol. Instit. (V.N.I. G.R.I.), Trudy, Bull. 250, Microfauna U.S.S.R., Sbornik 14, p. 176-229, 12 pl., 2 tables, [in Russian].

Principally a monographic study of the Middle Carboniferous (Namurian, Bashkirian, and Moscovian Stages) Fusulinidae of northern Siberia; however, the writer utilizes the stratigraphic ranges of 27 significant smaller foraminifers (all previously described) and compares them (mostly Palaeotextulariilae, Bradyinidae, and Archaediscidae) to the current fusulinid zonation used in this region of the U.S.S.R.

60. Lipina, O. A., Mkrtchian, O. M., and Khachatrian, R. O., 1959, The Kizel Horizon of the southwestern part of the Birsk Saddle: Akad. Nauk S.S.S.R., Doklady, v. 125, no. 6, p. 1323-1325, 1 text-fig., [in Russian].

The writers report the occurrence of a microfauna of 40 previously described smaller foraminifers from 3 Devonian-Lower Carboniferous formations encountered in boreholes taken in the southwestern part of the Birsk Saddle, U.S.S.R. The Upper Devonian carbonate sequence is practically devoid of foraminifers. Overlying this is an argillaceous carbonate sequence which contains an Etroeungt foraminiferal assemblage (*Endothyra* ex. gr. *communis, E. communis regularis, Quasiendothyra kobeitusana*) and a Cherepet assemblage (*Chernyshinella glomiformis-Palaeospiroplectammina tschernyshinensis*). The uppermost sandy argillaceous sequence is correlated with the Kizel Limestone, as it contains the diagnostic *Endothyra constifer-E. spinosa-Tournayella discoidea* assemblage.

61. Ludbrook, N. H., 1967, Permian deposits of South Australia and their fauna: Roy. Soc. South Australia, v. 91, p. 65-87, 5 pl., 2 text-fig.

Lower Permian sediments occur in all the main sedimentary basins of South Australia. In general, most of the formations, a few of which are herein named and described, carry a widely distributed agglutinated foraminiferal fauna in which *Hyperammina, Ammodiscus,* and *Hemidiscus* are the most common forms. From surface and subsurface sections the writer describes a microfauna of twenty-three species, of which five are new. All forms are illustrated by whole-specimen photomicrographs. The new species are: *Saccammina orca, Hemidiscus balmei, Ammovertella* (?) *glomospiroides, A. howchini,* and *Recurvoides wilsoni.* It is thought that the above microfauna is indicative of a restricted environment of low temperatures or low salinity.

62. MacQueen, R. W., and Bamber, E. W., 1967, Stratigraphy of Banff Formation and lower Rundle Group (Mississippian), southwestern Alberta: Geol. Survey Canada, Paper 67-47, 37 p., 3 pl., 9 text-fig.

The writers report the occurrence of two Mississippian foraminiferal assemblages from rocks in the Canadian Cordilleran of western Canada. The two foraminiferal assemblages are: a lower Osage microfauna of endothyroid and tournayellids from the basal Livingston Formation, thought to be similar to that of the Cherepet Horizon of the Russian Platform; and a Meramecian *Eoendothyranopsis-Globoendothyra* assemblage within the Livingston Formation [foraminiferal identifications by B. L. Mamet].

63. MacQueen, R. W., and Bamber, E. W., 1968, Stratigraphy and facies relationships of the Upper Mississippian Mount Head Formation, Rocky Mountains and foothills, southwestern Alberta: Bull. Canadian Petroleum Geol., v. 16, no. 3, p. 225-287, 12 pl., 11 text-fig., 1 table, 2 appendices.

The writer reports the occurrence of smaller foraminifers in the Upper Mississippian (Meramecian) Mount Head Formation (Rundle Group) of southwestern Alberta, Canada. Numerous excellent thin-section photomicrographs of various carbonate facies contain conspicuous endothyroid foraminiferal elements.

64. MAKARENKO, M. V., and PCELINTSEV, P. E., 1962, Carboniferous and Devonian deposits of the northwestern part of the Bolshekinel Arch: Geol. Neft i Gasa, Moscow, no. 1, p. 28-32, 1 text-fig., [in Russian].

Three Carboniferous microfaunal zones based upon previously described taxa of smaller foraminifers are reported from a series of boreholes taken near Kuybeshev (Volga), U.S.S.R. The lower Tournaisian is characterized by the occurrence of numerous bispherids; the middle Viséan by Archaediscidae and Endothyridae, and the Bashkirian by Palaeotextulariidae and Fusulinidae.

65. MALAKHOVA, N. P., 1967, The Permian deposits of the Bagariak River. *IN*: Permian deposits of the eastern side of the Urals: Akad. Nauk S.S.S.R., Sbornik po vopr. stratig. No. 9, Ural Filial, Instit. Geol.-Geochem., Sverdlovsk, p. 11-24, [in Russian].

The writer describes various Permian conglomerates exposed along the Bagariak River, eastern Urals, U.S.S.R. It is noted that these conglomerates carry pebbles which can be dated by their contained microfaunas as Silurian, Devonian, Lower and Middle Carboniferous. Lists of the smaller foraminifers and fusulinids are given; no new taxa are mentioned.

66. MALAKHOVA, N. P., 1967, Fauna in metamorphic rocks of the Urals: Akad. Nauk S.S.S.R., Urals Filial, Instit. Geol.-Geochem., Sverdlovsk, 144 p., 74 pl., 3 text-fig., 6 tables, [in Russian].

The writer describes and illustrates various diagenetic alterations due to recrystallization and replacement of carbonate sediments exposed to physio-chemical changes. Most of the illustrated examples are of foraminiferal Upper Paleozoic rocks from the Ural Mountains, U.S.S.R. Numerous photomicrographs of various Archaediscidae, Endothyridae, and Fusulinidae are included which show various stages of test wall destruction due to recrystallization.

67. MALAKHOVA, N. P., and MALAKHOV, A. A., 1961, The Moscovian and Ghzelian Stages in the central part of the Urals: Nauk S.S.S.R., Ural Filial, Inst. Gorno-Geol., Trudy, Bull. 59, 85 p., 3 text-fig., 13 tables, [in Russian].

The writers have prepared a complete stratigraphic compendium of the brachiopod and foraminiferal subdivisions and zonations currently in use for the Middle and Upper Carboniferous rocks of the Urals region of the Soviet Union. These zonations are based upon previously described taxa.

68. MAMET, B. L., 1968, Foraminifera, Etherington Formation (Carboniferous), Alberta, Canada: Bull. Canadian Petroleum Geol., v. 16, no. 2, p. 167-179, 4 text-fig.

Four distinctive foraminiferal assemblages are recognized in the Etherington Formation of southwestern Alberta, Canada. Their ages range from late Viséan to middle early Namurian (Lower Carboniferous, microfaunal zones 16 to 18 in Eurasia). The Etherington Formation is believed to be the time-equivalent of the Upper Mississippian Chester Group of the Midcontinent region of the United States. Previously described species characteristic of each microfaunal zone are listed.

69. MAMET, B. L., MORTELMANS, G., and SARTENAER, P., 1965, Réflexions à propos du Calcaire d'Etroeungt: Bull. Soc. Belge Géologie, v. 74, no. 1, p. 41-51, 4 text-fig., [in French].

The writers describe the smaller foraminifers from the controversial Upper Devonian-Lower Carboniferous (Famennian-Tournaisian) boundary beds of Belgium. They note that in the type-section of the Etroeungt Limestone and in the surrounding region the upper Famennian is shown to contain a succession of distinct assemblages of Tournayellids, *Quasiendothyra* ex. gr. *communis* and *Q. communis communis*. The stratotype of the Etroeungt Limestone is nearly coincident with the base of the *Quasiendothyra kobeitusana* Zone. Comparison is made with the smaller foraminiferal succession present in the Soviet Union, where an identical sequence is observed.

70. MAMET, B. L., and BELFORD, D. J., 1968, Carboniferous Foraminifera, Bonaparte Gulf Basin, northwestern Australia: Micropaleontology, v. 14, no. 3, p. 339-347, 5 text-fig.

A sequence of Lower Carboniferous foraminiferal microfaunas (no new taxa) is recorded from outcrop sections and well samples from the Bonaparte Gulf Basin region of northwestern Australia. Foraminiferal zonal assemblages have been recognized from probable lower or middle Tournaisian, upper Tournaisian, upper Viséan and lowermost Namurian rocks. Distinctive lower and middle Viséan foraminiferal assemblages are not known. The foraminiferal microfaunas show a strong Tethyan influence and closely resemble those recorded previously from southeast Asia. This conclusion is of particular paleogeographic importance, as it suggests free migration at this time interval through the seas between Gondwana and Laurasia.

71. MAMET, B. L., and MASON, D., 1968, Foraminiferal zonation of the Lower Carboniferous Connor Lakes section, British Columbia: Bull. Canadian Petroleum Geol., v. 16, no. 2, p. 147-166, 5 text-fig.

An abnormally thick sequence of carbonate rocks near Connor Lakes in southeastern British Columbia includes 10 foraminiferal zones of middle Tournaisian to early Namurian (Lower Carboniferous) age. The foraminiferal assemblages contain abundant endemic North American microfaunas but also Eurasiatic forms. This widespread distribution of some elements of the Eurasiatic microfaunas permits the recognition of the original Lower Carboniferous zonation at the type section in Europe and allows its extension into the North American Cordilleras. Significantly, the writers note the most obvious difference between the Cordilleran microfauna and that of the Eurasiatic realm is the replacement of *Eostaffella-Pseudoendothyra* by *Eoendothyranopsis.*

72. MARUCHKIN, I. A., and SOLOVIEVA, M. N., 1964, New discovery of Permian deposits in the western part of the Alai Range: Lvov Univ., Vestnik, ser. geol. Bull. 2, p. 47-51, 2 text-fig., [in Russian].

A thick sequence of conglomerates exposed along the Kok-su River (westcentral Asia, U.S.S.R.) is dated as Permian owing to the discovery of a small microfauna of fusulinids, endothyroids, ammodiscids, and bradyinids. All taxa have been previously described.

73. MATUKHIN, R. G., BOGUSH, O. I., and JUFEREV, O. V., 1966, New data on the Upper Devonian and Lower Carboniferous of the Noril'sk region: Akad. Nauk S.S.S.R., Sibirskoe Otdel., Izvestiia, Geol. i Geofizika. No. 12, p. 107-109, 1 text-fig., [in Russian].

The writers note that 6 formations were penetrated in a recent borehole near the Yenissey River in northcentral Siberia, U.S.S.R. Three of these formations carry smaller foraminiferas which indicate an Upper Devonian, and middle and upper Tournaisian (Lower Carboniferous) age for this group of rocks. The foraminiferal assemblages (previously described species of Endothyridae and Tournayellidae) are compared to those from the Kuznetz Basin and the Ural Mountains.

74. MIKLUKO-MAKLAI, K. V., 1956, The Upper Permian deposits of the northwestern Caucasus: Materialy po geologii Europeiski territorii S.S.S.R., Materialy V.S.E.G.E.I., n. ser. Bull. 14, p. 60-78, 9 text-fig., [in Russian].

The writer describes the biostratigraphic subdivision of the Upper Permian deposits of the northwestern Caucasus Mountains, U.S.S.R., based primarily on assemblages of previously described smaller foraminifers. Representative genera include: *Nodosaria, Robuloides, Hemigordiopsis, Lasiodiscus, Pararobuloides, Neodiscus,* and *Cribrogenerina.* The writer claims that his proposed subdivision, utilizing characteristic species of the above genera, is as precise as that based on Fusulinidae. However, no formal biostratigraphic zonation is proposed.

75. MILON, Y., 1923, Etude préliminaire des calcaires briovériens de St.-Thurial et de leur microfaune: Soc. Géol. Minér. de Bretagne, Bull., v. 4, pt. 2, p. 113-116, [in French].

The writer reports the presence of the smaller foraminifers *Endothyra, Valvulina,* and *Nodosinella,* along with calcispheres, in the St.-Thurial Breccia of northwestern France. [The above microfauna suggests a Carboniferous age for the enclosing rock. However, the Brioverian of northwestern France is of Precambrian age and no smaller foraminifers have subsequently been reported. The Carboniferous microfauna reported here is probably a result of a mix-up and mislabeling of foraminiferal slides.]

76. OKIMURA, Y., 1967, Carboniferous palaeotextulariid foraminifers from the Akiyoshi Limestone Group, southwest Japan: Jour. Sci. Hiroshima Univ., ser. C, v. 5, no. 3, p. 255-266, pl. 17, 2 text-fig.

Nine species of Palaeotextulariidae are described and illustrated by thin-section photomicrographs from the lower part of the Carboniferous Akiyoshi Limestone Group of southwestern Japan. The microfaunal assemblage is composed of: *Palaeotextularia consobrina* Lipina, *P. vulgaris* (Reitlinger), *P.* sp. A, *Deckerellina* sp., *Deckerella* sp., *Cribrostomum* sp., *Climacammina antiqua* (Brady), *C. volgensis* Reitlinger, and *C.* sp. A.

Biostratigraphically, the foraminiferal zones below the *Millerella* sp. A Zone are characterized by the dominance of *Palaeotextularia,* while the *Millerella* sp. A Zone and the overlying ones carry a greater percentage of *Climacammina.* The progressive change of chamber arrangement, aperture pattern and test size, as well as the stratigraphic distribution, bear close resemblance to what have been observed in the British Viséan and Namurian sequence.

77. PAPROTH, E., 1953, Eine Kohlenkalkfauna aus dem Kulmkonglomerat von Frankenberg an der Eder: Paläont. Zeit., v. 27, no. 3/4, p. 169-207, pl. 11-12, 2 text fig., [in German].

The writer reports that smaller foraminifers representing an assemblage of endothyroids, ammodiscids, and textularids, occur in the Lower Carboniferous (uppermost Viséan)conglomerates near Frankenberg, West Germany. The foraminifers are said to be abundant, diverse, and dominated by agglutinated forms.

78. PARKER, W. K., and JONES, T. R., 1872, On the nomenclature of the Foraminifera. Pt. 15, The species figured by Ehrenberg: Ann. and Mag. Nat. Hist., London, v. 10, ser. 4, p. 253-271.

Mainly a revision of Ehrenberg's "Mikrogeologie," with particular reference to described Paleozoic foraminifers (smaller foraminifers and fusulinids). [With the exception of the genus *Tetrataxis,* all of the other taxa have been regarded as *nomina nuda* and have been discarded.]

79. POHL, R. E., BROWNE, R. G., and CHAPLIN, J. R., 1968, Foraminifera of the Fraileys Member (Upper Mississippian) of central Kentucky: Jour. Paleontology, v. 42, no. 2, p. 581-582.

Preliminary note in which the writers report the presence of a foraminiferal faunule of remarkable variety and abundance. The faunule is found in the lower part of the Big Clifty-Fraileys Member of the Golconda Formation (Upper Mississippian) of central Kentucky. Preliminary examination of this faunule indicates that there are foraminiferal representatives of at least 16 families and 37 genera. The particular samples that were studied produced an average yield of 200 specimens per gram. An abundant megafauna occurs with the Foraminifera. The writers plan to publish several manuscripts, each devoted to taxonomically allied forms.

80. QUIRING, H., 1939, Die Ostasturischen Steinkohlenbecken: Preuss. Geol. Land., Archiv für Lagestättenforschung, No. 69, 66 p., 3 pl., 14 text-fig., 3 tables, [in German].

The writer reports the occurrence of the smaller foraminifers *Endothyra* sp. cf. *E. bowmani, E.* sp. cf. *E. crassa,* and *Textularia* from rocks of Lower Carboniferous age (Peña Limestone) in northwestern Spain.

81. RACKMANOVA, S. G., 1962, Tentative correlations of the "productive layers," the Tula and the Aleksin Horizons of the Volgograd Province, by means of electric logging and microfaunal determinations: Vsesoiuznyi Nauch-Issled. Instit. Prirodnykh gazov, Trudy, Moscow, Bull. 16/24, p. 161-175, 1 pl., 1 table, [in Russian].

The writer demonstrates through the use of an excellent biostratigraphical chart (including thin-section photomicrographs of foraminifera) the population variability of 18 Lower Carboniferous (Viséan) foraminiferal genera that occur within various facies. The Tula/Aleksin boundary is drawn at the first appearance of *Brunsia-Glomospira,* Palaeotextulariidae and *Monotaxis* [now *Howchinia*]. [This proposed boundary reflects more of a facies relationship than a pertinent biostratigraphical break. Moreover, the "Tula" of this report appears to be considerably younger than the type Tula.]

82. RAUSER-CHERNOUSSOVA, D. M., 1936, Zur Frage von der stratigraphischen Bedeutung der Ober-Paläozoischen Foraminiferen: Bull. Acad. Sci. U.R.S.S., ser. geol. 1, p. 61-86, 2 text-fig., [in Russian with German summary].

One of the earliest published articles on the zonation of Upper Paleozoic strata by means of smaller foraminifers and fusulinids.

In a lucid summary the writer notes that the Endothyridae appear in Devonian time and undergo rapid development in the Tournaisian interval (*Endothyra bowmani* assemblage). [*Endothyra bowmani* would now probably be classified as *Spinoendothyra* or *Tuberendothyra*; the range of this species is now considered as Viséan to Namurian.] The spirillinids [now Tournayellidae] attain their acme during the Tournaisian. Nonionids [now Endothyrida] *Cribrospira* and *Samarina* are characteristic of the Viséan, and in association with *Endothyra crassa* [now *Endothyranopsis*] and *E. globulus* [now *Globoendothyra*]. The Endothyridae are the direct ancestors of the fusulinids, which appear in Viséan time with primitive *Orobias* [now *Eostaffella, Mediocris,* and *Pseudoendothyra*].

The writer also includes detailed foraminiferal lists for the Kizel Limestone and the Oka Series.

83. RAUSER-CHERNOUSSOVA, D. M., 1947, On the paleogeography of the central part of the Russian Platform during Carboniferous time: Akad. Nauk S.S.S.R., Izvestia, ser. geol. No. 6, p. 87-96, 1 text-fig., [in Russian].

The microfauna of previously described smaller foraminifers is reported from, and characteristic of, the Tula Formation (Lower Carboniferous) of the central Russian Platform. Among the characteristic forms noted for this formation the following are considered diagnostic: *Endothyra compressa* [now *Endothyranopsis*], *Endothyra* ex. gr. *omphalota, E. convexa,* and *Archaediscus* ex. gr. *moelleri.*

84. RAUSER-CHERNOUSSOVA, D. M., 1949, Stratigraphy of the Carboniferous and Artinskian

sediments of the uralian part of Bashkiria: Akad. Nauk S.S.S.R., Trudy, Inst. Geol. No. 105, ser. geol. No. 35, p. 3-21, 1 text-fig., 2 tables, [in Russian].

The writer reports the occurrence and stratigraphic distribution of 129 species of smaller foraminifers, representing the following genera: *Ammodiscus, Glomospira, Endothyra, Bradyina, Globivalvulina, Tetrataxis, Spiroplectammina* [now *Palaeospiroplectammina*], *Deckerella, Climacammina, Nodosaria, Dentalina, Geinitzina,* and *Pachyphloia*, along with fusulinids, in rocks ranging in age from Upper Carboniferous to Permian time (Artinskian) from the uralian portion of Bashkiria, U.S.S.R. One new species, *Spiroplectammina bashkirica* [now *Palaeospiroplectammina*], is described and illustrated by a single thin-section photomicrograph.

85. RAZNITSIN, V. A., 1958, The Carboniferous rocks of the gas-oil bearing Timan-Petchora region: Vses. Nauchno-Issled. Instit. Prirod. Gasov, Trudy, Bull. 4 (12), p. 17-36, 2 text-fig., [in Russian].

The Carboniferous rocks of northern Russia have been subdivided into 27 biostratigraphical zones, of which the Lower Carboniferous rocks can be subdivided into 13 biostratigraphical zones. In most instances Middle and Upper Carboniferous zonation is based primarily on fusulinid and ammonoid species.

In this paper the writer places the base of the Carboniferous at the beginning of the *Quasiendothyra kobeitusana* foraminiferal assemblage. The Viséan is considered to include the Tarussa-Protvae Horizon, while representatives of the Namurian stage are absent. [A number of reported anomalous foraminiferal occurrences, such as the presence of *Forschia* in the Etroeungt and *Climacammina* in the Kizel Limestone, have not been substantiated by later workers].

86. REITLINGER, E. A., 1959, Foraminifera of the border stage of the Devonian and Carboniferous in the western part of central Kazakhstan: Akad. Nauk S.S.S.R., Doklady, v. 127, no. 3, p. 659-662, 1 text-fig., [in Russian].

The Upper Devonian-Lower Carboniferous (Famennian-Tournaisian) boundary is placed by this writer at the base of the "explosion" of the *Quasiendothyra kobeitusana-Q. konensis-Q. mirabilis* foraminiferal assemblage. A diagram showing the stratigraphic position of this assemblage and 22 other previously described smaller foraminifers from the western part of central Kazakhstan, U.S.S.R., is also included.

87. RENZ, C., and REICHEL, M., 1945, Beiträge zur Stratigraphie und Paläontologie des ostmediterranen Jungpaläozoikums und dessen Einordnung im griechischen Gebirgssystem: Eclogae Geol. Helvetiae, v. 38, no. 2, p. 211-313, 1 pl., 3 text-fig., [in German].

The writers present a summary of the biota found to date on the islands of the eastern Mediterranean Sea, in particular that of Cyprus and the Aegean Islands. For the Upper Carboniferous and Permian rocks of this region, age determinations are based upon numerous fusulinids and smaller foraminifers (all previously described or only identified to genus). The smaller foraminifers are species referred under the Palaeotextulariidae, Biseriamminidae, Tetrataxidae, Miliolidae, and Nodosaridae.

88. ROZONOVA, E. D., 1963, Lithology and environmental conditions of the lower Viséan in the Kuznetz Basin: Akad. Nauk S.S.S.R., Inst. Geol. i razr. gor. iskop., Moscow, 136 p., 30 pl., 29 text-fig., 3 tables, [in Russian].

The writer reports the occurrence of three microfaunal assemblages (68 taxa) from the Lower Carboniferous (Viséan) rocks of the Taisonsk, Fominsk, and Verchotomsk Horizons in central Asia. [The stratigraphy utilized, based mainly on smaller foraminiferal occurrences, is a revised version previously presented by Grozdilova and Lebedeva (1954). All of the mentioned taxa have previously been described, with the exception of the form *Planoendothyra kusbassica,* which, to the compilers' knowledge, is a *nomen nudum.*]

89. SAURIN, E., 1950, Les Fusulinidés des calcaires de Ky-Lua Langson (Tonkin): Bull. Serv. Géol. Indochine, v. 29, no. 5, 32 p., 7 pl., 2 text-fig., [in French].

Primarily a report on the fusulinid microfaunas of the Upper Carboniferous rocks of Indochina, southeast Asia. One smaller foraminifer, *Textularia* sp. [now *Palaeotextularia*], is described and illustrated by a single thin-section photomicrograph.

90. SEMIKHATOVA, S. V., 1949, On the stratigraphy of the Lower and Middle Carboniferous of the Don-Medvedich Uplift: Akad. Nauk S.S.S.R., Doklady, v. 69, no. 6, p. 845-848, [in Russian].

The writer reports that the occurrence of characteristic smaller foraminiferal assemblages allows recognition of four Lower Carboniferous horizons in rocks present in the Don Uplift of the Soviet Union. The Lower Carboniferous (Tournaisian) Maleva Horizon is characterized by the presence of *Bisphaera malevkensis* and *B. irregularis;* the middle Tournaisian Chernyshin Horizon by *Endothyra glomisformis* [now *Chernyshinella*], *Endothyra tuberculata* [now *Tuberendothyra*], *Spi-*

roplectammina tschernyshinensis [now *Palaeospiroplectammina*]; the Viséan Tula Horizon with *Endothyra globulus* [now *Globoendothyra*], and the late Viséan Oka Horizon with *Endothyra omphalota* [now *Omphalotis*], and *Endothyra crassa* [now *Endothyranopsis*].

91. SKINNER, J. W., 1969, Permian Foraminifera from Turkey: Univ. Kansas, Paleontological Contrib., Paper 36, 14 p., 32 pl., 2 text-fig.

The writer describes a Permian foraminiferal microfauna from two measured sections 30 to 31 kilometers south-southwest of Ankara, Turkey. The microfauna consists principally of fusulinids, although two species of the smaller foraminifer *Kahlerina* (*Endothyridae*) are described and illustrated by thin-section photomicrographs; one species, *Kahlerina globosa* is new. The fusulinid microfauna suggests that the enclosing rocks are rather low in the "Zone of *Yabeina*."

92. SKINNER, J. W., and WILDE, G. L., 1966, Permian fusulinids from Sicily: Univ. Kansas, Paleontological Contrib., Paper 8, 16 p., 20 pl., 1 text-fig.

Primarily a paper describing the Permian fusulinids found in exotic blocks of limestone in the Sosio Valley of Sicily, Mediterranean region. The description of one new species of a form now regarded as an endothyroid-type smaller foraminifer is also included. This new species, *Kahlerina siciliana*, is described and illustrated by thin-section photomicrographs.

93. SKINNER, J. W., and WILDE, G. L., 1967, Permian Foraminifera from Tunisia: Univ. Kansas, Paleontological Contrib., Paper 30, 22 p., 32 pl., 3 text-fig.

From the marine Permian rocks exposed at Djebel Tebaga, in southern Tunisia, North Africa, a relatively diverse fusulinid microfauna is reported and described. In association with the fusulinids is a new species of endothyroid-type smaller foraminifer, *Kahlerina africana*. The entire microfauna is illustrated by excellent thin-section photomicrographs.

94. SOLOVIEVA, M. F., 1967, New data on the Lower Carboniferous foraminiferal genus *Eoendothyranopsis* in eastern Taimyr: Uchenye Zapiski, Nauch.-Issledov. Inst. Geol. Arktiki, Paleont. i biostratigraphiia, Bull. 18, p. 24-37, 3 pl., 1 text-fig., [in Russian].

The writer describes and illustrates (thin-section photomicrographs) 4 new Lower Carboniferous (Viséan) endothyroid foraminifers from the sediments of eastern Taimyr, northern U.S.S.R. The new forms are: *Eoendothyranopsis mediocriformis, E. subtilis, E. lebedevae,* and *E. rotayi* (Lebedeva) *taimyrica* n. subsp. This microfauna is compared to similar occurrences of this genus in the Viséan rocks of Canada and the United States.

95. SOSNINA, M. I., 1967, New lagenid species of the southern Primor'ja, studies with application to the Lakovykh Plenok region: Vses. nauch.-issl. geol. instit (V.S.E.G.E.I.), Trudy, n. ser. v. 129, Biostrat. Sbornik No. 3, p. 61-75, 6 pl., 8 text-fig., [in Russian].

From the Permian rocks of southern Primor'ja, U.S.S.R., a microfauna of lagenid species is described and illustrated by thin-section photomicrographs and line drawings. The described microfauna consists of 8 new species. These are: *Geinitzina senkinensis, Pachyphloia extensa, P. langei, Marginulinella typica* (n. gen.), *M. composita, M. cubiformis, M. vulgaris,* and *M. amplituda.* A short section is also devoted to the orientation and proper thin-sectioning of lagenids.

96. STEVENS, C., 1968, Variability of Pennsylvanian marine fossils correlated with depth and distance from shore (abstract): Geol. Soc. America, Program Ann. Meetings, Mexico City, p. 291.

Based upon a study of nearshore marine biotas in the Pennsylvanian (Desmoinesian) rocks in Colorado, the writer states that variability of the biotas increases with increasing depth and distance from shore in relatively shallow water. It is noted that the number of types of foraminifers increases from 1 or 2 (fischerinids) [probably hedraetids] nearshore to 6 to 8 in offshore areas. Two other types, the palaeotextulariids and *Bradyina,* appear to be restricted to water about 2.5 miles offshore, where the water depth was greater than 50 feet.

97. SUYETENKO, O. D., 1968, Foraminifera found for the first time in southeastern Mongolia: Akad. Nauk S.S.S.R., Doklady, v. 180, no. 3, p. 691-694, 1 text-fig., [in Russian; English translation *IN*: Doklady ESS, v. 180, p. 50-52, 1 text-fig.].

The writer reports the occurrence of four noncoeval foraminiferal assemblages in the Permo-Carboniferous rocks of southeastern Mongolia. The ages of the assemblages are: (1) Viséan to Namurian, (2) Upper Carboniferous, (3) Lower Permian, and (4) Upper Permian. The determinations are based upon previously described species of fusulinids and smaller foraminifers (most only referred to genus).

98. TARAZ, H., 1969, Permo-Triassic section in central Iran: American Assoc. Petroleum Geologists, Bull., v. 53, no. 3, p. 688-693, 2 text-fig.

An exceptionally thick and very fossiliferous Permian-Lower Triassic marine transitional sequence has been discovered in the Abadeh region of central Iran. The writer reports the occurrence of a number of smaller foraminifers and fusulinids which date the lower part of this section as late Early Permian age. Reported smaller foraminiferal genera include: *Cribrogenerina, Pseudovermiporella, Geinitzina, Pachyphloia, Climacammina, Deckerella, Tuberitina, Palaeotextularia, Lunucammina,* and *Hemigordius*.

99. TERMIER, H., 1936, Etudes géologiques sur le Maroc central et le moyen Atlas septentrional. Pt. 3, Paléontologie, pétrographie: Protectorat Répub. Françoise au Maroc, Serv. Mines, Notes et Mém. no. 33, 1566 p., 97 pl., 63 text-fig., [in French].

The writer presents a very detailed study of the geology of central Morocco and of the northern part of the central Atlas Mountains region of North Africa. Lower Carboniferous (Viséan) foraminiferal assemblages are described from a number of localities, and representative foraminiferal specimens illustrated by excellent thin-section photomicrographs. All of the listed taxa have been previously described or identified only to genus. The foraminiferal assemblages consist primarily of forms assigned under the Endothyridae, Palaeotextulariidae, and Archaediscidae.

100. TERMIER, H., 1942, Présence du Viséan dans les Djebilet (Maroc): Soc. Géol. France, C.R., no. 12, p. 125-127, [in French].

The writer reports the occurrence of 12 Lower Carboniferous smaller foraminifers (all originally described from the Viséan of England by Brady) from a limestone formation of the Jebel Tekzim of central Morocco, North Africa.

101. THOMPSON, M. L., and MELLEN, F. F., 1949, Foraminifers in the Black Warrior Basin of Mississippi and Alabama. *IN*: Guidebook 7th. Field trip Mississippi Geol. Soc., p. 44-54, pl. 4, 5.

The writers report the occurrence of two microfaunal assemblages of Mississippian endothyroid foraminifers from the subsurface of the Black Warrior Basin of Mississippi and Alabama. Large endothyroids are characteristic of the Middle Mississippian, whereas plectogyroid forms and an abundance of the fusulinid *Millerella* characterize the Upper Mississippian. One thin-section photomicrograph of a "plectogyroid-type" *Endothyra* is given on Plate 5.

102. TURNER, J. S., 1950, The Carboniferous limestone in County Dublin, south of the river Liffey: Roy. Dublin Soc., Sci. Proc., v. 25, No. 13, p. 169-192, pl. 5, 6, 2 text-fig.

The writer reports the occurrence of a microfauna of smaller foraminifers from the Lower Carboniferous (middle Viséan) *Cyathaxonia* beds north of Dublin, Ireland. The microfauna is composed of previously described species of Endothyridae, Palaeotextulariidae, Tetrataxidae, and Archaediscidae; it is not illustrated.

103. USTRITSK, V. I., and CHERNIAK, G. E., 1967, The Carboniferous of the Taimyr Peninsula. *IN*: Stratigraphy of the Paleozoic of northern Siberia: Akad. Nauk S.S.S.R., Sibirsk Otdel. Izdat. Nauka, p. 216-219, [in Russian].

The writers report that there are two Tournaisian (mostly Endothyridae and Tournayellidae), three Viséan (mostly Endothyridae), and two Bashkirian (mostly Archaediscidae) foraminiferal assemblages in the Late Paleozoic rock sequences of the Taimyr Peninsula, U.S.S.R. All of the foraminifers are previously described taxa. Other biotic elements include: corals, brachiopods, ostracodes, and fusulinids. The microfauna and megafauna belong to the boreal paleobiological realm.

104. USTRITSK, V. I., and CHERNYAK, G. E., 1967, The Permian of the Taimyr Peninsula. *IN*: Stratigraphy of the Paleozoic of northern Siberia: Akad. Nauk S.S.S.R., Sibirsk Otdel. Izdat. Nauka, p. 220-223, [in Russian].

The writers report that the terrigenous Permian sediments of the Taimyr Peninsula, U.S.S.R., reach a thickness of approximately 5,000 meters. The lower portion is marine and is subdivided into three foraminiferal horizons, mainly based upon numerous previously described species of *Nodosaria, Protonodosaria, Frondicularia, Dentalina, Ammobaculites,* and *Rectoglandulina*. The upper portion of the Permian section is non-marine and dated on the contained flora.

105. VADÁSZ, M. E., 1911, Paläontologische Studien aus Zentralasien: Mitteilungen aus dem Jahrb. d. kgl. Ungarischen Geol. Reichsanst., v. 19, no. 2, p. 55-115, 3 pl., 1 map, [in German].

The writer reports the occurrence and describes the smaller foraminifers *Saccammina fusulinaeformis* and *S. socialis*? [now *Saccamminopsis*] from an Upper Carboniferous crinoidal limestone in central Asia. *S. socialis*? is illustrated (Pl. 2, fig. 20) by a whole-specimen drawing.

Lists are given of other previously described species of smaller foraminifers from the Upper Carboniferous rocks of various localities in central Asia.

106. VAKHRAMEIEV, V. A., 1940, Stratigraphy of the Middle Carboniferous deposits of the north-

eastern Balkash region (Kazakhstan): Akad. Nauk S.S.S.R., ser. geol. Bull. 4, p. 115-130, 5 text-fig., [in Russian with English summary].

The writer reports the occurrence of a diverse microfauna from the Middle Carboniferous Moscovian limestones of Kazakhstan, U.S.S.R. Encountered within these limestones are a dozen previously described smaller foraminifers and some fusulinids. [This report is somewhat antiquated, and the foraminiferal determinations are open to question; many of the cited taxa are now known to be restricted to rocks of Lower Carboniferous age.]

107. VENTCH, F. R., 1965, Upper Paleozoic. *IN*: Sergunkova, O. I., Stratigraphy of the Uzbek S.S.R., Pt. 1, Paleozoic: Akad. Nauk S.S.R., Tashkent, Instit. Geol.-Geoph., p. 259-371, 1 table, [in Russian].

The writer reports the occurrence of 90 Late Paleozoic biostratigraphic horizons ranging in age from Middle Carboniferous to Upper Permian that are useful in subdividing the rock sequences in the Tchatkalo-Kyraminsk and Gissar Mountains, and the Alaisk and Turkestan Ridges, Uzbek region U.S.S.R. The most common and useful determinations are based upon fusulinids, although various Archaediscidae, Biseriamminidae, and Bradyinidae (all previously described) appear to be ubiquitous in Middle Carboniferous (Bashkirian and Moscovian) time.

108. YOUNG, J., 1873, On the occurrence of *Saccammina carteri* (Brady) in the limestone series of Lanarkshire Coalfield: Geol. Soc. Glasgow, Trans., v. 4, p. 263-266.

The writer reports and describes the occurrence of the smaller foraminifer *Saccammina carteri* [now *Saccamminopsis fusuliniformis*; see Chapman, 1898 and Sollas, 1921] from the Lower Carboniferous (upper Viséan) rocks of Scotland.

109. ZIMMERMAN, E., 1910, Kohlenkalk und Kulm des Velberter Sattels im Süden des westfälischen Carbons: Jahrb. der königlich preussischen geol. Landesanstalt, Berlin, v. 30, pt. 2, p. 369-432, 25 text-fig., [in German].

The writer reports and lists the occurrence of a few Lower Carboniferous (Viséan) smaller foraminifers from western Germany. The foraminifers are illustrated by rather crude line drawings. The microfaunal assemblage consists of the following forms: *Endothyra parva, Valvulina* cf. *V. palaeotrochus* [now *Tetrataxis*], *Bigenerina* sp. [perhaps *Valvulinella*?] and *Rotalia* sp. [now regarded as *Endothyra*].

DISTRIBUTION OF ARTICLES ACCORDING TO GEOLOGIC AGE AND CATEGORY

PRECAMBRIAN
24, 75

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DEVONIAN
1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23, 25, 34, 48, 60, 65, 69, 73, 86

MISSISSIPPIAN
1, 8, 15, 21, 26, 27, 28, 29, 31, 32, 33, 34, 35, 38, 39, 40, 43, 44, 45, 48, 50, 52, 54, 56, 57, 60, 62, 63, 64, 65, 68, 69, 70, 71, 73, 75, 76, 77, 79, 80, 81, 82, 83, 85, 86, 88, 90, 97, 99, 100, 101, 102, 103, 108, 109

PENNSYLVANIAN
6, 29, 30, 31, 37, 38, 42, 43, 46, 47, 49, 51, 53, 59, 64, 65, 66, 67, 76, 84, 85, 87, 89, 90, 96, 97, 103, 105, 106, 107

PERMIAN
36, 38, 41, 46, 51, 55, 58, 61, 66, 72, 74, 84, 87, 91, 92, 93, 94, 95, 97, 98, 104, 107

GENERAL
3, 14, 78, 96

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384. A FORAMINIFERAL FAUNA FROM THE EASTERN CONTINENTAL SHELF OF AUSTRALIA

A. D. ALBANI
School of Applied Geology, The University of New South Wales, Kensington, N.S.W.

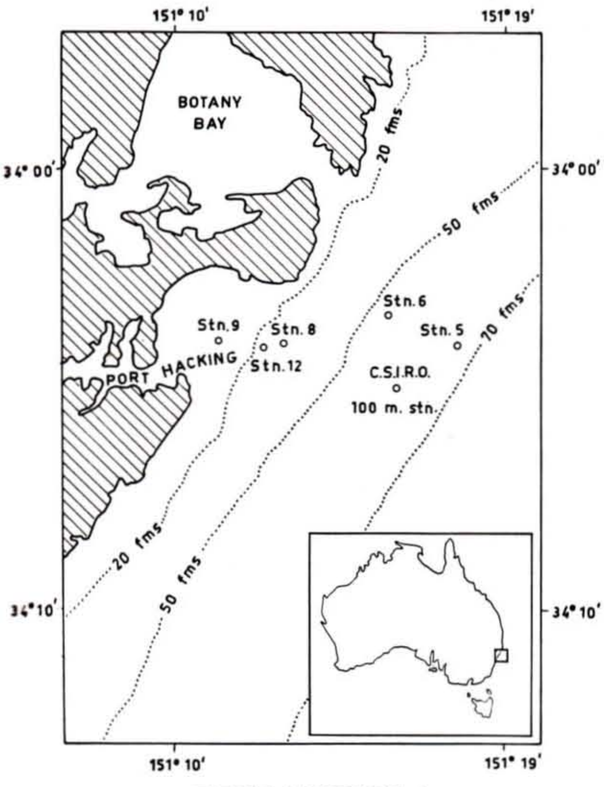
ABSTRACT

A marked difference in foraminiferal population is observable off Sydney between 50 and 60 metres. This is discussed, taking into account all the available ecological data. Bottom currents are considered a major factor in the formation of the faunal boundary between these two depths. Taxonomic notes are added for several species and six of them are recorded for the first time from Australian waters.

INTRODUCTION

In a recent study on the distribution of the crab *Lyreidus tridentatus* off Sydney (MacIntyre, personal communication) several traverses were made and bottom sediments collected. The crab was found to be distributed over the continental shelf in depths exceeding 60 metres, but absent at shallower depths. Along the traverses, stations were selected and the foraminiferal population examined.

A sharp difference in foraminiferal population (text fig. 1) exists between 50 metres (stn. 12) and 60 metres (stn. 8), reflecting environmental changes which seem to affect at the same time the distribution of foraminifera and crabs.



TEXT FIGURE 1
Locality sketch map

The foraminiferal population is here discussed from two points of view:

a) The boundary between 50 and 60 metres; in so doing only the stations 12 (50 metres) and 8 (60 metres) are compared;

b) The foraminiferal fauna, in which the species found at all the stations are considered and listed in Table 1. Taxonomic notes are added for those species recorded for the first time and a few of them are illustrated by unretouched photographs (Albani, 1964). Systematic notes for all the other species may be found elsewhere (Albani, 1968).

THE BOUNDARY AT 50-60 METRES

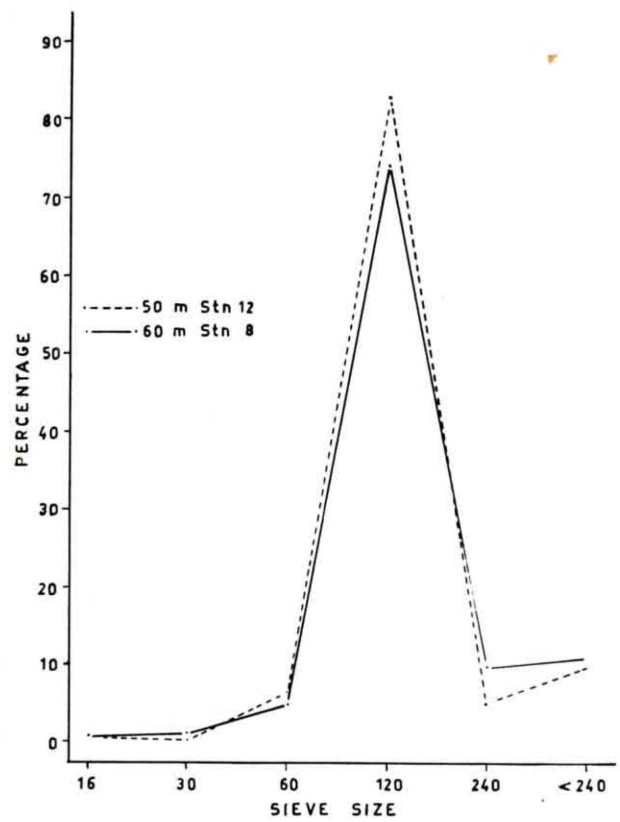
The physical environment

The hydrological environment at the CSIRO Marine Laboratory's Port Hacking 100 m. station (text fig. 1) was described by Newell (1966). His data (p. 81, fig. 4) showed a division of the water column into an upper zone (above 30 m.) and a lower zone (below 50 m.) separated by an intermediate zone. The latter zone showed the maximum amount of chlorophyll *a*. The properties of the two zones are summarized below:

	Uppermost zone 0-30 m.	Lowest zone 50-100 m.
Nitrate	low	high
Phosphate	low	high
Density	low	high
Temperature	high	low
Chlorinity	high	low
Oxygen	high	low
pH	high	low

From bottom samples new data can be added. Although size analyses (text fig. 2) show little difference between the two stations (8 and 12) the $CaCO_3$ content increases from 16.5 (as % of dry weight) at 50 m. to 26.0 at 60 m. The organic matter shows a similar increase, from 0.75 at 50 metres to 2.0 at 60 m.

Another very strong difference, and in the writer's opinion a very significant one, is a sharp decrease in turbulence with depth. Bottom photographs show that the pattern and intensity of ripple marks at 60 m. was much less pronounced than at 50 metres.



TEXT FIGURE 2
Distribution of grain size

The foraminiferal distribution

The total population has been here considered, no staining technique having been used at the time of collecting; the foraminifera have been extracted from 200 grams of sediment from each station and the concentration has been split to about 1000 specimens. They have been identified and listed in Table 1, where the relative abundance of the species present at stations 12 and 8 is also shown.

A very sharp difference in population has been found to exist between 50 metres (stn. 12) and 60 metres (stn. 8), as shown graphically in text fig. 3. In text fig. 3, the circles *a* and *b* represent the benthonic population at 50 m. and 60 m. respectively, and each sector shows the relative abundance of each species.

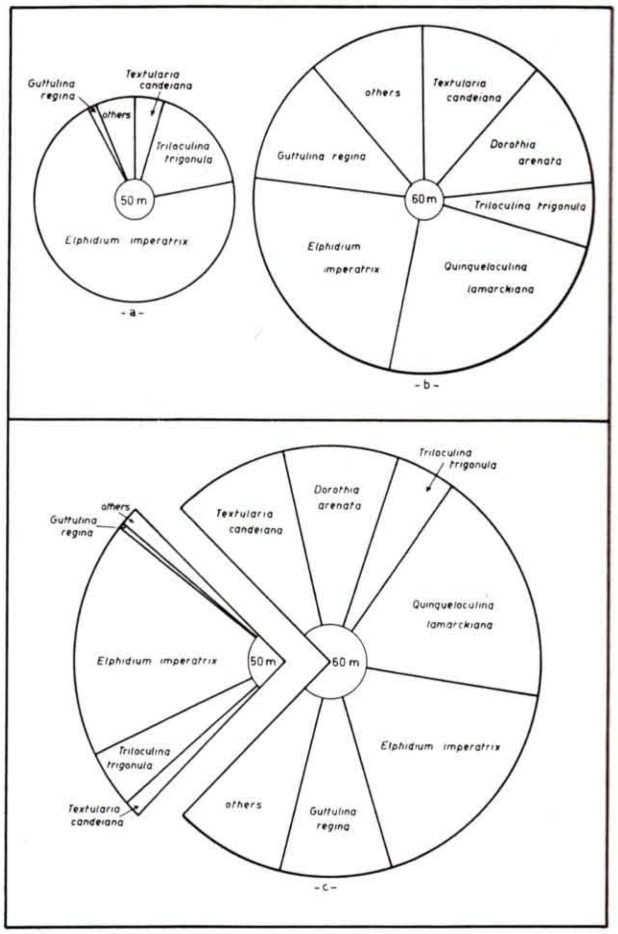
At 50 m. (text fig. 3a) the most abundant species is *Elphidium imperatrix* (71%) which, together with *Triloculina trigonula*, forms nearly the total. At 60 m. (text fig. 3b) the population is three times greater than that at 50 m., reflecting in part the increase of organic matter and $CaCO_3$ noted from 50 m. to 60 m. The population increase is not only due to an increase in the relative abundance of each species but also to a substantial increment in the number of species (from 8 species at 50 m. to 20 at 60 m.).

Elphidium imperatrix and *Triloculina trigonula* have the same relative abundance at 50 m. and 60 m. *Textularia candeiana* and *Guttulina regina* increase from 5% and 1.5% respectively at 50 m. to 12% for both at 60 m. Furthermore, *Quinqueloculina lamarckiana* and *Dorothia arenata* are absent at 50 m. but reach 24% nd 12% respectively at 60 m.

A more direct graphic comparison can be obtained, as in text fig. 3c, by using a circle to represent the total combined populations at both 50 m. and 60 m. In this figure it can be noted that the actual amounts of *Elphidium imperatrix* and *Triloculina trigonula* are graphically the same at both stations. The increased abundance of *Textularia candeiana* and *Guttulina regina* from 50 m. to 60 m. is also graphically shown.

The boundary between surface water and slope water, as described by Newell (1966) is at about 50m., but since all the hydrological parameters vary gradually with depth and season, it is somewhat indistinct and variable, too variable, in fact, to be the only cause for the sharp faunal boundary which exists between 50 and 60 metres.

It is the writer's opinion that bottom currents, a parameter seldom considered in ecological studies, play an important rôle in causing the ecological boundary shown by the foraminiferal population and by the crab *Lyreidus tridentatus*.



TEXT FIGURE 3
Diagrammatic representation of benthonic population

TABLE 1

FORAMINIFERAL SPECIES	50 m. (stn. 12)	60 m. (stn. 8)
Textularia candeiana d'Orbigny, 1839	R	C
Textularia porrecta Brady, 1884	—	—
Dorothia arenata Cushman, 1936	—	C
Cyclogyra foliacea (Philippi) 1844	—	—
Spiroloculina communis Cushman and Todd, 1944	—	VR
Spiroloculina lucida Cushman and Todd, 1944	—	VR
Quinqueloculina lamarckiana d'Orbigny, 1839	—	VC
Quinqueloculina pseudoreticulata Parr, 1941	—	VR
Flintina crassatina (Brady), 1884	—	VR
Flintina triquetra (Brady), 1879	—	VR
Ptychomiliola separans (Brady), 1884	—	—
Pyrgo subpisum Parr, 1950	—	—
Triloculina tricarinata d'Orbigny, 1826	VR	R
Triloculina trigonula (Lamarck), 1804	F	F
Miliolinella labiosa (d'Orbigny), 1839	VR	R
Dentalina emaciata Reuss, 1851	VR	—
Dentalina vertebralis Batsch, 1781	—	—
Frondicularia longistriata Cushman, 1921	—	—
Lenticulina costata (Fichtel & Moll), 1798	—	—
Lenticulina cultrata (Montfort), 1808	—	—
Lenticulina limbosa (Reuss), 1863	—	—
Lenticulina orbicularis (d'Orbigny), 1826	—	R
Lenticulina reniformis (d'Orbigny), 1846	VR	VR
Marginulinopsis bradyi (Goes), 1894	—	—
Vaginulinopsis subgibba (Parr), 1950	—	R
Guttulina regina (Brady, Parker & Jones), 1870	VR	C
Guttulina seguenzana (Brady), 1884	VR	—
Sigmoidella elegantissima (Parker & Jones), 1865	VR	R
Ramulina globulifera Brady, 1879	—	—
Brizalina alata (Seguenza), 1862	—	VR
Elphidium imperatrix (Brady), 1881	VC	VC
Globigerinella siphonifera (d'Orbigny), 1839	—	VR
Globorotalia inflata (d'Orbigny), 1839	VR	—
Globigerinoides quadrilobatus sacculifer (Brady), 1877	—	VR
Globoquadrina dutertrei (d'Orbigny), 1839	VR	—
Dyocibicides biserialis Cushman & Valentine, 1930	—	VR

VR = less than 5%
R = 5% - 10%
F = 10% - 15%
C = 15% - 25%
VC = greater than 25%

THE FORAMINIFERAL FAUNA

Of the 38 species found and listed in Table 1 the following 6 are recorded for the first time from Australian waters: *Flintina fichteliana, Pyrgo subpisum, Dentalina emaciata, Lenticulina costata, Lenticulina limbosa,* and *Marginulinopsis bradyi.* Taxonomic notes are here added for a few species; in the arrangement of superfamilies the writer has followed Loeblich and Tappan (1964). The abbreviated form of each reference is given in synonymies, but full references to all cited literature may be found in the bibliography.

Order FORAMINIFERIDA
Superfamily LITUOLACEA
Genus **Textularia** Defrance, 1824
Textularia porrecta Brady, 1884
Plate 10, figure 1

Textularia agglutinans, var. *porrecta* BRADY, 1884, p. 363, Pl. 43, fig. 4.
Textularia porrecta Brady, COLLINS, 1958, p. 353.

The test is elongate, subcylindrical and formed by many chambers, of which the later ones are very slightly inflated. The wall is finely arenaceous.

Figured specimen.—Stn. 6.

Dimensions.—Length 4.7 mm., maximum width 1.05 mm.

Remarks.—This species is very common at stn. 6. It has been recorded from the Great Barrier Reef (Collins, l.c.), the Bass Strait (Brady, l.c.), and from the Great Australian Bight (Chapman and Parr, 1935).

Genus **Dorothia** Plummer, 1931

Dorothia arenata Cushman, 1936

Plate 10, figures 2, 4

Dorothia arenata CUSHMAN, 1936, p. 32, Pl. 5, figs. 11a-c

Dorothia arenata Cushman, CUSHMAN, 1937, p. 101, Pl. 11, figs. 9a and b.

The test is short and tapering; the early coiled portion is obscured although visible. The chambers are distinct and inflated, with a coarsely arenaceous wall, especially in the early part.

Figured specimens.—60 m.

Dimensions.—Length 2.54 mm., breadth 1.36 mm., thickness 1.01 mm.

Distribution.—Common at 60 m.

Remarks.—This species has been recorded off Mindano in 494 fm. and in Sibuko Bay (Borneo) in 347 fm.

From Australian waters it has been recorded from Tasmania (Parr, 1950), the Bass Strait, off Cape Howe (Chapman, 1941), and from the Great Barrier Reef (Collins, 1958).

Superfamily MILIOLACEA

Genus **Cyclogyra** Wood, 1842

Cyclogyra foliacea (Philippi), 1844

Plate 10, figure 5

Orbis foliaceus PHILIPPI, 1844, Enum. Moll. Sicil., vol. 2, p. 147, Pl. 24, fig. 26.

Cornuspira foliacea (Philippi), CUSHMAN, 1929 (1918 etc.), p. 79, Pl. 20, figs. 3-5.

Cornuspiroides foliaceus (Philippi), BARKER, 1960, p. 22, Pl. 11, figs. 5, 6.

Several large and typical specimens occur at stn. 6.

Figured specimen.—Stn. 6.

Dimensions.—Maximum diameter 2.80 mm.

Remarks.—As *Cornuspira foliacea* it has been recorded from Tasmania and the Bass Strait (Chapman, 1941).

Genus **Flintina** Cushman, 1921

Flintina fichteliana (d'Orbigny), 1839

Plate 10, figures 12, 13, 15, 16

Triloculina fichteliana D'ORBIGNY, 1839, p. 171, Pl. 9, figs. 8-10.

Triloculina fichteliana d'Orbigny, CUSHMAN, 1929 (1918 etc.), p. 63, Pl. 17, figs. 1a-c.

Triloculina fichteliana d'Orbigny, CUSHMAN, 1932, p. 55, Pl. 12, figs. 6a-c.

The tests are subcircular in front view and slightly compressed with rounded periphery in end view. The chambers are ornamented by many longitudinal costae. The aperture is rounded or slightly elliptical and shows a bifid tooth which often projects beyond the outline of the aperture. Very often it shows a distinct perforation.

Figured specimen.—Stn. 6.

Dimensions.—Length 1.34 mm., breadth 1.67 mm., thickness 0.70 mm.

Remarks.—Samples from the shelf as well as from Port Hacking contain a few juvenile specimens, typically triloculine, and many adult individuals which show the planispiral arrangement of the latest chambers, three in each whorl. Aperture and tooth characteristics, wall ornamentation, arrangement of early chambers, visible in broken specimens, show that the *Flintina*-type forms are clearly conspecific with the *Triloculina*-type forms. This species is therefore placed in the genus *Flintina*.

According to Cushman (1932) this species, although typical of the West Indies, extends into the Indo-Pacific areas. This appears to be the first record from Australian waters.

Genus **Ptychomiliola** Eimer and Fichert, 1899

Ptychomiliola separans (Brady), 1884

Plate 10, figures 11, 14

Miliolina separans BRADY, 1884, p. 175, Pl. 7, figs. 1-4.

Ptychomiliola separans (Brady), CUSHMAN, 1921 (1918, etc.), p. 67, Pl. 17, figs. 6-8.

This species occurs abundantly at stn. 6.

Figured specimens.—Stn. 6.

Dimensions.—Fig. 11: total length 3.02 mm., total width 1.56 mm.; Fig. 14: total length 3.13 mm., total width 2.01 mm.

Remarks.—This species is known only from shoal water of the Indo-Pacific; from Australian waters it has been recorded from Tasmania, the Bass Strait (Chapman, 1941), and from the Great Australian Bight (Parr, 1943).

Genus **Pyrgo** Defrance, 1824

Pyrgo subpisum Parr, 1950

Plate 10, figure 3

Pyrgo subpisum PARR, 1950, p. 297, Pl. 7, figs. 5, 6.

The tests are large and globular with wall smooth and polished. The aperture is broadly elliptical, with a raised rim and a large plate-like bifid tooth. This species is very abundant at stn. 6.

Figured specimen.—Stn. 6.

Dimensions.—Length 1.30 mm., breadth 1.30 mm., thickness 1.20 mm.

Remarks.—As stated by Parr (l.c.), "*P. subpisum* is probably the same species as figured by Wiesner (1931, Pl. 16, fig. 188), under the name of *Biloculina vespertilio* Schlumberger. The early chambers in the microspheric form of Schlumberger's species, . . . are, however, arranged on a sigmoiline and not a quinqueloculine plan, . . ."

The tooth structure and the general shape of the test are very close to *Pyrgo vespertilio* Schlumberger (Barker, 1960, p. 4, Pl. 2, fig. 8), but the size of the tooth, the shape of the aperture's rim, and the suture of the last chamber make the shelf specimens conspecific with *P. subpisum*, which is here considered as a species quite distinct from *P. vespertilio*.

While *P. vespertilio* has been recorded from Tasmania and off Cape Howe (Chapman, 1941), *P. subpisum* has been described by Parr from Antarctic material; this seems to be the first record from Australian waters.

Superfamily NODOSARIACEA

Genus **Dentalina** d'Orbigny, 1826

Dentalina emaciata Reuss, 1851

Plate 10, figure 7

Dentalina emaciata REUSS, 1851, p. 63, Pl. 3, fig. 9.

Dentalina emaciata Reuss, HEDLEY, HURDLE and BURDETT, 1965, p. 18, Pl. 6, fig. 18.

The only specimen found at 60 m. is identical with the specimen figured by Hedley *et al.* (1965). The short apical spine is present and, as they remarked, it is shown "in the type figure of Reuss," although not clearly visible in the figures by Brady (1884, Pl. 62, figs. 25, 26).

Figured specimen.—60 m.

Dimensions.—Length 2.54 mm., width 0.45 mm.

Remarks.—This species has been recorded from Japan, the Hawaiian Islands, and from off the west coast of New Zealand (Hedley *et al*, 1965). It is the first record from Australian waters.

Dentalina vertebralis (Batsch), 1781

Plate 10, figure 6

Nautilus (Orthoceras) vertebralis BATSCH, 1791, p. 3, No. 6, Pl. 2, figs. 6a, b.

Nodosaris vertebralis, var. *albatrossi* CUSHMAN, 1923 (1918 etc.), p. 87, Pl. 15, fig. 1.

Dentalina vertebralis (Batsch), HEDLEY, HURDLE and BURDETT, 1965, p. 19, Pl. 6, fig. 19.

The views of Hedley, Hurdle and Burdett are here followed. The specimens show the typical longitudinal costae. The sutures are visible and the chambers, especially in the early part of the test, are not inflated.

Figured specimen.—Stn. 6.

Dimensions.—Length 6.9 mm., width 0.6 mm.

Remarks.—As *Dentalina albatrossi*, it has been recorded from Tasmania (Parr, 1950), and, as *Nodosaria vertebralis*, from 50 miles off the northern coast of New South Wales (Sidebottom, 1918).

Genus **Frondicularia** Defrance, 1826

Frondicularia longistriata Cushman, 1921

Frondicularia annularis d'Orbigny, var. *longistriata* Cushman, CUSHMAN, 1921, p. 218, Pl. 39, fig. 6.

Frondicularia longistriata Cushman, PARR, 1950, p. 331.

The test is compressed and elongated, with a pointed initial portion. The greatest width is one third up from the base, although it may be variable; in fact, in one specimen it is at the base, as in *F. annularis* d'Orbigny. The characteristic striation is present over the whole surface of the test. A few specimens occur at stn. 6.

Remarks.—This species has been recorded from Tasmania (Parr, 1950).

Genus **Lenticulina** Lamark, 1804

Lenticulina costata (Fichtel and Moll), 1798

Nautilus costatus FICHTEL and MOLL, 1798, p. 47, Pl. 4, figs. g-i.

Lenticulina costata (Fichtel and Moll), HEDLEY, HURDLE and BURDETT, 1965, p. 14, Pl. 4, figs. 14a, b.

Very few specimens occur at stn. 6; they appear to be the first record from Australian waters.

Lenticulina cultrata (Montfort), 1808

Plate 10, figure 10

Robulus cultratus MONTFORT, 1808, *Conchyliologie systématique et classification méthodique des Coquilles*, 1. Schoell (Paris), p. 214.

Lenticulina cultrata (Montfort), HEDLEY, HURDLE and BURDETT, 1965, p. 15, Pl. 4, figs. 15a, b.

Several specimens occur at stn. 6, all showing the very pronounced keel.

Figured specimen.—Stn. 6.

Dimensions.—Length 2.24 mm., breadth 1.78 mm., thickness 0.67 mm.

Remarks.—It has been recorded from the Great Australian Bight (Chapman and Parr, 1937), Tasmania, the Bass Strait, off Cape Howe (Chapman, 1941), and from the Great Barrier Reef (Collins, 1958).

Lenticulina limbosa (Reuss), 1863

Robulina limbosa REUSS, 1863, *Sitz. Akad. Wiss. Wien*, vol. 48, Pt. 1, p. 55, Pl. 6, fig. 69.

Robulus limbosus Reuss, CUSHMAN and MCCULLOCH, 1950, p. 297, Pl. 39, figs. 1, 2.

The test is closely coiled and strongly biconvex in peripheral view. The chambers (6 to 8 in the last-formed coil) are uniform in shape. The umbilical area is occupied by a large boss of clear calcite. The periphery is ornamented by a small rounded keel.

Remarks.—This species is here recorded for the first time from Australian waters.

Lenticulina orbicularis (d'Orbigny), 1826

Plate 10, figure 9

Robulina orbicularis D'ORBIGNY, 1826, p. 288, Pl. 15, figs. 8, 9.

Cristellaria orbicularis (d'Orbigny) CUSHMAN, 1921, p. 224.

Only a few specimens at 60 m., the characteristic keel very pronounced.

Figured specimen.—Stn. 8.

Dimensions.—Length 2.18 mm., breadth 2.12 mm., thickness 1.00 mm.

Remarks.—It has been recorded from 40 miles off Cape Wiles (Parr, 1943), from the Bass Strait (Chapman, 1941) and from Tasmania (Chapman and Parr, 1937).

Genus **Marginulinopsis** Silvestri, 1904

Marginulinopsis bradyi (Goes), 1894

Cristellaria bradyi GOES, 1894, *Kongl. Sven. Vet.—Ak. Handl.*, vol. 25, No. 9, p. 64.

Marginulinopsis bradyi Goes, BARKER, 1960, p. 136, Pl. 65, figs. 11-13.

Only a few specimens at stn. 6. They represent the first record from Australian waters.

Genus **Vaginulinopsis** Silvestri, 1904

Vaginulinopsis subgibba (Parr), 1950

Plate 10, figure 8

Lenticulina subgibba PARR, 1950, p. 321, Pl. 11, figs. 1, 2.

Lenticulina subgibba Parr, HEDLEY, HURDLE and BURDETT, 1965, p. 16, Pl. 3, figs. 12, text figs. 2a-d.

A few specimens at stn. 8. They all show the uncoiled portion composed of 2-3 chambers. The coiled portion is composed of 7 chambers, very slightly inflated and with smooth surface; the last two sutures are moderately depressed, while those of the early chambers are distinct and gently curved. The distinguishing feature of this species is in the coiled portion: the last chamber extends with its lower part over the early chambers. The uncoiled portion has chambers more inflated and depressed sutures. The radiate aperture is at the peripheral angle.

Figured specimen.—60 m.

Dimensions—Length 2.17 mm., maximum width of uncoiled chambers 0.63 mm.

Remarks.—The presence of the uncoiled portion places this species in the genus *Vaginulinopsis* (Loeblich and Tappan, 1964, p. C524). As *Lenticulina subgibba* it has been recorded from the eastern coast of Tasmania (Parr, 1950) and from the western continental shelf of New Zealand.

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385. THE LARGER AND PELAGIC FORAMINIFERA OF MANGOPIR, WEST PAKISTAN

A. A. KURESHY
Geology Department, College of Science, Baghdad, Iraq

ABSTRACT

Oligocene and Miocene strata, well exposed in Mangopir, are highly fossiliferous and characterized by various species of larger foraminifera. Minor shale intercalations of the Miocene Gaj series have yielded a few pelagic species, all of diagnostic value for age determinations. The Nari series is characterized by **Lepidocyclina (Eulepidina) dilatata** (Michelotti), **L. pustulosa** Douville, **L. forresti** Vaughan, **L. (Nephrolepidina) glabra** Rutten, **Cycloclypeus communis** Martin, and **Nummulites fichteli** Michelotti and is assigned an Oligocene age. It is succeeded by the Gaj series, which is characterized by **Miogypsina antillea** (Cushman), **M. gunteri** Cole, **M. thecideaeformis** (Rutten), **Lepidocyclina (Nephrolepidina) bikiniensis** Cole. The larger foraminifera are associated with **Globigerinoides triloba triloba** (Reuss), **G. triloba sacculifera** (Brady), **G. rubra** (d'Orbigny), and **Globigerina foliata** Bolli, which are diagnostic of the Lower Miocene.

The depositional environment of these formations is deduced on the basis of the larger foraminifera, which are evidence of a shallow marine environment in a tropical or sub-tropical region. It is unusual to find pelagic species in association with the larger foraminifera in such a reritic environment, but this is probably attributable to current action.

INTRODUCTION

At Mangopir, near Karachi in West Pakistan, the stratigraphic section is well represented by the Nari and Gaj series. The Nari series is of Oligocene age and is characterized by larger foraminifera, the most common and abundant of which are the Lepidocyclinas, these associated with *Nummulites fichteli* Michelotti, *Cycloclypeus communis* Martin, *Heterostegina involuta* Silvestri, and *Spiroclypeus bullbrooki* Vaughan and Cole. The Nari series is succeeded by the Gaj series, which yielded *Lepidocyclina* (*Nephrolepidina*) *bikiniensis* Cole, *Miogypsina antillea* (Cushman), *M. gunteri* Cole, *M. thecideaeformis* (Rutten), *Taberina malabarica*, and *Austrotrillina howchini* (Schlumberger). These larger foraminifera are associated with *Globigerinoides triloba triloba* (Reuss), *G. triloba sacculifera* (Brady), *G. rubra* (d'Orbigny), and *Globigerina foliata* Bolli, which are characteristic of the Lower Miocene, their occurrence frequently recorded from clastic and non-clastic deposits of the Makran area of West Pakistan and from other parts of the world in deposits of the same age.

The depositional environment of these formations was determined on the evidence of the larger foraminifera, although none of them are living in the present ocean. The knowledge of their isomorphs and of their comparative morphology suggests that these forms are good indicators of shallow marine deposition. The presence of some pelagic forms is abnormal in an environment in which larger foraminifera flourished, but such planktonic forms are not uncommon in the neritic environment into which they are often swept by ocean currents.

STRATIGRAPHY

The Mangopir area has extensive outcrops of Gaj series deposits, whereas exposures of the Nari series (Oligocene) are limited. The Gaj is exclusively marine in origin, lithologically composed of fossiliferous limestone and shale, while the Nari is partly marine and partly non-marine in origin. The limestone facies of the Nari series is marine in origin, and yielded characteristic larger foraminifera; the sandstone is non-marine in origin and barren. The lithological characters of these series are as follows:

Gaj series: This is of Lower Miocene age and consist of limestone with thin intercalations of shale. The limestone which yielded the larger foraminifera is yellow in color, the shale light yellowish. A few fragile pelagic foraminifera were recorded from the shale partings.

Nari series: This, of Oligocene age, is composed of limestone and sandstone. The lower part consists of limestone, whitish to creamish in color, bearing larger foraminifera; the upper part, a thick monotonous deposit of coarse sandstone, fluviatile in origin, is unfossiliferous.

MICROFAUNA

The limestone facies of the Gaj series is characterized by the presence of species of *Miogypsina* and *Lepidocyclina* associated with *Austrotrillina howchini* and *Taberina malabarica*. The shale partings of the Gaj series contain pelagic forms belonging to the genera *Globigerinoides* and *Globigerina*. Both the pelagic and the larger forms are characteristic of the Lower Miocene. These pelagic forms are also recorded from Miocene formations of various localities in West Pakistan.

The Nari series is characterized by larger foraminifera, the most diagnostic forms being *Lepidocyclina* and *Nummulites*; these are confined to the Nari series. Other larger foraminifera associated with these species are *Cycloclypeus communis*

Martin, *Heterostegina involuta* Silvestri, and *Spiroclypeus bullbrooki* Vaughan and Cole. No pelagic forms were recorded from the Nari series. The species represented in the Gaj and Nari series, together with their references, are as follows:

GAJ SERIES: LARGER FORAMINIFERA

Miogypsina antillea (Cushman), VAUGHAN and COLE, 1941, Geol. Soc. Amer. Sp. Paper 30, pl. 45, figs. 5-7.

Miogypsina gunteri Cole, VAUGHAN and COLE, 1941, *Ibid.*, pl. 45, fig. 8.

Miogypsina thecideaeformis (Rutten), MOHAN, 1958, Micropal., Vol. 4, No. 4, pl. 2, figs. 8-13.

Lepidocyclina (*Nephrolepidina*) *bikiniensis* Cole, COLE, 1954, U. S. Geol. Surv. Prof. Paper no. 260-0, pl. 14, figs. 1-8.

Austrotrillina howchini (Schlumberger), EAMES *et al.*, 1962, Cambridge Univ. Press, pl. 6, fig. A.

Taberina malabarica EAMES *et al.*, 1962, *Ibid.*, pl. 6, fig. B.

Heterostegina involuta Silvestri, SILVESTRI, 1937, Pal. Italica, Vol. 32 Sup., pl. 14, fig. 3.

PELAGIC FORAMINIFERA

Globigerina foliata Bolli, BOLLI, 1957, U. S. Mus. Bull. 215, pl. 24, fig. 1.

Globigerinoides triloba triloba (Reuss), BOLLI, 1957, *Ibid.*, pl. 25, fig. 2.

Globigerinoides triloba sacculifera (Brady), BOLLI, 1957, *Ibid.*, pl. 25, figs. 5, 6.

Globigerinoides rubra (d'Orbigny), BOLLI, 1957, *Ibid.*, pl. 25, figs. 12, 13.

NARI SERIES: LARGER FORAMINIFERA

Nummulites fichteli Michelotti, NUTTALL, 1925, Ann. Mag. Nat. Hist., Ser. 9, V. 15, pl. 37, fig. 1.

Lepidocyclina forresti Vaughan, HANZAWA, 1962, Micropal. 8, no. 2, pl. 2, fig. 4.

Lepidocyclina canelli Lemoine and Douville, COLE, 1957, Bull. Amer. Paleont., V. 37, no. 163, p. 329.

Lepidocyclina pustulosa Douville, COLE, 1963, Bull. Amer. Paleont., V. 46, no. 205, pl. 1, fig. 5.

Lepidocyclina (*Eulepidina*) *dilatata* (Michelotti), NUTTALL, 1926, Ann. Mag. Nat. Hist., Ser. 9, V. 22, pl. 13, figs. 1-4.

Lepidocyclina (*Nephrolepidina*) *glabra* (Rutten), BURSCH, 1947, Mem. Suiss. Paleont., V. 65, pl. 3, fig. 10.

Lepidocyclina bikiniensis Cole, COLE, 1954, U.S. Geol. Survey Prof. Paper no. 260-0, pl. 14, figs. 1-8.

Lepidocyclina angulosa Provale, HANZAWA, 1957, Geol. Soc. Amer. Mem. 66, pl. 21, fig. 5.

Lepidocyclina (*Nephrolepidina*) *borneensis* (Provale), CHATTERJI, 1961, Micropal., V. 7, no. 4, pl. 1, figs. 1-6.

Cycloclypeus communis Martin, SILVESTRI, 1937, Paleont. Italica, V. 32 Sup., pl. 9, figs. 2-6.

Heterostegina involuta Silvestri, SILVESTRI, 1937, *Ibid.*, pl. 14, fig. 3.

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PALEOECOLOGY

The smaller benthonic foraminifera are most useful in paleoecological studies. The larger foraminifera are of less value because most of them are extinct, but their isomorphs may be used to a limited degree for paleoecological studies. The pelagic foraminifera reveal little about the conditions of deposition, but they are good indicators of general environmental condition in past times. Since their distribution is governed by the action of currents, they are not restricted in their occurrence to a single sedimentary basin.

In the Mangopir area paleoecological studies are entirely based on the larger foraminifera, since these constitute the major faunal assemblages of Nari and Gaj series. The species of *Lepidocyclina, Miogypsina, Cycloclypeus, Heterostegina, Spiroclypeus, Austrotrillina,* and *Taberina* are indicative of a shallow marine depositional environment, a conclusion based upon the knowledge of their isomorphs living in tropical and subtropical regions today.

The association of pelagic foraminifera with the larger foraminifera species of Gaj series is striking, because of the fact that pelagic foraminifera more often are deposited in bathyal or abyssal sediments. As a result of current action, however, it is not unusual for some pelagic forms to be deposited along with the benthonic forms of the neritic zone, as in this particular instance.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XXI, PART 2, APRIL, 1970

RECENT LITERATURE ON THE FORAMINIFERA

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

AOKI, NAOAKI. Notes on the stratigraphic distributions of some planktonic foraminiferal species in the Kazusa group, Boso Peninsula.—Trans. Proc. Palaeont. Soc. Japan, n. ser., No. 74, June 30, 1969, p. 81-88, text fig. 1 (range chart).—Ranges for 9 species in the Pliocene and Pleistocene.

BANERJI, RANJIT K. Observations on the Upper Cretaceous Foraminifera from Vridhachalam, South India.—Jour. Palaeont. Soc. India, v. 13, 1968 (1969), p. 1-19, text figs. 1, 2 (diagram, graph), tables 1, 2.—Distribution and abundance of 82 species recorded in 3 zones and 2 subzones.

BÉ, ALLAN W. H., JONGEBLOED, WILLEM L., and MCINTYRE, ANDREW. X-ray microscopy of Recent planktonic Foraminifera.—Jour. Paleontology, v. 43, No. 6, Nov. 1969, p. 1384-1396, pls. 161-167, text fig. 1 (diagram).—Beautiful illustrations of 23 species, revealing internal morphology, wall thickness, and surface features.

BEARD, JOHN H. Pleistocene paleotemperature record based on planktonic foraminifers, Gulf of Mexico.—Trans. Gulf Coast Assoc. Geol. Soc., v. 19, 1969, p. 535-553, pls. 1-3, text figs. 1-5 (map, time scales, graphs, correl. diagram).—Study based on sediment cores from deep water and shelf. Correlation between absolute age scale (potassium-argon) back to 4½ million years, geomagnetic reversals, paleobathymetry, paleotemperatures, stages of continental glaciation, and extinctions and relative abundance of selected planktonic species. Several significant species of *Globorotalia* are illustrated: *G. menardii, G. miocenica, G. multicamerata,* and *G. pertenuis,* n. sp.

BELFORD, D. J. Permian Foraminifera from BMR bores 6, 7, 8, and 9, Western Australia.—Australia Bur. Min. Res., Geol. Geophys., Palaeont. Papers, 1965, Bull. 80, 1968, p. 1-13, pls. 1-3, text figs. 1-3 (distrib. charts).—Many species illustrated and recorded on distribution charts.

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BERGGREN, W. A. Cenozoic foraminiferal faunas.—Initial Reports of the Deep Sea Drilling Project (JOIDES), v. I, Nat. Sci. Found., June 1969, p. 594-607, pls. 1-3, text figs. 1-7 (diagrams).—Late Miocene to Pleistocene from 3 Gulf of Mexico sites and middle to late Eocene from the Bermuda Rise.

BRÖNNIMANN, PAUL, CHAROLLAIS, JEAN, KOEHN-ZANINETTI, LOUISETTE, and ROSSET, JEAN. Décourverte de Foraminifères du Trias supérieur dans la klippe des Annes (Haute-Savoie).—Compte Rendu des Séances, Soc. Phys. Hist. Nat. Genève, n. ser., v. 4, fasc. 1, Jan.-April 1969 (Oct. 1969), p. 89-99, 1 pl., text figs. 1, 2 (drawings).—Species of *Glomospirella* and related genera in thin sections.

BRYANT, WILLIAM R., MEYERHOFF, A. A., BROWN, NOEL, K., JR., FURRER, MAX A., PYLE, THOMAS E., and ANTOINE, JOHN W. Escarpments, reef trends, and diapiric structures, eastern Gulf of Mexico.—Bull. Amer. Assoc. Petr. Geol., v. 53, No. 12, Dec. 1969, p. 2506-2542, text figs. 1-29 (maps, arcer profiles, diagrams, photomicrographs).—Late Aptian-Albian reef and forereef facies in samples from cores and dredge hauls from Florida Platform, Campeche Platform, and Jordan Knoll are dated by their Foraminifera.

CASTELLARIN, ALBERTO, and CITA, MARIA BIANCA. La coupe Priabonienne de Nago (Prov. Trento) et la limite Éocène-Oligocène.—Mém. Bur. Recherches Géol. Min., Colloque sur l'Éocène, Paris, May 1968, v. III, No. 69, 1969, p. 93-117, pls. 1-3, text figs. 1-3 (geol. section, map, strat. section), table 1.—Foraminifera listed and illustrated from a section between Biarritzian and lower Oligocene.

Étude de quelques coupes Priaboniennes dans le Monte Baldo (Prov. Verona et Trento, Italie) et discussion des limites de l'étage.—Ibid., p. 119-143, pls. 1-3 (strat. sections, photomicrographs), text fig. 1 (map), tables 1-3.—Illustrations of *Nummulites.*

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Foraminiferal subdivisions, Part II *in* Lower Cretaceous (Albian) of the Yukon: Stratigraphy and foraminiferal subdivisions, Snake and Peel Rivers.—Geol. Survey Canada, Paper 68-26, 1969, p. 28-44, tables 1-3.—Six subdivisions recognized and ranges and abundance of 145 species shown.

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GLAÇON, GEORGETTE, and SIGAL, JACQUES. Précisions morphologiques sur la paroi du test de *Globorotalia truncatulinoides* (d'Orbigny), *Globigerinoides ruber* (d'Orbigny) et *Globigerinoides trilobus* (Reuss). Réflexions sur la valeur taxinomique des détails observés.—Comptes rendus séances Acad. Sci. Paris, tome 269, ser. D, No. 11, Sept. 15, 1969, p. 987-989, pl. 1.

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HOFKER, J., SR. An analysis of the subfamily Notorotaliinae (Foraminifera) Hornibrook, 1961.—New Zealand Jour. Geol. Geophys., v. 12, Nos. 2, 3, Aug. 1969, p. 460-483, text figs. 1-86 (drawings, phylogenetic diagram).—Internal structure described in *Notorotalia, Cribrorotalia, Discorotalia,* and *Parrellina*. Origin was from a form like *Protoelphidium*.

KEIJ, A. J. *Bicornifera lindenbergi* n. sp. from the upper Oligocene of Escornebéou, S. W. France.—Neues Jahrb. Geol. Paläont. Mh., Stuttgart, Jahrg. 1969, Heft 4, April 1969, p. 241-246, text figs. 1-7 (map, drawings, graph). —A problematic genus. A specimen of an undescribed species also found in the Oligocene of Alabama.

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QUILTY, PATRICK G. Upper Eocene planktonic Foraminiferida from Albany, Western Australia.—Jour. Royal Soc. Western Australia, v. 52, pt. 2, 1969, p. 41-58, text figs. 1-7 (map, graphs, diagrams, 2 plates of fossils), tables 1-4.—Fifteen species (1 new) and 5 forms (1 new). Abundant specimens of *Globigerapsis index* are studied as to generic significance of bullae and several bullae-bearing genera are rejected.

ROCHA, A. TAVARES, and TORQUATO, JOAQUIM RAUL. Contribuição para o conhecimento da microfauna e da mineralogia das areias de praia das Ilhas da Taipa e de Coloane (Provincia Portuguesa de Macau).—Bol. Instit. Invest. Cientif. Angola, v. 4, no. 1, 1967, p. 89-104, 1 pl., text figs. 1-3 (maps), tables 1-5.—A meager fauna of Foraminifera from a shallow, warm, low salinity environment in Portuguese Macao.

ROSS, CHARLES A. Upper Paleozoic Fusulinacea: *Eowaeringella* and *Wedekindellina* from Yukon Territory and giant *Parafusulina* from British Columbia.—Geol. Survey Canada, Bull. 182, 1969, p. 129-134, pls. 14-16.—Three species, 2 new.

Middle and Upper Pennsylvanian Fusulinaceans, Gila Mountains, Arizona.—Jour. Paleontology, v. 43, No. 6, Nov. 1969, p. 1405-1422, pls. 170-174, text figs. 1, 2 (map, stratig. section), table 1.—Twenty-two species, 2 new.

SADA, KIMIYOSHI. Microfossils of the lowest part of the Taishaku Limestone (Studies of the stratigraphy and the microfossil faunas of the Carboniferous and Permian Taishaku Limestone in West Japan, No. 4).—Trans. Proc. Palaeont. Soc. Japan, N. Ser., No. 75, Sept. 30, 1969, p. 119-129, pls. 12, 13, tables 1-7.—Ten species, 3 new and 6 indeterminate.

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SIDO, MARIA. *Nummofallotia* Barrier et Neumann, 1959 et *Goupillaudina* Marie, 1957, dans les formations sénoniennes de la Transdanubie, (Hongrie).—Bull. Hungarian Geol. Soc., v. 99, No. 2, April-June 1969, p. 181-187, pls. 1, 2.—Three species, one of *Nummofallotia* and two of *Goupillaudina.*

SINGH, S. N., and KALIA, PRABHA. *Bronnimannina* —a new genus of Foraminifera from the Middle Kirthars of Shri Kolayatji area, Bikaner, Rajasthan.—Jour. Palaeont. Soc. India, v. 13, 1968 (1969), p. 44-47, pl. 5.—*Bronnimannina eocenica* gen. et sp. nov. in the Pavonitinidae from beds of Lutetian age.

SKINNER, JOHN W., and WILDE, GARNER L. *Pseudofusulina californica*, new name for *Pseudofusulina tenuis* Skinner and Wilde.—Jour. Paleontology, v. 43, No. 6, Nov. 1969, p. 1441.

SRIVASTAVA, J. P., and MANDWAL, N. K. Microfossils from Zewan beds (Permian) of Kashmir.—Jour. Palaeont. Soc. India, v. 11, 1966 (1968), p. 38-40, pls. 12, 13.—Ten species (8 indeterminate) of Foraminifera.

TEWARI, B. S., and BHARGAVA, O. N. Kutch microfauna: Oligocene Foraminifera and Ostracoda from Waghopadar, southwestern Kutch.—Jour. Palaeont. Soc. India, v. 10, 1965 (1968), p. 26-30, pls. 10, 11.—Fifteen species of Foraminifera, none new, indicating shallow, warm conditions.

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TEWARI, B. S., and KUMAR, ASHOK. Recent Foraminifera from beach sands of Jaffna, Ceylon. —Jour. Palaeont. Soc. India, v. 11, 1966 (1968), p. 41-44, pls. 14, 15.—Ten species, none new.

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The genus *Trocholina* from the Cretaceous rocks of Ariyalur Stage, South India.—Jour. Palaeont. Soc. India, v. 11, 1966 (1968), p. 45-51, pl. 16, text figs. 1-5 (graphs), tables 1, 2.—Biometric study of *T. sahnii* from lower Maestrichtian.

THOMAS, CHARLES W. Paleontological analyses of North Pacific ocean-bottom cores.—Pacific Science, v. 23, No. 4, Oct. 1969, p. 473-482, text figs. 1-4 (map, correl. diagram, graphs), tables 1-3.—Two cores south of the Aleutians and one on the Marcus-Necker Ridge.

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WICKENDEN, R. T. D. An undeformed specimen of the Lower Cretaceous foraminifer *Haplophragmoides gigas* Cushman, from Alberta.—Geol. Survey Canada, Bull. 182, 1969, p. 135-137, text fig. 1 (drawing).

In addition, the following papers appeared in Internat. Conf. on Planktonic Microfossils, 1st, Geneva, 1967, Proc. [Leiden, E. J. Brill and Co.], v. 2, 1969, edited by P. Brönnimann and H. H. Renz:

BOLTOVSKOY, ESTEBAN. Foraminifera as hydrological indicators.—p. 1-14, text fig. 1 (hydrology map), table 1.—Includes table of temperature ranges for 20 planktonic species in the South Atlantic and its Antarctic sector.

BRATU, ELENA. Distribution des Foraminifères planctoniques dans le flysch interne paléocène-éocène à la courbure des Carpates Orientales —(Roumanie).—p. 15-20, pl. 1, text fig. 1 (range chart).

BROWN, NOEL K., JR. Heterohelicidae Cushman, 1927, amended, a Cretaceous planktonic foraminiferal family.—p. 21-67, pls. 1-4, text figs. 1-15 (line drawings, diagrams, phylogenetic chart, thin section photos), table 1.—Monographic treatment with detailed synonymies includes 13 species in 6 genera. *Pseudotextularia cushmani* in the Campanian is new.

CIFELLI, RICHARD, and SMITH, ROBERTA K. Problems in the distribution of Recent planktonic Foraminifera and their relationships with water mass boundaries in the North Atlantic. —p. 68-81, text figs. 1-7 (maps, graphs).—Species characteristic of slope waters, the Sargasso Sea, and equatorial waters.

CLARKE, WILLIAM J., and BLOW, WALTER H. The inter-relationships of some late Eocene, Oligocene and Miocene larger Foraminifera and planktonic biostratigraphic indices.—p. 82-97, text figs. 1-3 (correl. and range charts).—Includes tables showing ranges of larger Foraminifera against the planktonic zonation.

COSTEA, IOAN, and COMSA, D. Organismes planctoniques à la limite Jurassique-Crétacé dans la Plate-forme Moësienne (Roumanie).—p. 100-122, pls. 1-4, text figs. 1-8 (maps, graph, range and abund. chart).—Mostly tintinnids but includes radiolaria and 3 species of *Globigerina*.

EXPLANATION OF PLATE 10

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3.	*Pyrgo subpisum* Parr; oblique view of aperture; ×46.	74
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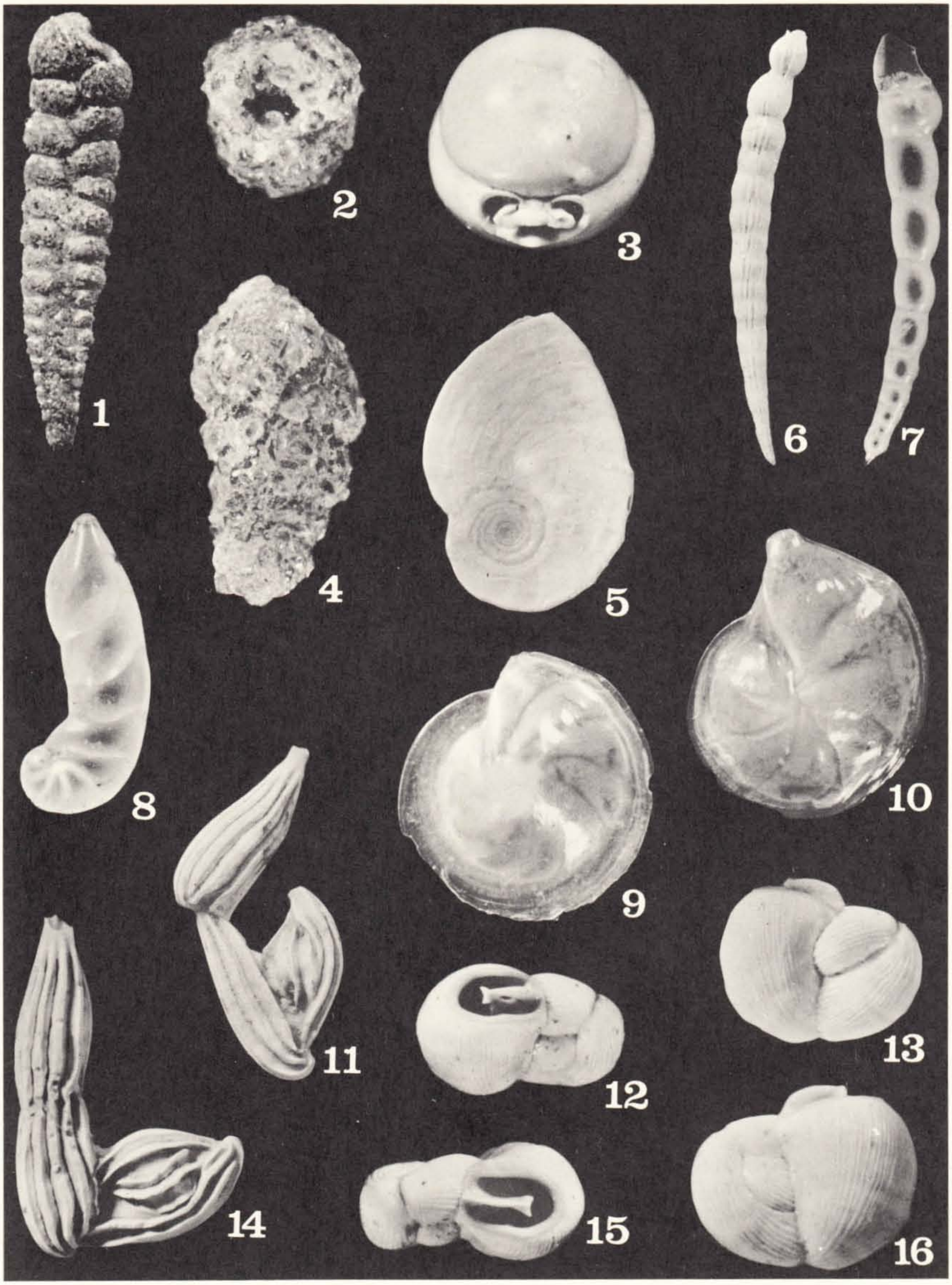

Albani: Australian Continental-shelf foraminifera

DOUGLAS, ROBERT G. Upper Cretaceous biostratigraphy of northern California.—p. 126-152, text figs. 1-6 (map, zonation charts, range charts).—Comparisons with sections in North America, Europe, and Africa.

DUPEUBLE, PIERRE-ALAIN. Foraminifères planctoniques (Globotruncanidae et Heterohelicidae) du Maestrichtien supérieur en Aquitaine occidentale.—p. 153-162, pls. 1-4.—Fourteen species, none new. *Abathomphalus* considered a synonym of *Globotruncana*.

EICHER, DON L. Cenomanian and Turonian planktonic Foraminifera from the western interior of the United States.—p. 163-174, text figs. 1-5 (loc. and distrib. maps, columnar sections, range charts).—Ranges given for 29 species.

EJEL, FOUAD. Zones stratigraphiques du Paléogène et problème de la limite Éocène moyen-Éocène supérieur dans la région de Damas (Syrie).—p. 175-181, text figs. 1-3 (map, zone and distrib. charts).

EL-NAGGAR, ZAGHLOUL RAGHIB. New suggestions for the division and correlation of Paleocene strata by the use of planktonic Foraminifera. —p. 182-201, chart 1 (distrib. and evolutionary development).

Correlation of the various planktonic foraminiferal zonations of the Paleocene.—p. 202-223, chart 1 (correl.).

HAGN, HERBERT, and LINDENBERG, HANS GEORG. Revision der von C. W. Gümbel 1868 aus dem Eozän des bayerischen Alpenvorlandes beschriebenen planktonischen Foraminiferen.—p. 229-249, pl. 1, text figs. 1-6 (maps, line drawings, photographs).—Illustrations of *Globigerina eocaena*.

HAY, WILLIAM W., and MOHLER, HANS PETER. Paleocene-Eocene calcareous nannoplankton and high-resolution biostratigraphy.—p. 250-253, text fig. 1 (correl. chart).—Foraminiferal and calcareous nannoplankton zones correlated.

HEMLEBEN, CHRISTOPH. Ultramicroscopic shell and spine structure of some spinose planktonic Foraminifera.—p. 254-256, pls. 1-3.—Stereoscan photos show smooth spine surfaces contrasted with rough wall surfaces and the two surfaces sharply separated, even continuing to the base of the spine within the wall. A spine pulled out of the wall leaves a smooth socket.

HINTE, JAN ENGELBERT VAN. A *Globotruncana* zonation of the Senonian Subseries.—p. 257-266, text figs. 1-3 (zone charts).

The nature of biostratigraphic zones.—p. 267-272, text figs. 1-4 (zone diagrams).

HOFKER, JAN, JR. On the internal structure of Recent Pacific planktonic Foraminifera.—p. 273-278, pls. 1-4.—Photomicrographs of wall structure.

HOFKER, JAN, SR. Have the genera *Porticulasphaera*, *Orbulina* (*Candorbulina*) and *Biorbulina* a biologic meaning?—p. 279-286, pls. 1-3.—These genera are stages that develop in several different species rather than true genera.

"Globigérines" du Jurassiques Supérieur.—p. 287-290, text fig. 1 (foram drawings).—These globigerines belong in *Trochammina*.

HOOPER, KENNETH. Processing of foraminiferal data: a computer program.—p. 291-306, text figs. 1-9 (Fortran program).

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RUTH TODD
U. S. Geological Survey
Washington, D. C. 20560