CONTRIBUTIONS
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Volume XVI (1965)

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ROBERT M. KLEINPELL

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290. ANNOTATED BIBLIOGRAPHY OF PALEOZOIC NONFUSULINID FORAMINIFERA, ADDENDUM 2

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ABSTRACT

This addendum includes 112 annotated references pertaining to Paleozoic nonfusulinid Foraminifera and can be considered complete through the year 1962. As in previous bibliographies (Toomey, 1959, 1961, 1963)[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, by brackets, all taxonomic changes noted from subsequent publications, thus making the bibliography a more useful working tool. Brief comments on pertinent facets of certain foraminiferal works are also made by the compiler.

INTRODUCTION

This annotated bibliography consists of 40 references containing original descriptions of genera and species, and taxonomic nomenclature of Paleozoic nonfusulinid Foraminifera. An additional 72 references with mention of foraminiferal names, incidental occurrences, and corrections of earlier errors are included for completeness.

The 112 references have been annotated by the compiler, except for the most recent publications in which the authors included comprehensive abstracts. In such cases the author's abstract has served as a nucleus, and additions and deletions have been made accordingly. The annotations include geologic age, geographic locality, type of illustrations, original language, new forms described, and comments in brackets on taxonomic changes noted from subsequent publications.

The bibliography may be considered reasonably complete through 1962, with the exception of the Soviet references which, owing to their general unavailability to most American workers, may be assumed to be only partially complete.

Including this addendum the total number of annotated Paleozoic nonfusulinid foraminiferal references has reached 550. It will be greatly appreciated if any omissions in this bibliography are brought to the attention of the compiler.

COMMENTS

Text Figure 1 is an attempt to show chronologically the distribution of articles relating to Paleozoic Foraminifera according to designated geographic provinces. Even with the inclusion of the present 112 references very little change in trend can be noted since 1963. Perhaps, the only apparent difference is the filling out of the post-1950 columns thus rendering a more complete and realistic picture of actual distribution.

In Text Figure 2 the foraminiferal literature output has been plotted according to geologic age. Similarly, as noted above, the over-all trend remains the same as that noted in 1963.

Of significant interest to all Paleozoic foraminiferal workers is the excellent paper by Henbest (annotation 62) on the petrography of certain Late Paleozonic encrusting Foraminifera. This contribution represents a milestone in Paleozoic foraminiferal research; its high standards of excellence should serve as a model for future workers to follow. Not only has the writer been at great pains to document and expand his very original findings, but he has had a wealth of experience which he could call into play to present a formidable piece of research.

In direct contrast to the above work, is one by Deleau and Marie (annotation 50) in which some most unscientific principles appear to have been used in erecting so-called "new genera." Seemingly, the concept of what actually constitutes a valid genus or species has either been ignored or twisted into incomprehensible diction. Work of this type is unfortunate, to say the least. The problem of attempting to straighten out the unrealistic taxonomy presented by Deleau and Marie will be a formidable task.

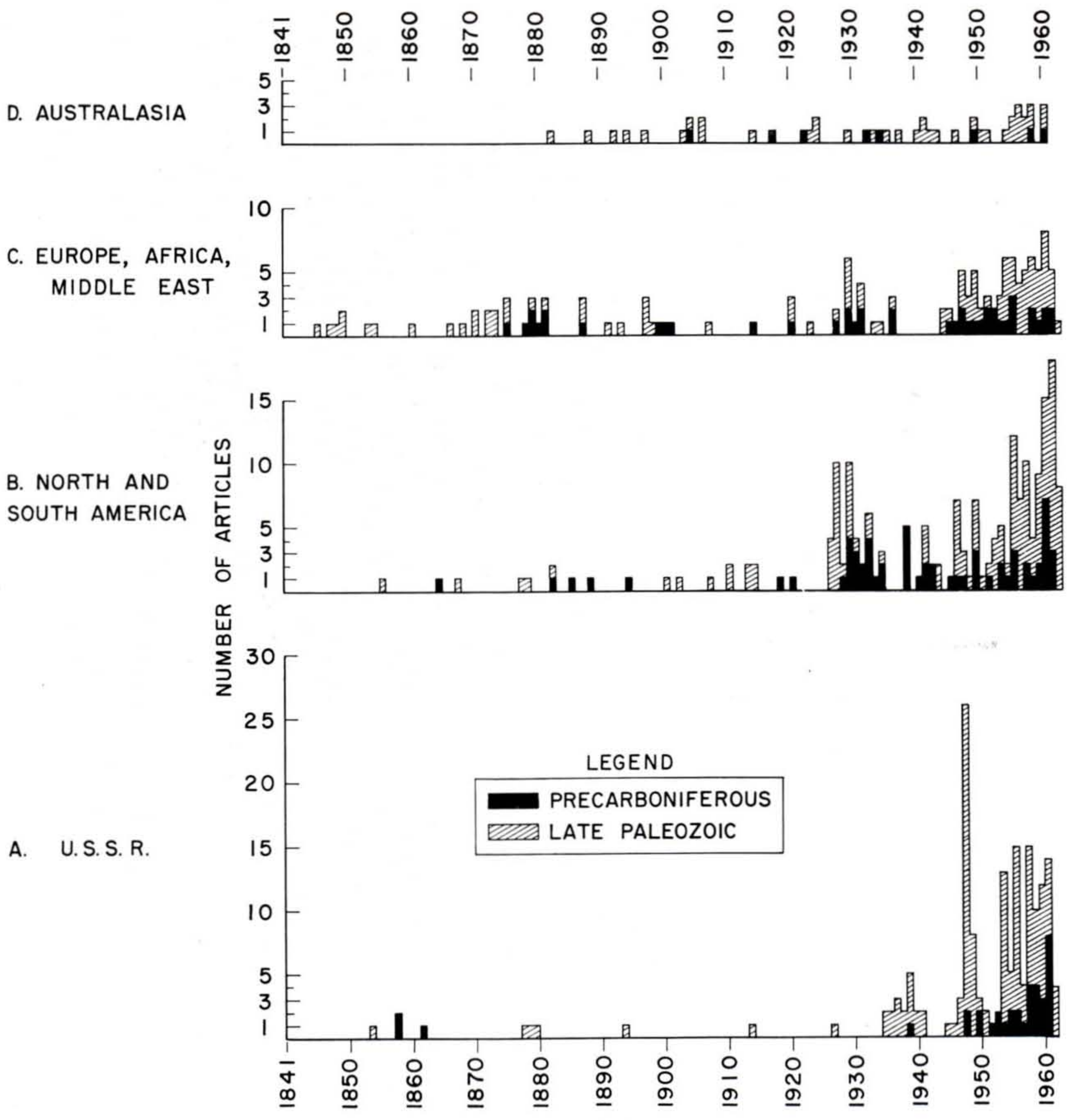
ANNOTATED BIBLIOGRAPHY

A. *PRECARBONIFEROUS FORAMINIFERA:*

1. ANTROPOV, I. A., 1959, Devonian Foraminifera of Tatary: Izv. Kazansk. Filiala, Acad. Sci. S.S.S.R., Ser. Geol. Sci., No. 7, p. 11-33, 1 pl., 7 text-fig., [in Russian].

   The writer studied Devonian (Givetian-Fammenian) Foraminifera from subsurface samples derived from 40 wells located in Tatary and from 10 wells located in the adjoining regions of Udmurtiya, Bashkiria, and Kuibyshev provinces, U.S.S.R. From these well samples one new genus and four new species of Foraminifera were described and illustrated by thin-section photomicrographs. The new forms are: *Uslonia permira* n. gen., *Parathurammina polypora, Nodosinella tatarstanica,* and *Textularia perparva.* A new genus, *Rectangulina,* is erected and questionably placed

[1] Contr. Cushman Found. Foram. Research, v. 10, p. 71-105; v. 12, p. 33-46; v. 14, p. 77-94.



TEXT FIGURE 1
Geographic Distribution of Paleozoic Foraminiferal Literature

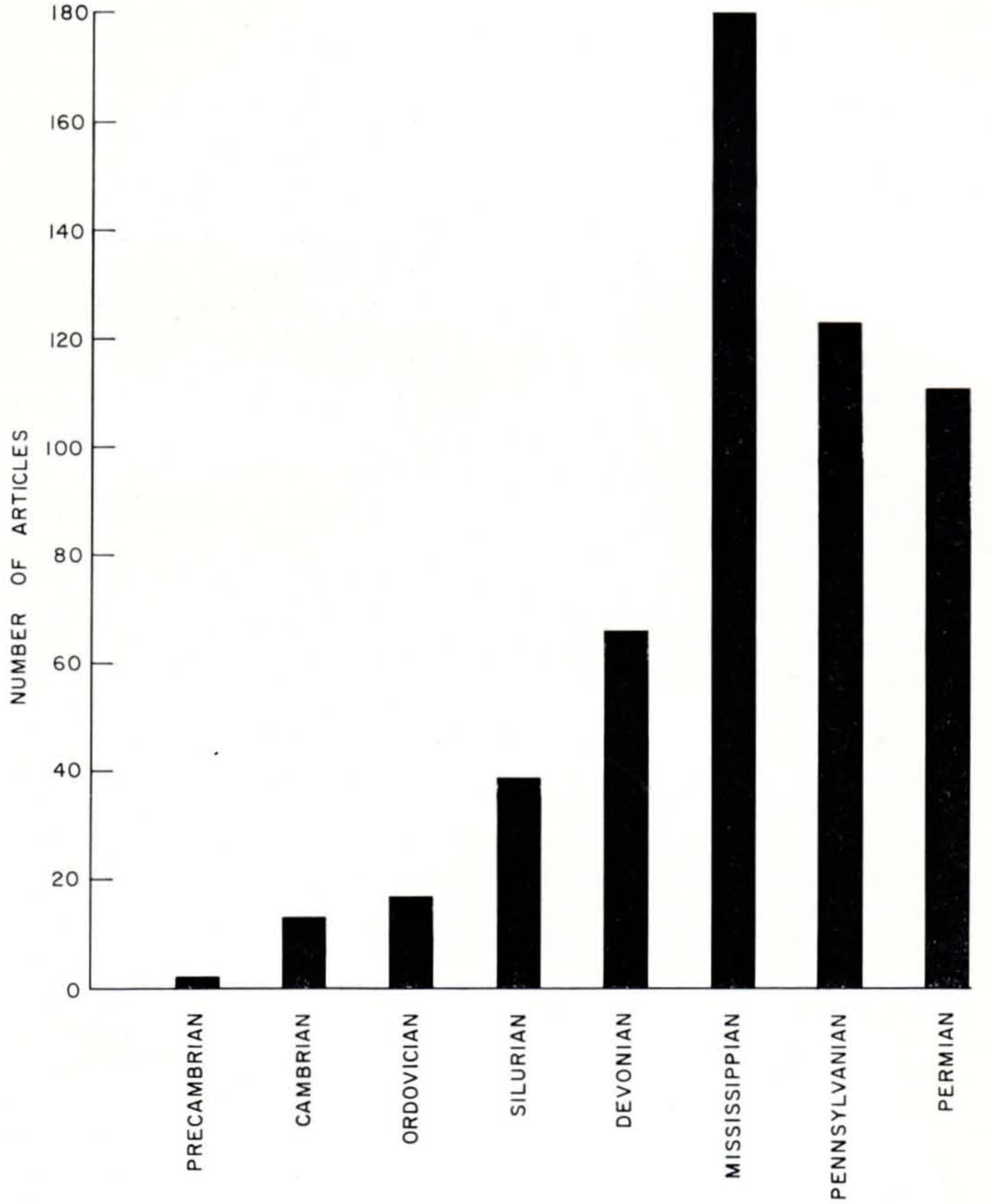
under the algae. The genoholotype is *Syniella tortuosa* Antropov, 1950, formerly described under the Foraminifera. One other variety, *Rectangulina tortuosa* var. *tenuis* (Antropov), formerly described as *Syniella tenuis* Antropov, is also given.

In the course of this study 36 species of Foraminifera, belonging to 23 genera (mostly previously described) were examined. From this microfaunal study, it was possible to note that the distribution of Foraminifera in the Devonian section is extremely erratic. The pre-Givetian, Givetian, lower Frasnian section, composed primarily of terrigenous rocks with some minor carbonate intervals, contain an impoverished foraminiferal suite. The remaining beds of the Frasnian and Fammenian stages, which are characterized chiefly by carbonates, contain a comparatively rich foraminiferal microfauna.

This distinctive Devonian foraminiferal assemblage is dominated by the quantitative predominance of saccamminids and by the first relative abundance of multilocular forms. Along with the profuse unilocular forms there also existed the more specialized forms, *i.e.*, lagenids, textularids, endothyrids, ammodiscids, and others.

2. BYKOVA, E. V., 1961, Foraminifera of the Caradocian Stage of Eastern Kazakhstan: Acad. Sci. Kazakh. S.S.R., 70 p., 25 pl., 32 text-fig., [in Russian].

This is the first published monograph on the Foraminifera of the Ordovician Period. In it descriptions are given of 42 new species, 5 new gen-



TEXT FIGURE 2
Geological Distribution of Paleozoic Foraminiferal Literature

era, and 1 new family. The stratigraphic distribution of Foraminifera in the Angrensor Series of the Caradocian Stage, Stepnyak Region, eastern Kazakhstan, S.S.R., is given, and two microfaunal zones are distinguished. The foraminiferal assemblages include forms with chitinoid tests, and those with calcareous tests. The Foraminifera with calcareous tests have a subordinate and stratigraphically limited use since they are not confined to any distinct part of the section; most of them were described from rocks of a different age.

The new forms are: Maylisoriidae n. fam. [replaces Alexanderllidae Bykova (1958), since the latter name was already pre-occupied], *Blastammina vulgaris*, *B. secunda*, *B. ellipsoidalis*, *B. inflata*, *Ordovicina mikrona*, *O. triangularis*, *O. lagenaformis*, *O. septata*, *Chitinolagena gutta* n. gen., *Maylisoria pseudoscheda* n. gen., *M. substricta*, *M. scita*, *M. gliris*, *M. eisenackia*, *M. biglobosa*, *M. maylisoriensis*, *M. perfecta*, *M. magna*, *M. pseudocostata*, *M. camerata*, *M. fragilis*, *M. subtilis*, *M. folaria*, *M. urbana*, *M. obunca*, *M. harrenda*, *M. pannosa*, *M. multiformis*, *M. sarisa*, *M. senta*, *M. flexuosa*, *M. rotunda*, *M. concentrica*, *M. recta*, *Labyrinthochitinia tastikoliensis* n. gen., *L. grandis*, *L. pellita*, *L. gemma*, *Cribrosphaera pertusa*, *Paratikhinella karakanensis*, *Turbienta bifida* n. gen., and *Parasyniella geniculosa* n. gen.

In the Angrensor Series two microfaunal zones have been delineated: (1) the lower part of the section characterized by four species of *Labyrinthochitinia*, and (2) the upper part of the section in which species of *Maylisoria* are dominant, and for which various species of *Blastammina*, *Ordovicina*, and *Chitinolagena* are also characteristic.

Thin-section photomicrographs taken at relatively high-power (×330) are given for the entire microfauna.

3. Cooper, C. L., 1948, Kinderhook micropaleontology: Jour. Geology, v. 56, no. 4, p. 353-366, 1 text-fig.

The writer briefly notes that in the Louisiana Limestone of Missouri there are two species of the foraminifer *Ammodiscus*. [The Louisiana Limestone was formerly regarded as Mississippian (Kinderhookian) in age; however, recent studies on the conodont fauna indicate that the unit should now be regarded as uppermost Devonian (Fammenian) in age.]

4. Cushman, J. A., 1935, Paleozoic Foraminifera, their relationships to modern faunas and to their environment: Jour. Paleontology, v. 9, no. 3, p. 284-287.

After examining a number of so-called examples of Precambrian and Cambrian Foraminifera the writer concludes that few show enough structure even to warrant their being placed with the Foraminifera. One exception to this is Chapman's Malverns fauna from the Upper Cambrian of England, which is regarded as the only authentic record of early Paleozoic Foraminifera [Wood, 1946, has shown that the fauna Chapman described from the Upper Cambrian of the Malverns was in fact derived from a loose rock fragment of early Jurassic age.]

A brief discussion of the evolution of the foraminiferal test wall along with pertinent ecologic observations is also given.

5. Eisenack, A., 1961, Hystrichosphären als Nahrung ordovizischer Foraminiferen: Neues Jahrb. für Geol. u. Paläontol., p. 15-19, 4 text-fig., [in German].

The writer calls attention to foreign bodies found inside the tests of Ordovician Foraminifera (*Ordovicina, Amphitremoida,* and *Psammosphaera*). The foreign bodies include microscopic spherules, which the author hypothetically assumes to be unassimilated membranes of algae, taken in as food by the Foraminifera. On two occasions membranes of Hystrichosphaera were found inside the tests. The problem of how they got there remains unsolved, since the apertures of the tests have a smaller diameter than the diameter of the Hystricosphaera, and the test forms an area which is closed in on all sides.

6. Eisenack, A., 1962, Mikrofossilien aus dem Ordovizium des Baltikums: Senck. leth., v. 43, no. 5, p. 349-366, pl. 44, 7 text-fig., [in German].

The writer briefly discusses the stratigraphic significance of 17 previously described Foraminifera from the Ordovician of the Baltic Region of Europe.

7. Glaessner, M. F., 1963, Major trends in the evolution of the Foraminifera: *In*: Evolutionary Trends in Foraminifera, p. 9-24, 1 table, Elsevier Publishing Co., Amsterdam.

The writer lucidly discusses the major evolutionary trends of the Foraminifera during the Paleozoic Era and notes that a major "burst" of evolution occurred in the Devonian. In this instance it took about 50 million years before major taxonomic diversification was achieved. The first major evolutionary novelties were septation and calcareous wall secretion. Both express changes in basic physiological processes which are advantageous. These novelties provided the basis of intense future structural differentiation of the test and textural differentiation of the shell wall during Late Paleozoic times.

In reference to Paleozoic Foraminifera at least five propositions are considered. These are: (1) the non-septate forms are more primitive than the septate, (2) the higher, or septate, spirally coiled arenaceous Foraminifera form a well defined group, (3) the Fusulinidae are derived directly from the Endothyridae, (4) the different lines of the porcellaneous Foraminifera have a common origin in a coiled non-septate form, and (5) the Polymorphinidae are derived from Lagenidae, but there is no clear evidence concerning the origin of this family.

The writer notes in passing that the Scandinavian-Baltic Lower Cambrian index fossil *Platysolenites antiguissimus* Eichwald, is indistinguishable from the genus *Bathysiphon* and is considered as the oldest known Foraminifera. These specimens are from the Blue Clay of Revel on the Baltic Sea.

8. Glenister, B. F. and Crespin, I., 1959, Upper Devonian microfauna from the Fitzroy Basin, Western Australia: Australian Jour. Sci., v. 21, no. 7, p. 222-23.

The writers report an Upper Devonian (uppermost Frasnian) microfauna from the Virgin Hills Formation, Fitzroy Basin, Western Australia. Radiolaria, conodonts, sponge spicules, and agglutinated Foraminifera comprise the assemblage. Recognized foraminiferal genera (all agglutinated) include: *Bathysiphon, Hyperammina, Lagenammina, Sorosphaera,* and *Tolypammina*. [See Crespin, 1961, for a complete description of the agglutinated Foraminifera.]

9. Gutschick, R. C., 1962, Arenaceous Foraminifera from oncolites in the Mississippian Sappington Formation of Montana: Jour. Paleontology, v. 36, no. 6, p. 1291-1304, pl. 174-175, 6 text-fig.

An agglutinated foraminiferal fauna derived from insoluble residues of algal oncolites from the lower part of the Sappington Formation of Montana is described and illustrated by whole-specimen photomicrographs and excellent sketches. Seven genera and ten species are represented; of these one genus and three species are new. The new forms are *Oxinoxis botrys* n. gen., *Hyperammina sappingtonensis,* and *Tolypammina continuus.* Paleoecological observations and relationships are also discussed. Comparison is made with the fauna of the Louisiana Limestone of Missouri; it is suggested that both faunas are similar, if not identical. [Both the Louisiana Limestone and the Sappington oncolite horizon were originally defined as Mississippian (Kinderhookian) in age; however, recent studies on conodonts indicates that both of these units should now be regarded as uppermost Devonian (Fammenian) in age.]

10. GUTSCHICK, R. C., SUTTNER, L. J., and SWITEK, M. J., 1962, Biostratigraphy of transitional Devonian-Mississippian Sappington Formation of southwest Montana: Billings Geol. Soc. 13th Annual Field Conference Guidebook, p. 79-89, 2 pl., 10 text-fig.

The writers briefly discuss an agglutinated foraminiferal assemblage in association with other microfaunal elements, from the uppermost Devonian (Fammenian) Sappington Formation of southwestern Montana. The Foraminifera were obtained from an algal (oncolite)-sponge biostromal horizon by the HCl acid insoluble residue method. The Foraminifera are referred to previously described forms under the ammodiscids, tolypamminids, hyperamminids, and reophacids. Representative foraminiferal types are illustrated by whole-specimen photomicrographs.

11. HARRIS, R. W., 1930, Occurrence and significance of certain microfauna in the Ordovician of Oklahoma and elsewhere: Oklahoma Acad. Sci., Proc., v. 10, p. 56-59, 3 pl.

The writer briefly notes previously described agglutinated Foraminifera recovered from acid residues of the Ordovician Viola Limestone of southern Oklahoma. The foraminifers are illustrated by somewhat primitive sketches.

12. HILLS, J. M., 1935, The insoluble residues of the Cambro-Ordovician limestones of the Lehigh Valley, Pennsylvania: Jour. Sed. Pet., v. 5, no. 3, p. 123-132, 3 text-fig.

The writer briefly describes collections of Cambrian Foraminifera derived from hydrochloric acid insoluble residues from 6 horizons of the Upper Cambrian Leithsville Formation and Allentown Limestone. The writer gives no specific descriptions but states that the foraminifers have an oval shape with a simple aperture, or are spherical with a neck and consist of a single chamber or 3-4 chambers. The Foraminifera occur most abundantly in the lower division of the Allentown Limestone, which is correlated with the Upper Cambrian Hoyt Limestone of New York.

13. HÖEG, O. A., 1932, Ordovician algae from the Trondheim Area: Skrift. Norske Vidensk Akad. Oslo, Math.-nat. kl., No. 4, p. 63-96, pl. 1-11, text-fig. 7-13.

The writer illustrates and describes from the Ordovician rocks of Norway a *Problematicum* of the following description: "a small body of undifferentiated structure . . . body segmented, consisting of rings, width about 50 microns, length 270 microns, but perhaps more. Body partly curved. They have what may be pores at one end." [Reitlinger (1959) states that this form is very similar to the form described as *Obruchevella* and tentatively referred it under the Foraminifera.]

14. HOSKINS, D. M., 1961, Stratigraphy and paleontology of the Bloomsburg Formation of Pennsylvania and adjacent states: Pennsylvania Geol. Survey, 4th ser., Bull. G-36, 124 p., 7 pl., 1 map.

A sparse foraminiferal fauna is reported from the Silurian (Niagaran-Cayugan) Bloomsburg Formation of the Appalachian Mountains Region of the eastern United States. The fauna is briefly described and illustrated by the whole-specimen photomicrographs. All forms reported have been previously described; they are: *Bathysiphon* cf. *B. exiguus* Moreman, *Lagenammina* cf. *L. cornuta* Grubbs, and *L.* cf. *L. stilla* Moreman.

The writer postulates that the Bloomsburg microfauna (principally ostracodal) was deposited in brackish water.

15. ILYINA, N. S., 1961, New data on the tectonic deformations in the central regions of the Russian Platform: Acad. Sci., S.S.S.R., Doklady, v. 140, no. 1, p. 185-88, 3 text-fig., [in Russian].

From the Upper Devonian (Frasnian) sediments, the Yevlanovo-Livensk horizon, in the Royminsk well of the southeastern slope of the Koverninsk Depression, U.S.S.R., E. A. Reitlinger has identified 8 species of previously described Foraminifera associated with the alga *Issinella devonica* Reitlinger. The reported Foraminifera are: *Umbella bella* Maslov [now *Umbellina;* see Loeblich and Tappan, 1961, p. 284], *Tikhinella multiformis* (Lipina), *T.* cf. *pirula* Bykova, *T. measpis* Bykova, *Enodosaria stalinogorski* Lipina, *E. evlanensis* Lipina, *E. rauserae* (Tschern.), and *Eogeinitzina devonica* Lipina.

16. ILYINA, N. S., and FILIPPOVA, M. F., 1961, New data on Devonian deposits of the Ulyanovsk Arch: Acad. Sci. S.S.S.R., Doklady, v. 141, no. 1, p. 177-180, 3 text-fig., [in Russian].

The writers report the occurrence of the foraminifer *Eonodosaria evlanensis* Lipina from the Devonian (Frasnian) Yevlanovsk horizon from the Alatyrsk borehole that was drilled into the Ulyanovsk Arch, U.S.S.R.

17. JAANUSSON, V., 1960, The Viruan (Middle Ordovician) of Öland: Publ. Paleon. Inst., Univ. Uppsala, no. 28, p. 207-288, 5 pl., 26 text-fig., 8 tables.

The foraminifer *Ordovicina oligostoma* Eisenack is mentioned (p. 230) as occurring in the Middle Ordovician Dalby Limestone exposed on the Swedish island of Öland in the Baltic Sea.

18. KROPACHEV, S. M., 1961, Concerning the klippen of Middle Devonian limestones in Lower Carboniferous clay shales on the Marykh River (Northern Caucasus): Acad. Sci. S.S.S.R., Doklady, v. 139, no. 5, p. 1190-1193, 1 text-fig., [in Russian].

The writer reports the occurrence of the foraminifer *Bisphaera* sp. associated with a coral fauna from the Middle Devonian (Givetian) klippen in the northern Caucasus Mountains of the U.S.S.R.

19. MENNER, V. I., 1961, Stratigraphy of the Devonian deposits of the northwestern Siberian Platform: Acad. Sci. S.S.S.R., Doklady, v. 141, no. 6, p. 1441-44, [in Russian].

The foraminifer *Umbella* ex. gr. *bella* Maslov is reported from the Upper Devonian (Frasnian) deposits of the northwestern Siberian Platform, U.S.S.R. [Loeblich and Tappan (1961, p. 284) have shown that the name *Umbella* is preoccupied; they have proposed the new name *Umbellina* for this form.]

20. MIKLUKHO-MAKLAY, A. D., 1961, Certain Devonian algae of central Asia and of other regions of the U.S.S.R. and their rock-forming and paleogeographic importance: Acad. Sci. S.S.S.R., Doklady, v. 138, no. 3, p. 655-658, [in Russian].

The writer notes the occurrence of the form *Umbella* from the Upper Devonian rocks of the Alay and Turkestan Ranges of central Asia. In this instance, *Umbella* is regarded as a charophyte, more exactly as *Trochiliscus*. [Later study, Loeblich and Tappan (1961, p. 284) has shown the name *Umbella* to be preoccupied; a new name *Umbellina* has been proposed and the form in question is regarded as a foraminifer placed under the Nodosinellidae.]

21. MILON, Y., 1928, Recherches sur les Calcaires Paléozoiques et le Briovérien de Bretagne: Ph. D. Thèses, Faculté des Sciences de l'Université de Paris, 151 p., 8 pl., 77 text-fig., [in French].

The writer presents a general résumé of worldwide Precarboniferous foraminiferal occurrences up to that time (1928). Most forms are illustrated by line-drawings, but a few are illustrated by thin-section photomicrographs. Forms from the Upper Devonian (Frasnian) of Villede-d'Ardin, France, identified as "Calcisphères épineuses" would now be regarded as representatives of the genus *Parathurammina*.

22. NITECKI, M. H., 1961, Catalogue of type specimens of Foraminifera in the Walker Museum of Paleontology: Fieldiana, Geology, v. 13, no. 2, p. 109-160.

The writer lists the following 44 types of Silurian and Devonian Foraminifera now in the custody of the Walker Museum of Paleontology: *Ammodiscus abbreviatus* Ireland, 1939; *A. exsertus* Cushman, 1910; *A. exsertus* var. *minutis* Ireland, 1939; *A. incertus* (d'Orbigny); *Arenosiphon gigantea* Grubbs, 1939; *Bathysiphon curvus* Moreman, 1930 [now placed under *Hyperammina curva* (Moreman); see Mound, 1961, p. 35]; *B. curvus* var. *gracilis* Ireland, 1939, *B. parallelus* Dunn, 1942, and *B. rugosus* Ireland, 1939 [now placed under *B. exiguus* Moreman; see Mound, 1961, p. 36]; *B. dimunitionis* Moreman, 1930; *Bifurcammina bifurca* Ireland, 1939; *B. conjuncta* Ireland, 1939; *B. parallela* Ireland, 1939; *Ceratammina cornucopia* Ireland, 1939; *Colonammina conea* Moreman, 1930; *C. verruca* Moreman, 1930; *Glomospira siluriana* Ireland, 1939; *Lagenammina cornuta* Grubbs, 1939; *L. distorta* Ireland, 1939; *L. sphaerica* Moreman, 1930; *L. stilla* Dunn, 1932; *Lituotuba exserta* Moreman, 1930; *L. inflata* Ireland, 1939; *Placopsilina*? *lineata* Grubbs, 1939; *Psammophax bipartita* Ireland, 1939; *Psammosphaera angularis* and *P. gracilis* Ireland, 1939 [now placed under *P. cava* Moreman; see Mound, 1961, p. 26]; *P. cava* Moreman, 1930; *P. magna* Dunn, 1942; *Saccammina moremani* Ireland, 1939; *Sorosphaera irregularis* Grubbs, 1939 [now placed under *S. osgoodensis* Stewart and Priddy; see Mound, 1961, p. 34]; *Tholosina sedentata* Ireland, 1939; *Thurammina cylindrica* Grubbs, 1939; *T. delicata* Ireland, 1939; *T. globosa* Ireland, 1939; T. *globula* Grubbs, 1939; *T. polygona* Ireland, 1939; *T. sphaerica* Ireland, 1939; *T. subpapillata* Ireland, 1939; *T. tubulata* Moreman, 1930; *T. unitubula* Grubbs, 1939; *Webbinella bipartita* Ireland, 1939; and *W. coronata* Ireland, 1939.

23. OZONKOWA, H., 1962, The genus *Umbellina* (Foraminifera) - an index fossil in the Devonian of the Holy Cross Mountains: Ann. Soc. Geol. Pologne, v. 32, fasc. 1, p. 107-117, pl. 7-8, 3 text-fig., [in Polish with English summary].

The writer reports the presence of three species of the genus *Umbellina* from a thin limestone bed in the Devonian (middle Givetian) sequence from the eastern part of the Kielce-Lagow Synclinorium, Holy Cross Mountain, Poland. Of the three species described two are reported as new: *Umbel-*

lina polonica and *U. sanctacrucensis.* Thin-section photomicrographs and whole-specimen drawings are given. The author notes that it is possible that the forms described by Bykova and Polenova (1955) as *Umbella baschkirica* and *U. pugatchovensis* are varieties of the species *Umbellina bella* (Maslov).

24. PRONINA, T. V., 1960, New Ordovician and Silurian Parathuramminidae of the Urals. *In*: New species of ancient plants and invertebrates of the U.S.S.R. Vsesoyuz. Nauch.-Issledovatel. Geol. Inst. (VSEGEI), Min. Geol. i Okhrana Nedr. S.S.S.R., Pt. 1, p. 138-140, pl. 25, [in Russian].

A new species of Middle and Upper Ordovician foraminifer, *Parathurammina sergiensis,* is described from thin-sections of this age from the western side of the Ural Mountains of the U.S.S.R.

In addition a new species of Silurian (Wenlockian) foraminifer, *Cribrosphaeroides michailovensis* is also described. This form is based on over 100 tests found in thin-section from 10 locations on the western side of the Urals. Both forms are illustrated by thin-section photomicrographs [Although the Silurian form is described as *Cribrosphaeroides michailovensis* in the text and on the plate legend, it is erroneously labeled as *Cribrosphaerella michailovensis* on plate 25.]

25. REITLINGER, E. A., 1959, Atlas of microscopic organic remains and *problematica* in the ancient deposits of Siberia: Acad. Sci. S.S.S.R., Trudy, Geol. Inst., Bull. No. 25, 62 p., 22 pl., [in Russian].

A number of forms originally described as Foraminifera from the Cambrian rocks of Siberia are listed in this publication as structures of undoubted organic origin but of uncertain systematic position. Those genera previously regarded as Foraminifera (Reitlinger, 1948; Suleimanov, 1945; and Antropov, 1950) are *Obruchevella, Glomovertella, Cavifera, Syniella, Archaesphaera,* and *Vicinesphaera.* Most Russian authors are still describing new species of the above genera and placing them under the Foraminifera. Under some of the above genera the following five new forms have been described and illustrated by thin-section photomicrographs: *Archaesphaera cambrica,* (Lower and Middle Cambrian), *A. cambrica* var. *crafta* (Middle Cambrian), *Vicinesphaera eosqualida* (Cambrian?), *Obruchevella parva* (Cambrian?), and *O. sibirica* (Upper Cambrian or Ordovician). [Bykova, 1961, states that the genera *Glomovertella, Obruchevella,* and *Cavifera,* can now be classified among the Foraminifera with certainty.]

26. RUSCONI, C., 1950, Diferentes organismos del Ordovicio Y del Cambrico de Mendoza: Mus. Nat. Hist. Mendoza, Rev., v. 4, no. 3, p. 63-70, 5 text-fig., [in Spanish].

Two new species identified as questionable Foraminifera are described from the Middle and Upper Cambrian of Mendoza, Argentina. Both species are illustrated by very generalized whole-specimen drawings. The new forms are ?*Clavulina isidrensis,* and ?*Pseudoglandulina alfaensis.* [Reitlinger, 1959, notes that in shape *Obruchevella* is somewhat reminiscent of the questionable foraminifer ?*Pseudoglandulina alfaensis* Rusconi.]

27. SHEVCHENKO, V. I., 1961, Fammenian deposits of the Stalingrad Region: Acad. Sci. S.S.S.R., Doklady, v. 139, no. 4, p. 956-958, [in Russian].

Reports the occurrence of the foraminifers *Umbella saccamminiformis* Bykova [now *Umbellina;* see Loeblich and Tappan, 1961] and *Septatournayella rauserae* Lipina from the Upper Devonian (Fammenian) rocks of the Stalingrad Region of the U.S.S.R.

28. SHEVTSOV, S. I., 1961, The stratigraphy of Devonian deposits of the Kirov Region: Acad. Sci. S.S.S.R., Doklady, v. 139, no. 5, p. 1197-1200, [in Russian].

The writer reports the occurrence of the foraminifer *Eonodosaria evlanensis* Lipina from the Middle Devonian (Givetian) Yevlanovsk-Livensk horizon of the Kirov Region of the U.S.S.R.

29. VISTELIOUS, A. B., MIKUKHO-MAKLAI, A. D., and RABININ, V. N., 1953, Devonian limestones in the redbed strata of Tuarkira: Acad. Sci. S.S.S.R., Doklady, v. 90, no. 2, p. 231-234, [in Russian].

From Upper Devonian limestones within a redbed sequence from Tuarkira, U.S.S.R., the occurrence of a number of previously described Frasnian Foraminifera is reported.

30. WAERN, B., 1953, Palaeontology and stratigraphy of the Cambrian and lowermost Ordovician of the Bödahamn core: Geol. Inst. Univ. Upsala, Bull., v. 34, art. 9, p. 223-250, 1 pl., 4 text-fig.

The writer describes and illustrates by whole-specimen photomicrographs authentic Lower and Middle Cambrian Foraminifera from a boring on the southeastern coast of Sweden. The author describes them as agglutinated Foraminifera, similar to *Thurammina* and *Thuramminoides;* they are discoid in form, and their walls consist of silica and chiton. No generic or specific names are given.

31. WAINES, R. H., 1962, Devonian calcareous Foraminifera from Arrow Canyon Range, Clark County, Nevada (Abstract): A.A.P.G.-S.E.P.M. Program, San Francisco Meeting, March 26-29, p. 58.

The writer reports the occurrence of Devonian calcareous Foraminifera from a sequence of Devonian limestones in southern Nevada. The microfauna is assigned to 3 genera: *Endosaria* Lipina, *Tikhinella* Bykova, and a third genus, possibly new. This is the first reported occurrence of the above genera in North America. [This microfauna compares favorably with forms confined to late Frasnian rocks from the Russian Platform and southcentral China.]

32. WILLIAMS, J. S., 1943, Stratigraphy and fauna of the Louisiana Limestone of Missouri : U. S. Geol. Survey Prof. Paper 203, 133 p., 9 pl., 7 text-fig.

The Louisiana Limestone is reported to contain forms that resemble *Hyperamminoides, Lituotuba,* and *Ammodiscus.* [The Louisiana Limestone was previously regarded as Mississippian (Kinderhookian) in age; however, recent conodont studies now place this unit in the uppermost Devonian (Fammenian)].

33. WORKMAN, L. E., and GILLETTE, T., 1956, Subsurface stratigraphy of the Kinderhook Series of Illinois: Illinois Geol. Survey, Rept. of Investigations 189, 46 p., 2 pl., 20 text-fig.

The writers briefly report the following foraminiferal genera derived from insoluble residues of the Louisiana Limestone of western and central Illinois: *Ammodiscus, Lituotuba, Hyperammina, Bathysiphon, Tolypammina, Aschemonella*?, and simpler forms difficult to identify. [Formerly the Louisiana Limestone had been regarded as Mississippian (Kinderhookian) in age; however, recent conodont studies indicate that this unit is more properly placed in the uppermost Devonian (Fammenian)].

B. *LATE PALEOZOIC FORAMINIFERA:*

34. AIZENVERG, D. E., and BRASHNIKOVA, N. E., 1956, Faunal characteristics of the lower part of the Donets Tournaisian: Acad. Sci., S.S.S.R., Doklady, v. 108, no. 5, p. 907-909, [in Russian].

The writers present a short résumé of the foraminiferal subdivision of the Lower Carboniferous (Tournaisian) of the Donets Basin of the U.S.S.R., based upon previously described foraminiferal genera and species.

35. ARMSTRONG, A. K., 1962, Stratigraphy and paleontology of the Mississippian System of southwestern New Mexico and adjacent southeastern Arizona: New Mexico Bur. Mines and Min. Res., Mem. 8, 99 p., 12 pl., 41 text-fig.

Endothyroid Foraminifera are reported from the Mississippian Escabrosa Group of southwestern New Mexico and southeastern Arizona. The fauna is illustrated by rather poor thin-section photomicrographs. No new forms are reported; however, a rough endothyroid zonation is given for the Escabrosa Group of the Big Hatchet Mountains of New Mexico (text-fig. 3). The author identified *Endothyra* and *Paraendothyra* from the Osage portion of the section and *Endothyra symmetrica* Zeller [now *E. scitula;* see Toomey, 1961] from the uppermost Osage through middle Meramec portion of the section.

36. BAILEY, W. F., 1935, Micropaleontology and stratigraphy of the Lower Pennsylvanian of central Missouri: Jour. Paleontology, v. 9, no. 6, p. 483-502, pl. 55.

The writer reports 12 previously described genera of Foraminifera from Lower Pennsylvanian rocks of central Missouri. A brief discussion pertaining to the occurrence of foraminiferal genera in relation to rock type is also given. No specimens are illustrated.

37. BIGNOT, G., and NEUMANN, M., 1962, The structure of foraminiferal tests; bibliographic review: Rev. Micropaleontologie, v. 4, no. 4, p. 237-248, 2 pl., 2 text-fig., [in French].

A bibliographic survey of the chemical composition, microstructure, and general architecture of foraminiferal tests is given. Reference is made to Late Paleozoic foraminiferal wall structure, and a short discussion of some pertinent forms is included.

38. BOGUSH, O. I., and YUFEREV, O. V., 1957, Foraminifera and stratigraphy of the Carboniferous deposits of Kara-Tau and the western outskirts of Talasskii Ala-Tau: Acad. Sci., S.S.S.R., Doklady, v. 112, no. 3, p. 487-489, [in Russian].

The writers present a brief discussion of the Foraminiferal biostratigraphy of the Carboniferous rocks in the region bordering the eastern shore of the Caspian Sea (Kazakh. S.S.R.,), based upon previously described Foraminifera.

39. BOGUSH, O. I., and YUFEREV, O. V., 1961, Layers with *Endothyra communis* in Karatau and in the western spurs of the Talass Alatau: Bull. Moscow Soc. Nat. Hist., Geol. Ser., v. 36, no. 3, p. 89-101, 2 text-fig., [in Russian with English abstract].

On the basis of *Endothyra communis* Rauser-Chernoussova the writers were able to delineate the Upper Devonian-Lower Carboniferous boundary in the region bordering the eastern shore of the Caspian Sea (Kazakh, S.S.R.). [*E. communis* Rauser-Chernoussova, 1948, is now the type species for the genus *Eoendothyra;* see Miklukho-Maklai, 1960.]

40. BROTZEN, F., 1963, Evolutionary trends in certain calcareous Foraminifera on the Palaeozoic-Mesozoic boundary: *In*: Evolutionary Trends in Foraminifera, p. 66-78, 6 text-fig., Elsevier Publishing Co., Amsterdam.

In relationship to the nodosaroid-type Foraminifera the present writer adheres to the definition of Glaessner and concludes that all such forms that do not have a calcareous, hyaline and perforate wall do not belong to the Nodosariidea. Hence, some forms must be separated from this superfamily even if they possess many other characters in common; with this *sensu stricto* interpretation no genus of this group is known before the Upper Permian.

Cummings (1955) study of the wall structure of *Nodosinella* seems to indicate to the present writer, a position between the Endothyridea of the Upper Paleozoic and the Lagenidea of the Mesozoic. In relation to Cummings (1955) work on the Earlandiidae, it is apparent that such forms should not be included in the Endothyridea. Instead, an evolutionary trend may exist from the Earlandiidae via the Reophacidae to the Nodosinellidae.

None of Paalzow's (1935) Permian *"Nodosaria"* and *"Dentalina"* species have a real "Nodosariidea" wall structure. All transitions occur, from finely granular and agglutinated calcareous walls to completely calcareous radiate walls and preserved compound calcareous walls.

As an aid towards understanding the evolution of the nodosarioid groups, the writer has called the genera of the Upper Paleozoic with thick massive wall structure palaeonodosarioids; the Triassic and Lower Jurassic groups with a glassy, indistinct wall structure, the mesonodosarioids.

The Permian genera *Geinitzina* and *Spandelina* have compound walls or are agglutinated. It is impossible to unite them with the younger genera *Frondicularia* and *Lingulina,* with the perforate and radiate walls, therefore, the writer proposes that they should be called *Neogeinitzina* and *Neospandelina;* short diagnoses of the two new proposed genera are given.

41. BRAZHNIKOVA, N. E., 1962, *Quasiendothyra* and closely related forms in the Lower Carboniferous of the Donets Basin and other areas of the Ukraine: Acad. Sci. U.R.S.R., Kiev, Inst. Geol. Sci., Trudy, Ser. Strat. and Paleo., no. 44, p. 3-48, 14 pl., 1 text-fig., [in Russian].

From the Lower Carboniferous rocks of the Ukraine Region of the U.S.S.R. a microfauna of 32 species, of which 1 genus and 7 species are new, is described and illustrated by thin-section photomicrographs. The new forms are *Quasiendothyra*? *parallela, Q.*? *intermedia, Endothyra*? *chomatica, Dainella elegantula typica* n. gen., *D. elegantula ventrosa, D. elegantula evoluta,* and *Loeblichia minima.* A discussion of the evolutionary trends and relationships of *Quasiendothyra, Dainella,* and *Loeblichia* is also given.

Taxonomic changes include the following: *Quasiendothyra kedrovica* Durkina, 1959 = *Q. rotai* Dain; *Nanicella ammonoides* subsp. *paraammonoides* Brazhnikova, 1956 = *Loeblichia ammonoides* subsp. *paraammonoides* (Brazhnikova); *Quasiendothyra ukrainica* Brazhnikova, 1956 = *Loeblichia ukrainica* (Brazhnikova); and *Quasiendothyra ukrainica* var. *confusa* Brazhnikova, 1956 = *Loeblichia ukrainica* (Brazhnikova) form *confusa.*

42. CHOQUETTE, P. W., and TRAUT, J. D., 1963, Pennsylvanian carbonate reservoirs, Ismay Field, Utah and Colorado: *In*: Shelf Carbonates of the Paradox Basin, Symposium 4th Field conference Four Corners Geol. Soc., p. 157-184, 5 pl., 9 text-fig.

The writers report the genera *Calcitornella* and *Calcivertella* as prime faunal constituents in beds of Pennsylvanian (Desmoinesian) age occupying a stratigraphic position right above the algal plate mounds of the Ismay zone in the subsurface of southeastern Utah.

The foraminiferal limestones range from mud-supported to grain-supported and usually contain abundant grains in a matrix of carbonate mud. Diagnostic fossils in these rocks are fusulines and tubular, porcelaneous foraminifers belonging to the family Ophthalmidiidae. Many of the tubular foraminifers seem to have been sessile or encrusting, although they now occur as clasts. The sessile forms are of particular interest because foraminifers essentially identical to them also occur in the buildups, attached to algal thalli and other fossils. This relationship suggests that the ophthalmidids may have been derived chiefly from the algal banks; however, the abundance of ophthalmidids and absence of algal debris in these foraminiferal limestones implies that many or most of the foraminifers may actually have been attached to nonpreservable organisms, possible marine grasses or soft-bodied algae, as originally suggested by Henbest (1958, p. 109). [Genus *Calcitornella* now regarded as invalid; see Henbest, 1963.]

43. CHRONIC, J., 1958, Pennsylvanian paleontology in Colorado: *In*: Symposium on Pennsylvanian rocks of Colorado and adjacent areas, p. 13-16, 2 text-fig., Rocky Mountain Association of Geologists, Denver, Colorado.

The writer briefly outlines the progress to date in the identification of Pennsylvanian micro- and megafossils from Colorado. Text-fig. 2 lists distinctive previously described smaller Foraminifera from the Morrowan, Atokan, and Middle Desmoinesian rocks of Colorado.

44. CONKIN, J. E., CONKIN, B. M., and MCDONALD, D., 1963, Mississippian smaller Foraminifera from the southern peninsula of Michigan: Micropaleontology, v. 9, no. 2, p. 215-227, pl. 1, 5 text-fig.

A microfauna of 8 genera and 9 species, of which 1 species is new, is described from the Mississippian (Lower Osagian) Coldwater Shale of the southern peninsula of Michigan. The microfauna is composed of agglutinated forms derived from dilute acid insoluble residues. All representative species are illustrated by whole-specimen photomicrographs. The new species is *Ceratammina*? *michiganensis*. *Ceratammina* was previously known only from the Devonian of Oklahoma; this article records the first occurrence of this genus in the Mississippian. The writers believe that the Coldwater sediments were deposited in relatively cool waters.

45. COOPER, C. L., 1947, Role of microfossils in interregional Pennsylvanian correlations: Jour. Geol., v. 55, no. 3, pt. 2, p. 261-270.

The writer discusses the value of non-fusulinid Foraminifera in interregional correlation and concludes that the smaller Foraminifera have not furnished horizon markers in the same proportion as fusulinids. This is due to the lack of extensive work on these forms and to the long range of most of the known genera and species; a reflection of the reappearance of the like forms with the repetition of similar environmental conditions. Plummer's (1945) work on the Lower Pennsylvanian formations of central Texas is cited as an example.

46. COOPER, C. L., 1948, Kinderhook micropaleontology: Jour. Geology, v. 56, no. 4, p. 353-366, 1 text-fig.

The writer briefly notes the presence of Mississippian Foraminifera in a number of formations. The only described forms are *Endothyra baileyi* (Hall) from the Salem and St. Louis beds, and a few genera which Cooper (1957) reported from the Kinkaid beds (Chester) of Illinois.

Foraminifera have also been observed in the Jacobs Chapel, Chouteau, and Rockford Formations. The Jacobs Chapel Shale and Rockford beds contain many species of *Trepeilopsis, Glomospira*?, and one species of *Thurammina*. Many identical forms also occur in the Chouteau Limestone.

47. CRAIG, G. Y., 1954, The palaeoecology of the Top Hosie Shale (Lower Carboniferous) at a locality near Kilsyth: Quart. Jour. Geol. Soc., London, v. 110, p. 103-119, 3 text-fig.

Within a 24-inch Lower Carboniferous shale horizon in Scotland, 2 fossil communities have been delineated: (1) *Posidonia* community of dark pyritous shale carrying *Glomospirella* sp., *Hyperammina* sp. along with other macrofossils; unit 4 inches thick and, (2) *Lingula-Nuculopsis* community 20 inches thick and defined by a burrowing fauna; within this interval only *Glomospirella* is present with other macrofossils.

The writer regards the Foraminifera as probably benthonic animals living on the surface of the mud and concludes that the fauna as a whole suggests a shallow subtidal deposit (low-tide to 50 meters). It is significant that *Hyperammina* is restricted to the pyritous shale interval in a probably incipient anaerobic environment.

48. CRESPIN, I., 1956, Microfossils from the southwest part of the Canning Basin, western Australia, Appendix C, p. 54, *In*: The geology of the southwestern Canning Basin, western Australia: Dept. Nat. Div., Bur. Min. Res., Geol. Geoph., Australia, Rep. No. 29, 74 p., 22 text-fig., 1 map.

A purplish micaceous sandy shale (Dora Shale) from western Australia has yielded numerous agglutinated Permian Foraminifera. The fauna consists of *Ammodiscus nitidus* Parr, *Ammobaculites* cf. *woolnoughi* Crespin and Parr, *Hyperamminoides acicula* Parr, and *H*. cf. *expansus* Plummer [now placed under *Hyperammina expansa* (Plummer); see Conkin, 1954, p. 168]. This assemblage of Permian agglutinated Foraminifera is characteristic of the beds in the Wandagee Formation of the Carnarvon Basin and of the Noonkanbah Formation of the Kimberley Area.

49. CUMMINGS, R. H., 1961, The foraminiferal zones of the Carboniferous sequence of the Archerbeck borehole, Canonbie, Dumfriesshire: Bull. Geol. Survey Gt. Brit., no. 18, pt. 8, p. 107-128, pl. 4, 2 text-fig. [faunal lists on p. 47-66, Appendix B].

The smaller Foraminifera present in thin-section from the calcareous beds of the Archerbeck borehole, in southern Scotland, have been examined in detail with particular reference to assemblage patterns, diagenetic alteration, and facies control. These microfaunas indicate that the beds are in continuous stratigraphical sequence ranging from Lower Visean at the bottom of the bore, to Lower Namurian at about 600 feet, the upper limit of sampling. The entire section has been subdivided on the basis of the sequence of foraminiferal assemblages in terms of the zonal system recently proposed by the writer. Numerous paleoecologic observations are also included.

50. DELEAU, P., and MARIE, P., 1959, The fusulinids of the Westphalian C of the Abadla Basin and some other Foraminifera of the Algerian Carboniferous (Colomb-Bechar Region): Publ. Serv. Carte Geol. Algerie, n. s., Bull. 25, Travaux des Colloborateurs, p. 45-160, pl. 1-12, [in French].

From the Carboniferous of Algeria, North Africa, a microfauna of 49 species representing 29 genera, of which 7 species and 7 genera are new, is described and illustrated by very poor photomicrographs. Among the 49 species observed 5 were from the Namurian and the remaining 44 from the Westphalian C interval.

The new forms are: from the Namurian only *Spirillina bacteriformis;* the remainder from the Westphalian C: *Conicocornuspira conica* n. gen., *Hemigordiella* n. gen., *Hemigordiellina* n. gen., *Ondogordius campanula* n. gen., *Tolypamminella vermiculare* n. gen., *Pseudotetrataxis* n. gen., *Falsotetrataxis* n. gen., *Globigerina primitiva, G. deleaui,* and *Acervulina prima.*

Taxonomic changes include the following: *Glomospira disca* Cooper, 1941 = *Hemigordiella disca* (Cooper); *Hemigordius hemigordiformis* Cherdynzew, 1914 = *Hemigordiellina hemigordiformis* (Cherdynzew); *Tetrataxis planolocula* Lee and Chen, 1930 = *Pseudotetrataxis parviconica* (Lee and Chen); *Tetrataxis conica* var. *lata* Spandel, 1901 = *Pseudotetrataxis conica* (Ehrenberg) var. *lata* (Spandel); *Tetrataxis corona* var. *pauperata* Warthin, 1930 = *Pseudotetrataxis corona* (Cushman and Waters) var. *pauperata* (Warthin); *Valvulina deccurens* Brady, 1876 = *Pseudotetrataxis* cf. *deccurens* (Brady); *Tetrataxis concava* Galloway and Rynicker, 1930 = *Falsotetrataxis concava* (Galloway and Rynicker); *Tetrataxis maxima* Schellwien = *Polytaxis maxima* (Schellwien); *Endothyra ameradoensis* Harlton, 1927 = *Plectogyra ameradoensis* (Harlton); *Endothyra tschernovi* Rauser-Chernoussova and Reitlinger = *Plectogyra tschernovi* (Rauser-Chernoussova and Reitlinger); *Endothyra discoidea* Girty, 1915 = *Plectogyra discoidea* (Girty); *Endothyra similis* Rauser-Chernoussova and Reitlinger = *Plectogyra* aff. *similis* (Rauser-Chernoussova and Reitlinger); *Millerella* sp. Zeller, 1950 = *Endothyra* sp.; *Bradyina magna* Roth and Skinner, 1930 and *B. magna* St. Jean, 1957 = *Glyphostomella magna* (Roth and Skinner); *Nodosinella laheeii* Waters, 1927 = *Nodosinella crassa* Waters; and *Palaeotextularia asper* Cooper, 1947 = *Textularia asper* Cooper.

The genotype of *Hemigordiella* is *Hemigordius calcarea* Cushman and Waters, 1928; the genotype of *Hemigordiellina* is *Glomospira diversa* Cushman and Waters, 1930 [*G. diversa* (*pars*) Cushman and Waters 1930), fig. 11-13 placed under *G. gordialis* (Jones and Parker); see Mound, 1961, p. 22]; and the genotype of *Falsotetrataxis* is *Tetrataxis scutella* Cushman and Waters, 1928.

A general discussion as to test composition, foram classification, and ecology is also presented.

51. EASTON, W. H., 1962, Carboniferous formations and faunas of central Montana: U. S. Geological Survey Prof. Paper 348, 126 p., 14 pl., 1 text-fig., 5 tables.

One previously described form, *Endothyra* aff. *E. excentralis* Cooper, is briefly described from the Mississippian? Cameron Creek Formation of central Montana. The above form is illustrated (pl. 3, fig. 5, 6) by thin-section photomicrographs.

Identifications (by Henbest) of Pennsylvanian forms from the Devils Pocket Formation are given on pages 16 and 23 and on table 5.

52. ELIAS, G. K., 1962, Paleoecology, an exploration tool in southern Paradox Basin, Four Corners Area (Abstract): A.A.P.G.-S.E.P.M. Program, San Francisco Meeting, March 26-29, p. 40-41.

The writer briefly notes that in identifying the shoal environment in the Pennsylvanian of the Paradox Basin, the following diagnostic parameters are characteristic: "The rocks are light colored calcareous muds and disturbed calcareous muds interbedded with poorly winnowed intraclasts, pellets and Foraminifera (*Glomospira*)."

53. ELIAS, G. K., 1963, Habitat of Pennsylvanian algal bioherms, Four Corners area. *In*: Shelf carbonates of the Paradox Basin, Symposium, 4th Field Conference Four Corners Geol. Soc., p. 185-203, 13 text-fig., 1 table.

The writer reports the following foraminiferal genera from the Pennsylvanian (Desmoinesian) Paradox Formation from southeastern Utah: *Rectocornuspira*?, *Orthovertella*?, *Calcitornella*?, *Calcivertella*?, *Tetrataxis, Plectogyra*?, and *Climacammina*?. All of the above genera are found in what the writer designates as the pelletal mud and *Ivanovia* facies. Inferences as to water depth, mainly based upon analogous Recent Ophthalmidiidae (Foraminifera), suggest a depositional environment in waters less than 20 feet in depth.

54. FERGUSON, L., 1962, The paleoecology of a Lower Carboniferous marine transgression: Jour. Paleontology, v. 36, no. 5, 1080-1107, 6 text-fig., 2 tables.

The writer presents a detailed paleoecological study of the Scottish Visean (Upper Mississippian) fireclay-shale-limestone sequence which attempts to elucidate changes in the depositional environment and fauna concomitant with a marine transgression. Four topozones (both megafossil and microfossil) have been used as a basis for dividing the shale interval. The faunas of the lower half of the shale indicate deposition in very shallow, possibly brackish water, and the shales are compared to recent intertidal deposits. The fauna of the upper half of the shale suggests slightly deeper water although still well within the neritic zone. Subdivision of the shale sequence based on Foraminifera showed the following (from base to top):

Topozone I — The upper half of this interval contains abundant *Glomospira* sp.

Topozone II — *Glomospira* sp. is abundant throughout this zone.

Topozone III — The foraminiferal content is more varied: *Glomospira* is not so abundant; adherent Foraminifera *Stacheia congesta* Brady and *Stacheioides polytrematoides* (Brady) are abundant in the upper half of this zone, mainly encrusting productid spines; *Plectogyra baileyi* (Hall) is profuse in the upper half of this zone.

Topozone IV — The zone could be delineated on the occurrence of *Endothyra radiata* Brady and *E. globulus* Brady which are abundant throughout along with the forms found in Topozone III; although occurring in much greater abundance are *Fourstonella fusiformis* (Brady) and *Loeblichia ammonoides* (Brady). The upper half of this zone contains a much more varied foraminiferal content which includes *Tetrataxis conica* Ehrenberg, *Quasiendothyra* cf. *kobeitusana* Rauser-Chernoussova, *Endothyranopsis crassus* (Brady), *Palaeotextularia daviesella* Cummings, *Climacammina antiqua* and *Earlandia pulchra* Cummings.

The increase in the numbers and species continues into the lower layers of the overlying Second Abden Limestone where *Howchinia bradyana* (Howchin) and *Janischewskina* sp. were observed in thin-section. Among the smaller Foraminifera *Glomospira* sp. tends to give place to *Rastidiscus rasti* Cummings in the upper part of this zone.

Many pertinent paleoecological observations, principally pertaining to the enclosed megafauna, are also given.

55. GANELINA, R. A., 1956, New families and genera of invertebrates: Materially Vses. Nauchn. Issled. Geol. Inst. No. 12, p. 17-19, pl. 2, [in Russian].

Under the family Miliolidae the new genus and species, *Eosigmoilina explicata,* is described from the Middle Carboniferous rocks of the Donets Basin. The new form is illustrated by whole-specimen and thin-section photomicrographs. [On plate 2, one other form, *E. radtchenkovensis,* is illustrated by a single thin-section photomicrograph and is designated as a "new species." Since this "new species" was not mentioned in the text or formally described, it should be regarded as a *nomen nudum.*]

56. GERKE, A. A., 1961, Permian, Triassic, and Lower Jurassic Foraminifera from the petroleum regions of northcentral Siberia: Trans. Arctic Geol. Res. Inst., v. 120, State Petroleum and Mineral Fuels Engineering House, Leningrad, 270 p., 122 pl., 5 text-fig., 3 tables, [in Russian].

The study of the Permian, Triassic, and Lower Jurassic Foraminifera of northcentral Siberia yielded a microfauna of 106 species of Permian foraminifers. Of these 11 species are described as new and are illustrated by drawings. The new species are: *Saccammina tymjatiensis* Schleifer, *Hyperamminoides terris* Schleifer, *Ammodiscus septentrionalis, Nodosaria pseudoelabugae, Pseudonodosaria ventrosa* Schleifer, *Dentalina praenuntia, Frondicularia* (*Frondicularia*) *jacutica* Schleifer, *F.* (*F.*) *abies* Schleifer, *F.* (*F.*) *gloria* Schleifer, *F.* (*F.*) *costiferella,* and *Lagena antiqua* Schleifer.

The Permian deposits consist principally of thick sections of argillaceous sandstone, with some local coal-bearing sediments. In most cases a megafauna is rare, although Foraminifera are rather numerous. The "larger Foraminifera" of the family Fusulinidae are not present. The microfauna contains both agglutinated and calcareous forms, with the former predominating. In general, the agglutinated Foraminifera are more numerous and diversified in the lower horizons of the section, while the calcareous forms flourished at the start of the Upper Permian. The agglutinated Foraminifera are mainly represented by primitive genera in which the test is either not divided into chambers at all or else consists of a proloculus and a long undivided section. Of the more highly organized forms with multilocular tests, only the reophacids and a few poorly preserved *Trochammina*? specimens are known.

Taxonomic changes include: *Hyperamminella protea* Cushman and Waters, 1928, *Hyperammina johnsvalleyensis* Harlton, 1933, and *H. elegans* Crespin, 1958, are all placed under *Hyperamminoides proteus* (Cushman and Waters); and *Dentalina* aff. *kalinkoi* Gerke, 1952 = *Dentalina praenuntia* Gerke.

57. GERKE, A. A., 1962, *Frondicularia* of the Permian, Triassic, and Liassic sediments of northcentral Siberia: Scientific Research Inst. of Arctic Geol., Trans., v. 127, Paleo. and Biostrati., no. 3, p. 97-175, [in Russian].

The writer brings together in one article all descriptions of frondicularid foraminiferal species from the Permian, Triassic, and Liassic sediments of northcentral Siberia. Species descriptions are presented, but the reader is referred to the plates in the 1961 article. Essentially a compendium of the frondicularid portion of the much more extensive 1961 Gerke monograph.

58. GOLUBTSOV, V. K., 1961, Discovery of Permian deposits in the southwestern part of Belorussia (Brest Depression): Acad. Sci. S.S.S.R., Doklady, v. 139, no. 1, p. 166-169, 1 text-fig., [in Russian].

The writer reports the occurrence of Permian deposits in the southwestern part of Belorussia, Brest Depression, U.S.S.R. Basis for the Permian age is a large microfauna of previously described Kazanian Foraminifera. The fauna consists principally of species of *Nodosaria, Geinitzina, Dentalina,* and *Ammodiscus.* The writer claims that the Belorussian deposits can be correlated with the Lower Zechstein of Germany, Poland, and the Baltic Region.

59. HALLIGARTH, W. E., and SKIPP, B. A. L., 1962, Age of the Leadville Limestone in the Glenwood Canyon, western Colorado: U. S. Geol. Survey Prof. Paper 450-D, art. 129, p. 37-38, 1 text-fig.

The writers report three previously described genera of Foraminifera (*Plectogyra tumula* Zeller, *Endothyra* aff. *E. scitula* Toomey, and *Septaglomospiranella* sp. Lipina) from the Mississippian Leadville Limestone of western Colorado. This and previous studies indicate that *Plectogyra tumula* occurs in rocks no younger than Osage, and *Endothyra scitula* is restricted to the Meramec. The Foraminifera occur in massive cliff-forming oolitic limestones.

The Leadville Limestone in the Glenwood Canyon area may be as young as Meramec. There appears to be a sharp faunal break at the base of the *Endothyra scitula* zone which may be the boundary between the Osage and Meramec.

60. HATTIN, D. E., 1957, Depositional environment of the Wreford Megacyclothem (Lower Permian) of Kansas: Geol. Survey Kansas, Bull. 124, 150 p., 22 pl., 6 text-fig.

The writer lists a number of previously described foraminiferal genera from stratigraphic units (shales and limestones) of the Lower Permian (Wolfcampian) Wreford Megacyclothem of Kansas. A number of sound paleoecologic observations, in reference to foraminiferal environmental preference and restriction, are also given.

61. HENBEST, L. G., 1962, *Endothyra bowmani* Phillips, (1846), v. *Endothyra bowmani* Brown, 1843 (Foraminifera). Z.N.(S.) 768: Bull. Zoological Nomenclature, v. 19, pt. 4, p. 199-201.

In regard to the status of *Endothyra bowmani* the writer has petitioned the International Commission on Zoological Nomenclature to use its plenary powers to: (1) suppress the generic name *Endothyra* Brown, 1843, (2) suppress the specific name *bowmani* Brown, 1843, as published in the binomen *Endothyra bowmani*, and (3) rule that the nominal species *Endothyra bowmani* Phillips, (1846) is to be interpreted according to the description and figures published by Brady, 1876; [see Rosovskaya, 1962, for alternative proposal.]

62. HENBEST, L. G., 1963, Biology, mineralogy, and diagenesis of some typical Late Paleozoic sedentary Foraminifera and algal-foraminiferal colonies: Contr. Cushman Found. Foram. Research, Spec. Publ. No. 6, 44 p., 7 pl., 1 text-fig.

A detailed study of the petrology of certain Late Paleozoic sedentary Foraminifera (Tolypamminae and Cornuspirinae) revealed pertinent aspects of their diagenetic history and offered criteria applicable for determining original composition of seemingly agglutinate and magnesium calcite ("porcellaneous") shells. From this criteria it is now possible to identify certain homeomorphic sedentary genera more precisely than previously; this has resulted in the following taxonomic modifications: *Minammodytes, new name* (= *Serpulopsis* Girty, 1911) with type species *M. girtyi* = ?*Tolypammina delicatula* Cushman and Waters, 1928, and ?*Cornulites* Branson, 1961; a new genus and species, *Hedraites plummerae* = ?*Apterrinella grahamensis* Cushman, 1928 (not Cushman and Waters, 1928) and *A. grahamensis* Cushman and Waters, 1930 (*pars*); the form *Pseudovermiporella sodalica* Elliott, 1958, is herein placed under the Cornuspirinae and is regarded as the end-product of an evolutionary sequence in surface ornamentation from *Apterrinella* to *Hedraites* to *Pseudovermiporella;* the genus *Calcitornella* Cushman and Waters, 1928 is regarded as a synonym of *Apterrinella* Cushman and Waters, 1928, from which it cannot be separated by any criteria determinable at this time; the genus *Orthovertella* Cushman and Waters, 1928 is regarded as invalid since its generic features are indeterminate. The algal-foraminiferal colonies *Osagia* and *Ottonosia* Twenhofel, 1919 are herein restricted to the *Girvanella*-like algal species that are the primary constituents of the typical species of these form genera. By this restriction, typical Late Paleozoic sedentary genera that may be incorporated within the colony are excluded taxonomically.

Remarkable preservations of the described form *Hedraites* reveal new forms of foraminiferal parasites, *Minylecytheca oryxis* and *Minytrypetes mitus* preserved in the walls of foraminifera juvenaria. Finally, a new genus and species, *Dryorhizopsis cadyi,* of agglutinate foraminifer is described under the Hyperamminidae?

All new forms are described at length and are accompanied by excellent whole-specimen stereopaired photomicrographs, and both low and high-power (×1200) thin-section photomicrographs. Pertinent ecologic observations and conclusions are discussed throughout the paper.

63. HENBEST, L. H. and READ, C. B., 1944, Stratigraphic distribution of the Pennsylvanian Fusulinidae in a part of the Sierra Nacimiento of Sandoval and Rio Arriba Counties, New Mexico: U. S. Geol. Survey Oil and Gas Investigations, Prelim. Chart 2.

The discussion is primarily concerned with the distribution of Pennsylvanian Fusulinidae in north-central New Mexico. Smaller Foraminifera (i.e., *Bradyina, Climacammina, Spiroplectammina, Endothyra,* and *Tetrataxis*) are noted on columnar sections from rocks of Lampasan and Desmoinesian age, exposed in Jemez Canyon.

64. Hodgkinson, K. A., 1961, Permian stratigraphy of northeastern Nevada and northwestern Utah: Brigham Young Univ., Geol. Studies, v. 8, pp. 167-196, 11 text-fig.

Five previously described foraminiferal genera (*Palaeotextularia, Climacammina, Cribrostomum, Endothyra,* and *Permodiscus*) were identified from the Permian Ferguson Mountain Formation (Wolfcampian) of northeastern Nevada. Nonfusulinid Foraminifera are specially numerous at Twin Peaks in the Gold Hill District, Nevada. Representative genera are illustrated on one line drawing (text-fig. 4).

65. Hudson, R. G. S., 1960, The Permian and Trias of the Oman Peninsula, Arabia: Geol. Mag., v. 97, no. 4, p. 299-308, pl. 9, 1 text-fig.

A Permian microfauna of previously described forms is reported from the Bih Dolomites and Hagil Limestones of the Hagab Monocline in the Oman Peninsula, Arabia. Along with the fusulinid *Parafusulina* and other fusulinids, such typical Permian non-fusulinid genera as *Geinitzina, Pachyphloia, Padangia,* and *Robuloides* are also noted. It is noteworthy that the writer also reports such forms as *Hemigordius, Agathammina, Glomospira,* and *Climacammina* from the overlying Triassic Ghail Limestone. No illustrations of the microfauna are given.

66. Khachatryan, R. O., Krestovnikov, V. N., Lipina, O. A., and Rostovtseva, L. F., 1961, Tournaisian-Visean boundary deposits of the Ryauzyak River (southern Urals): Acad. Sci. SSSR, Doklady, v. 140, No. 4, p. 919-921, [in Russian].

This article discusses the Lower Carboniferous Tournaisian-Visean boundary problem in the southern Ural Mountains, U.S.S.R. Stratigraphic sub-division and delineation of the boundary beds is based upon previously described species of Foraminifera, corals, and brachiopods.

67. Kochansky-Devide, V. and Milanovic, M., 1962, Unterpermische Fusuliniden und Kalkalgen des Tara-Gebietes in der mittleren Crna Gora (Montenegro): Geoloski Vjesnik, Zagreb, 15/1, p. 195-228, 8 pl., [in Jugoslavian with German summary].

A fusulinid microfauna and calcareous algae are reported and illustrated from the Lower Permian (Wolfcampian) of Montenegro, Yugoslavia. Mention is made of a number of previously described smaller Foraminifera associated with the fusulinids and algae. One thin-section photomicrograph of *Tetrataxis* sp. is also given.

68. Kushnar, L. V., Miklukho-Maklay, A. D., Poroshnyakova, Ya. F., and Yagovkin, A. V., 1961, New data on the stratigraphy of the Lower Carboniferous of south Fergana: Acad. Sci. S.S.S.R., Doklady, v. 140, No. 3, p. 673-676, 2 text-fig., [in Russian].

This article deals primarily with the stratigraphy of the Lower Carboniferous rocks of the south Fergana area of central Asia, U.S.S.R. The stratigraphy is based upon previously described foraminiferal species.

69. Lane, B. O., 1962, The fauna of the Ely Group in the Illipah Area of Nevada: Jour. Paleontology, v. 36, No. 5, p. 888-911, pl. 125-128, 8 text-fig.

The foraminifer *Textularia* sp. is described from the early Pennsylvanian Ely Group of east-central Nevada, along with abundant fusulinids and a megafauna of shelly benthos. The foraminifer is illustrated by one thin-section photomicrograph. *Textularia* sp. is noted to occur in both the upper and lower *Chaetetes* zones of the outcrop area. [Form should probably be referred under the genus *Palaeotextularia;* see Cummings, 1956.]

70. Laporte, L. F., 1962, Paleoecology of the Cottonwood Limestone (Permian), northern mid-continent: Geol. Soc. America Bull., v. 73, p. 521-544, 4 pl., 5 text-fig.

From five distinct facies of the Permian Cottonwood Limestone, traced from southeastern Nebraska to northcentral Oklahoma, small Foraminifera have been found to occur as one of several common biotic elements in two facies. The facies from north to south are: (1) bioclastic, (2) fusuline, (3) platy algal, (4) shelly, and (5) silty *Osagia.* Palaeotextularids (*Palaeotextularia* and *Climacammina*) are a common biotic element in the bioclastic facies whereas *Ammodiscus* and *Hyperammina* are prevalent within the shelly facies.

Problematical "*Osagia*-encrustations," probably consisting of a symbiotic relationship of algae and encrusting Foraminifera, are present in all facies except the shelly facies.

The fusuline and bioclastic facies were deposited in a shallow, well-lit, moderately turbulent, offshore environment which had some restriction of circulation. The shelly facies was deposited in a less turbulent, offshore environment having good circulation; the more southerly, silty *Osagia* facies represents a nearer-shore, shallower, and more turbulent environment marginal to the shelly facies. Separating the above two facies was a broad shoal in which the platy algal facies was formed. This was an area of moderately turbulent, shallow, well-lit water, with some restriction of circulation.

71. Loriga, C., 1960, Foraminiferi del Permiano superiore delle Dolomiti (Val Gardena, Val Badia, Val Marebbe); Boll. Soc. Paleontologica

Italiana, v. 1, No. 1, p. 33-73, pl. 3-7, 14 text-fig., [in Italian with English abstract and summary].

As a first contribution to the knowledge of the foraminifera fauna of the Upper Permian (*Bellerophon* Formation) of the Italian Dolomites, a study of carbonate rock thin-sections was undertaken. From this initial study 33 species and one subspecies belonging to the genera *Nodosinella, Ammodiscus, Hemigordius, Monogenerina, Globivalvulina, Agathammina, Nodosaria, Geinitzina, Pachyphloia,* and *Frondicularia* are described. Among them, five species and one subspecies are recognized as new. The new forms are: *Geinitzina leonardii, Monogenerina conica, Nodosaria montanaroae, Pachyphloia elegans, P. reicheli,* and *Geinitzina spandeli dolomitica.* Excellent thin-section photomicrographs of most forms are included; a few reconstructions of the whole-specimens are illustrated by line drawings also. The writer noted that an abundance of Foraminifera is always accompanied by scarcity or absence of algae.

72. LOVE, J. D., HENBEST, L. G., and DENSON, N. M., 1953, Stratigraphy and paleontology of Paleozoic rocks, Hartville Area, eastern Wyoming: U. S. Geol. Survey Oil & Gas Investigations, Chart OC 44, 2 sheets.

Foraminiferal discussions by Henbest; essentially a more detailed summary of Pennsylvanian foraminiferal occurrence, range, and ecology, as that given by Henbest, 1958.

73. MCKAY, W. and GREEN, R., 1963, Mississippian Foraminifera of the southern Canadian Rocky Mountains, Alberta: Research Council of Alberta, Bull. 10, 77 p., 12 pl., 4 text-fig.

Four main foraminiferal range zones, two concurrent-range zones and one assemblage zone are recognized in the Mississippian strata of the Canadian Rocky Mountains. Faunas of these zones range in age from late Kinderhookian to early Chesterian. The following 8 species are described as new: *Tournayella*? *nonconstricta, Endothyra arrecta, E.*? *banffensis, E. flatile, E. incrassata, E.*? *morroensis, E. robusta,* and *Granuliferelloides jasperensis* n. gen.

The name *Endothyra symmetrica* Zeller, 1957, found to be preoccupied, is named *E. zelleri* [- this form renamed earlier as *Endothyra scitula;* see Toomey, 1961, p. 26].

In regard to the genus *Endothyra* the writers consider Phillips, 1846 as the author. This being so, then the genotype of *Endothyra* is a skew-coiled form, and thus *Plectogyra* Zeller 1950, also based on a skew-coiled form, becomes a junior synonym of *Endothyra.*

The endothyrids are associated with species of *Spiroplectammina, Ammodiscus, Tournayella*?, *Glomospirella, Archaediscus, Palaeotextularia,* and *Permodiscus.*

The Foraminifera are found associated with crinoids, corals, brachiopods, bryozoans, molluscs, gastropods, and algae, in rocks that reflect shallow water deposition.

Excellent thin-section photomicrographs of the Foraminifera are given on 12 plates.

74. MACFADYEN, W. A., 1962, *Ammodiscus* Reuss, 1862 (Foraminifera); proposed designation of type-species under the plenary powers Z.N.(S.) 1087, with a Note on *Spirillina arenacea* William, 1858, proposed as type-species of the genus *Ammodiscus* Reuss, 1862 by Tom Barnard: Bull. Zoological Nomenclature, v. 19, pt. 1, p. 27-34, 2 pl.

The writer petitions the International Commission to use its plenary powers to set aside all type-designations for the nominal genus *Ammodiscus* Reuss, 1862, made prior to the ruling now asked for, and, having done so, to designate *Spirillina arenacea* Williamson, 1858, as the type-species of that genus. [In a personal communication to the compiler, Loeblich noted that "the species proposed as described in the proposal is not a planispiral agglutinated form, but has an early irregular coil, such as is characteristic of *Glomospirella* Plummer. Thus approval of this species as the type by the Commission would make *Ammodiscus* a senior synonym of *Glomospirella* and leave nameless the species usually regarded as *"Ammodiscus."*]

75. MALAKHOVA, N. P., 1954, The lower boundary of the Visean on the western slopes of the Urals based on data from a study of the Foraminifera: Acad. Sci. S.S.S.R., Doklady, v. 97, No. 6, p. 1053-1056, 1 text-fig., [in Russian].

A short discussion as to the placement of the Lower Carboniferous (Visean) boundary on the western slopes of the Urals based upon a study of previously described Foraminifera.

76. MALAKHOVA, N. P., 1954, The Tournaisian stage of the eastern slopes of the northern and central Urals based on data from a study of the Foraminifera: Acad. Sci. Nauk S.S.S.R., Doklady, v. 99, No. 4, p. 605-608, 1 text-fig., [in Russian].

A résumé of the Lower Carboniferous (Tournaisian) biostratigraphy of the eastern slope of the northern and central Ural Mountains based upon previously described Foraminifera.

77. MAMAY, S. H., 1959, *Litostroma,* a new genus of problematical algae from the Pennsylvanian of Oklahoma: Amer. Jour. Botany, v. 46, No. 4, p. 283-292, 31 text-fig.

The writer reports a marine fauna of epiphytic Foraminifera preserved in actual growth positions on the surfaces of plants. [Foraminiferal identifications by Henbest; a long discussion as to the ecologic significance is also appended. See Henbest, 1958, for a complete description of this fauna.]

78. MAMAY, S. J. and YOCHELSON, E. L., 1962, Occurrence and significance of marine animal remains in American coal balls: U. S. Geol. Survey Prof. Paper 354-I, p. 193-224, pl. 26-34, text-fig. 42-45, 3 tables.

A study of the faunal remains derived from Pennsylvanian coal balls from Illinois, Kansas, Oklahoma, and Iowa, has yielded a large and varied microfauna; this fauna is principally derived from insoluble residues. Some nonfusulinid Foraminifera are reported (Table 3) from some of the coal balls from Illinois and Kansas. No new forms are reported. Whole-specimen photomicrographs are given (pl. 33, 34) of *Serpulopsis* [now *Minammodytes;* see Henbest, 1963], *Tetrataxis pauperata*? (Warthin), *Globivalvulina, Apterrinella,* and *Ammovertella.*

79. MIKLUKHO-MAKLAI, A. D., 1956, New families and genera of invertebrates: Materialy Vses. Nauchn.-Issled. Geol. Inst. No. 12, p. 9-15, [in Russian].

A complete revision of the Lower and Middle Carboniferous Archaediscidae of the Soviet Union is given by the writer. Three new genera are described and type species designated. These are *Planoarchaediscus* (type species = *Archaediscus spirillinoides* Rauser-Chernoussova, 1948); *Asteroarchaediscus* (type species = *Archaediscus baschkiricus* Krestovnikov and Theodorvitch, 1936); and *Neoarchaediscus* (type species = *Archaediscus incertus* Grozdilova and Lebedeva, 1954). Notes on the basis for separating the genera are included along with a discussion of the phylogeny of the Archaediscidae.

80. MIKLUKHO-MAKLAI, A. D., 1960, New early Carboniferous Endothyridae. *IN*: New species of ancient plants and invertebrates of the U.S.S.R.: Vesesoyuz. Nauch-Issledevatel. Geol. Inst. (VSEGEI), Min. Geol. i Okhrana Nedr. S.S.S.R., Pt. 1, p. 140-143, pl. 25, [in Russian].

From rocks of Lower Carboniferous age (Tournaisian Stage) of northeastern Siberia one new genus and species of foraminifer, *Eoendothyra orientalis,* is described and illustrated by thin-section photomicrographs. The type species is *Endothyra communis* Rauser, 1948.

The genus *Quasiendothyra* Rauser, 1948, is emended and one new species, *Q. caucasica,* is described and illustrated by thin-section photomicrographs. This form is described from Tournaisian rocks of the northern Caucasus Mountains of the Soviet Union.

81. MIKLUKHO-MAKLAI, A. D., 1960, New early Carboniferous Archaediscidae. *IN*: New species of ancient plants and invertebrates of the U.S.S.R.: Vsesoyuz. Nauch.-Issledevatel. Geol. Inst. (VSEGEI), Min. Geol. i Okhrana Nedr. S.S.S.R., Pt. 1, p. 149-151, pl 25, [in Russian].

A new species of *Archaediscus, A. kolymaensis,* is described from the lower Visean rocks of northeastern Siberia.

One new genus and species, *Quasiarchaediscus pamirensis,* is described from rocks of late Visean and early Namurian age of central Asia (southern Fergana, Pamir). Similar species are found in the Donets Basin.

All forms are illustrated by thin-section photomicrographs.

82. MIKLUKHO-MAKLAI, K. V., 1960, New Kazan Lagenidae of the Russian Platform. *IN*: New species of ancient plants and invertebrates of the U.S.S.R.: Vsesoyuz. Nauch.-Issledovatel. Geol. Inst. (VSEGEI), Min. Geol. i Okhrana Nedr. S.S.S.R., Pt. 1, p. 153-161, pl. 27-28, [in Russian].

A fauna of seven new species (one new subgenus) is described from the Permian Kazan (Guadalupian) rocks of the Russian Platform and illustrated by both excellent whole-specimen drawings and thin-section photomicrographs. The new forms are: *Nodosaria pseudoconcinna, N. urmaraensis, Pseudonodosaria nodosariaeformis, Tristix* (*Pseudotristix*) *tcherdynzavi* (n. subgen.), *Lingulonodosaria kamaensis, Spandelina longissima,* and *Lenticulina* (*Astacolus*) oblonga. One taxonomic change is also included: *Dentalina concinna* Paalzow, 1936, is placed under *Nodosaria pseudoconcinna.*

83. MILLER, H. W. and SWINEFORD, A., 1957, Paleoecology of nodulose zone at top of Haskell Limestone (Upper Pennsylvanian) in Kansas: Am. Assoc. Petroleum Geologists, Bull., v. 41, No. 9, p. 2012-2036, 3 pl., 7 text-fig.

The writers report a number of typical Late Paleozoic foraminiferal genera (mostly agglutinated) from the shales (Robbins Shale) above the nodulose zone in the Haskell Limestone (Virgilian) of northeastern Kansas. The writers note that the fauna is similar to the one described by Plummer (1944) from the Pennsylvanian of central Texas, and, in general, the fauna is seemingly uniform, long ranging, and of little use in correlation.

84. MILON, Y., 1928, Recherches sur les Calcaires Paléozoiques et le Briovérien de Bretagne: Ph.D. Thèses, Faculté des Sciences de L'Université de Paris, 151 p., 8 pl., 77 text-fig., [in French].

The writer reports the occurrence of the foraminiferal genera *Endothyra, Valvulina* [*Tetrataxis*], and *Archaediscus* from the Visean rocks of Belgium and France. Their stratigraphic significance and evolutionary development are also considered. Both excellent line drawings and thin-section photomicrographs are given.

85. Moore, C. A., 1947, The Morrow Series of northeastern Oklahoma: Oklahoma Geol. Survey Bull. 66, 151 p., 15 pl., 8 text-fig.

The writer reports (p. 49) the occurrence of the foraminifer *Endothyra* sp. from the Kessler Limestone of the Pennsylvanian (Morrowan) Bloyd Formation of northeastern Oklahoma. The Foraminifera were derived from HCl insoluble residues. Plate 9B shows a grain residue containing silicified casts of some *Endothyra* sp.

86. Mudge, M. R. and Yochelson, E. L., 1962, Stratigraphy and paleontology of the uppermost Pennsylvanian and lowermost Permian rocks in Kansas: U. S. Geol. Survey Prof. Paper 323, 213 p., 17 pl., 36 text-fig., 6 tables.

The writers noted the presence of smaller Foraminifera in the Kansas stratigraphic units from the Stotler Limestone through the Beattie Limestone (Upper Pennsylvanian-Lower Permian). Foraminiferal occurrences were plotted on distribution tables and some of the typical forms (all previously described) are illustrated by thin-section photomicrographs (pl. 8, figs. 1-4, pl. 10, figs. 4-6, 8).

87. Nitecki, M. H., 1961, Catalogue of type specimens of Foraminifera in the Walker Museum of Paleontology: Fieldiana, Geology, v. 13, No. 2, p. 109-160.

The writer lists the following Pennsylvanian types of Foraminifera in the custody of the Walker Museum of Paleontology: *Earlandia perparva* Plummer, 1930; *Endothyra watersi* Plummer, 1930; *E. whitesidei* Galloway and Ryniker, 1930; *Endothyranella armstrongi* Plummer, 1930; and *Nodosinella perelegans* Plummer, 1930 [changed to *Earlandinita perelegans* (Plummer); see Cummings, 1955, p. 227].

88. Odrzywolska-Bieniels, E., 1961, Permian microfauna from Sieroszowice: Polish Inst. Geol., Warsaw, Bull. 156, p. 79-93, pl. 1-2, [in Polish with Russian and English summaries].

The writer reports the occurrence of 22 previously described species of Permian Foraminifera from the Zechstein Formation in the borehole at Sieroszowice, to the north of the Fore-Sudeten Monocline, Poland. All forms are illustrated by thin-section photomicrographs. Many of the foram tests are filled with copper and iron sulphides. [The specimens on Plate 2, fig. 21 and 22, do not appear to be Foraminifera.]

89. Odrzywolska-Bienkowa, E., 1961, Zechstein microfauna from Meilnik borehole: Polish Inst. Geol., Warsaw, v. 5, no. 3, p. 539-549, 5 pl., 2 tables, [in Polish with Russian and English summary].

A microfauna of four previously described species of Foraminifera from a borehole into the Permian Zechstein Formation of eastern Poland is described and illustrated by whole-specimen photomicrographs. The described forms are: *Geinitzina cuneiformis* (Jones), *Spandelinoides geinitzi* (Reuss), *Nodosaria ovalis*? Schmid, and *Lingulina spandeli* Paalzow.

90. Parks, J. M., Jr., 1962, Reef-building biota from Late Pennsylvanian reefs, Sacramento Mountains, New Mexico (Abstract): AAPG-SEPM Program, San Francisco Meeting, March 26-29, p. 49.

The writer briefly notes that the reef-building potentiality of tubular unchambered Foraminifera (*Palaeonubecularia* and *Calcitornella*) together with algae (*Girvanella* and others), from the Late Pennsylvanian of New Mexico, has not been previously recognized. [Henbest, 1963, regards the genus *Calcitornella* as invalid; he also suggests (p. 31) that *Palaeonubecularia* Reitlinger, 1950, may be a junior synonym of *Apterrinella*.]

91. Potievskaja, P. D., 1962, Representatives of certain families of small Foraminifera from the Lower Permian of the northwestern border of the Donets Basin: Acad. U.R.S.R., Kiev., Inst. Geol. Sci., Trudy, Ser. Strati. and Paleo., no. 44, p. 49-94, 8 pl., [in Russian].

A Lower Permian fauna of 30 species (of which 10 are new) is described from the Lower Permian beds along the northwestern border of the Donets Basin, U.S.S.R. All forms are illustrated by thin-section photomicrographs. The new forms are: *Ammovertella cylindrica, Eolasiodiscus modificatus, E. rectus, Climacammina*? *sphaerica, Tetrataxis postminima, Globivalvulina donbassica, Nodosaria gracilis, N. concinna, N. magna,* and *Geinitzina primitiva.*

92. Plummer, F. B., 1947, Summary of classification of the Pennsylvanian formations of Texas, with special reference to the Lower Pennsylvanian of the Llano Region: Jour. Geol., v. 55, No. 3, pt. 2, p. 193-201, 2 text-fig.

The writer lists a few previously described Foraminifera found in the Lower Pennsylvanian formations of central Texas which appear to have stratigraphic signficance.

93. Porchniakova, J. F., 1958, The Namurian of the Peshkaut Mountain Range (south Ferghana): Leningrad Univ., Vesnik, Ser. Geol. and Geogr. No. 24, pt. 4, p. 32-38, 2 text-fig., [in Russian with English summary].

The article deals primarily with Carboniferous stratigraphy (Namurian-Bashkirian) in the region of the Peshkaut Range, south Ferghana, U.S.S.R. based upon the occurrence of previously described foraminiferal species. One foraminiferal range chart is included.

94. RAKHMANOVA, S. G., 1954, Characteristics of the Lower Tournaisian foraminiferal complex from the Russian Platform and its significance for stratigraphic classification: Trudy, Vseso. Neftegaz. Nauchu.-Issled., Inst., No. 4, p. 137-147, 1 text-fig., [in Russian].

The writer briefly discusses the value of smaller Foraminifera in stratigraphically subdividing the Lower Tournaisian rocks of the Russian Platform. All of the Foraminifera discussed have been previously described.

95. RAKHMANOVA, S. G., 1956, Paleontologic characterization of the Khovanshchina beds in several sections of the Russian Platform: Trudy Vses. Neftegaz. Nauchn.-Issled. Inst. No. 9, p. 62-67, 2 pl., [in Russian].

A study of numerous cores from wells penetrating the boundary beds between the uppermost Devonian and lowermost Tournaisian sediments has led to the delineation of the so-called Khovanshchina boundary beds in several sections of the Russian Platform.

The writer briefly outlines the microfaunal complex present in the Khovanshchina beds and notes that they are characterized by a predominance of spherical forms which besides rare parathuramminids, vicinesphaerids, archaesphaerids, and other spherical and semi-spherical forms (all of which are common in both the Upper Devonian and Lower Carboniferous), contain considerable numbers of characteristic minute spheres having a diameter of 0.1 mm. or slightly greater and are distinguished by their regular form and the complex structure of their test. The writer notes that these minute forms probably do not belong to any of the known foraminiferal genera mentioned above. Several poor photomicrographs of these problematical forms are included.

96. ROSOVSKAYA, S. E., 1962, *Endothyra bowmani* Phillips, (1846), v. *Endothyra bowmani* Brown, 1843, (Foraminifera); an alternative proposal: Bull. Zoological Nomenclature, v. 19, pt. 4, p. 202-204.

In regard to the status of *Endothyra bowmani* the writer has petitioned the International Commission on Zoological Nomenclature to take the following action: (1) use its plenary powers to suppress all former designations of type-species for the genus *Endothyra*, and (2) designate *Endothyra bradyi* Mikhailov, 1939, (= *Endothyra bowmani* Brady, 1876 (*non* Phillips) as the type-species of the genus *Endothyra;* [see also proposal by Henbest, 1962].

97. ROSS, C. A., 1962, Permian Foraminifera from British Honduras: Palaeontology, v. 5, pt. 2, p. 297-306, 46 pl., 2 text-fig.

Mainly concerns fusulinids; however, one species of nonfusulinid Foraminifera, *Tetrataxis* ap., is reported from the Upper Wolfcampian Macal Shale of the south-central British Honduras. The form is illustrated by one thin-section photomicrograph. The writer notes that the Honduras species shows similarities to *T. millsapensis* Cushman and Waters, 1928, but it has a deeper umbilical indentation.

Fusulinid species suggest correlation with the lower part of the Chochal Limestone of Guatemala, the Grupera Formation of Chiapas, Mexico, and the Lenox Hills Formation of west Texas.

98. RYBAKOV, F. F. and SAVINA, A. I., 1961, The problem of the lower boundary of the Kungurian Stage of the Kuybyshev Trans-Volga Region and the central Ural Area: Acad. Sci. Nauk S.S.S.R., v. 139, No. 3, p. 688, [in Russian].

The writers report a number of previously described Permian Foraminifera used in conjunction with an extensive megafauna in delineating the Artinskian-Kungurian (Leonard; approximately Middle to Upper) boundary in the Volga-Ural Region of the U. S. S. R. [Of special note is the reported occurrence of two previously described species of the genus *Bradyina;* this marks the youngest reported occurrence of this genus anywhere. See Morozoa, 1949, for original reported occurrence of *Bradyina* this high in the section.]

99. SCHERP, H., 1960, Foraminiferen aus dem Unteren und Mittleren Zechstein Nordwestdeutschlands, insbesondere der Bohrung Friedrich Heinrich 57 bei Kamp-Lintfort: Fortschr. Geol. Rheinland u. Westfalen 3, 67 p., 12 pl., 3 tables, [in German].

From a 65 meter core in the Lower and Middle Zechstein Formation (Permian) of northwest Germany the following genera of Foraminifera were found for the first time: *Proteonina, Earlandia, Hyperamminoides, Reophax, Nodosinella, Glomospirella, Lituotuba, Hemidiscus, Ammovertella, Tolypammina, Haplophragmoides, Monogenerina, Lagena, Pseudoglandulina, Marginulina, Vaginulina,* and *Siphononodosaria.* The occurrence of the last four genera is especially interesting because it had previously been assumed that the first three genera appeared at the earliest in the Mesozoic, whereas the last genus had been known from the Tertiary onward. Altogether 103 species and 16 subspecies were distinguished, of which 28 species and 16 subspecies are new. For comparison, an examination has been made of the Lower Zechstein Foraminifera from the core Borkenwirthe 1 near

Bocholt and from the Zechstein Limestone of the southern extremity of the Harz.

The microfauna has been obtained from shales and marls disintegrated by hydrogen peroxide and from limestones treated with monochloroacetic acid. The fauna is illustrated by excellent drawings.

The new forms are: *Proteonina circularis, P. circularis agglutinata* n. subsp., *P. elongata, Hyperammina acuta, H. acuta conica,* n. subsp., *H. elegantissima tenuis* n. subsp., *H. crescens, H. clavacoidea recta,* n. subsp., *H. clavacoidea pediformis* n. subsp., *H. bulbosa minuta* n. subsp., *H. bulbosa abrupta* n. subsp., *H. bulbosa insecta* n. subsp., *Hyperamminoides dacryum, H. dacryum abbreviata* n. subsp., *H. dacryum turris* n. subsp., *H. symmetrica, H. triangulata, Nodosinella tenera, Glomospira paucicurvata, G. paucicurvata incomposita* n. subsp., *G. regularis* [homonym; see Lipina, 1949, p. 205], *G. regularis hemisphaerica* n. subsp., *G. spiralis, G. cucurbita, Hemidiscus tumulus, Ammovertella mutabilis, Tolypammina simplex, T. revertens* [tolypamminids should probably be placed under the genus *Minammodytes;* see Henbest, 1963], *Glomospirella robusta, G. pavida, Haplophragmoides probata, Ammobaculites procera, A. procera iucunda* n. subsp., *A. directa, A. directa decora* n. subsp., *Geinitzina kirkbyi minuta* n, subsp., *Lunucammina hastata, L. plana, Calcitornella rotunda, C. inflata, C. extensa, Dentalina linea-margaritarum,* and *Siphonodosaria magnifica.*

100. SIMPSON, I. M., 1954, The Lower Carboniferous stratigraphy of the Omagh Syncline, Northern Ireland: Quart. Jour. Geol. Soc. London, v. 110, p. 391-408, pl. 18, 3 text-fig.

The Lower Carboniferous rocks in the Omagh Syncline, Counties Tyrone and Fermanagh, Northern Ireland, are about 8,000 feet thick and are divisable into four lithologically distinct groups: (1) Omagh Sandstone, (2) Claragh Sandstone, (3) Pettigo Limestone, and (4) Clonelly Sandstone. Of the above groups Foraminifera are found in all but the Omagh Sandstone.

The Claragh Sandstone Group contains *Plectogyra bowmanni* (Brady) and *Tetrataxis* cf. *decurrens* (Brady).

The Pettigo Limestone Group has the largest fauna consisting of *Archaelagena howchiniana* (Brady), *Cornuspira* sp., *Cribrostomum* sp., *Hyperammina* sp., *Nodosinella* sp., *Plectogyra bowmanni* (Brady), *P. baileyi* (Hall), and *Tetrataxis* cf. *conica* Eichwald.

Only *Spirillina* sp. has been identified from the Clonelly Sandstone group. All Foraminifera were identified by R. H. Cummings.

The zonal position of the Omagh Sandstone is indeterminable. The Claragh Sandstone is of C_1 age; the Pettigo Limestone falls within the C_2S subzone and the Clonelly Sandstone is considered to belong mainly to the S_2 subzone.

101. SKIPP, B. A. L., 1962, Zonation of calcareous Foraminifera in the Redwall Limestone (Mississippian), Arizona (Abstract): Program Annual Geol. Soc. America Meeting, Houston, Texas, p. 145-146.

A foraminiferal study of the Redwall Limestone of northern Arizona has resulted in the recognition of six foraminiferal zones from Kinderhook to late (?) Meramec in age. Endothyroid species originally described from the Soviet Union are also recognized from this interval.

The family Tournayellidae, previously described only from the uppermost Devonian and Tournaisian (Lower Mississippian) rocks of the Urals and parts of the Russian Platform, is represented in the Redwall Limestone of the Grand Canyon by the genera *Septaglomospiranella, Septabrunsiina, Septatournayella,* and *Tournayella.* The relative abundance of these previously unreported forms leads to the conclusion that they must be widespread in Mississippian rocks of the western United States.

102. SOSNINA, M. I., 1956, New families and genera of invertebrates: Materialy Vses. Nauch.-Issled. Geol. Inst. No. 12, p. 15-17, pl. 1-2, [in Russian].

Under the family Lagenidae, the new genus and species, *Wanganella ussuriensis,* is described from the Upper Permian rocks of the Primor'e Area of the Soviet Union and illustrated by numerous thin-section photomicrographs. [One other so-called "new species" is illustrated by a single thin-section photomicrograph ("*Nodosaria subquadrate*") but, the specimen is not formerly described or mentioned in the text, hence it should be regarded as a *nomen nudum.*]

103. TOOMEY, D. F., 1962, Note on a supposed "algal-Foraminiferal consortium" from the Permian of west Texas: Contr. Cushman Found. Foram. Research, v. 13, pt. 2, p. 52-54, pl. 12-13.

A previously described "algal-foraminiferal consortium" from so-called "algal balls" in the Permian Hueco Limestone of west Texas was re-examined. Results indicate that the reported "algal balls" are not primarily of algal origin, but instead represent a gregarious colony of the marine ploychaete *Spirorbis* and encrusting Foraminifera; that the foraminifer encrusting the spirorbid colony cannot be referred to the Jurassic?-Recent foraminiferal genus *Nubecularia* but is more correctly referred to the Late Paleozoic tubular encrusting genus *Calcitornella;* and the so-called "algal balls" cannot be considered a representative algal-foraminiferal consortium.

Taxonomic changes noted in this paper are as follows: *Nubecularia permiana* Johnson, 1950, is now placed under *Calcitornella permiana* (Johnson); *Palaeonubecularia* Reitlinger, 1950, is probably a synonym of *Calcitornella*.

The encrusting tubular *Calcitornella* is illustrated by thin-section photomicrographs; associated agglutinated Foraminifera derived from the spirorbid "balls" are illustrated by whole-specimen photomicrographs. [Henbest, 1963, regards the genus *Calcitornella* as invalid; he suggests (p. 31) that *Palaeonubecularia* Reitlinger, 1950, may be a junior synonym of *Apterrinella*.]

104. TROELL, A. R., 1962, Lower Mississippian bioherms of southwestern Missouri and northwestern Arkansas: Jour. Sed. Petrology, v. 32, No. 4, p. 629-644, 8 text-fig.

The writer reports the occurrence of the foraminifer *Earlandia* sp. in the inter-biohermal facies of the St. Joe Limestone (Lower Mississippian) of southwestern Missouri and northwestern Arkansas. The biohermal facies carried the foraminifer *Tuberitina* and the problematical *"Aeolisaccus."*

105. VANGEROW, von, E. G., 1962, Über *Ammodiscus* aus dem Zechstein: Paläont. Zeitschrift, v. 36, No. 1/2, p. 125-133, 9 text-fig., [in German].

The foraminiferal species *Ammodiscus roessleri* (E. Schmid, 1867), from the Permian Zechstein of Setters (Wetterau), Western Germany, is newly described and a neotype designated. In the process of collecting new material and examining older collections, a new species, *A. robustus,* was described. Both forms are illustrated by whole-specimen photomicrographs and thin-section drawings. Taxonomic modifications include. *Trochammina rösleri* Spandel, 1898, *Ammodiscus rösleri* Paalzow, 1935, Brand, 1937, and Triebel, 1948 = *Ammodiscus robustus* n. sp.

106. VILLA, F., 1961, Su Alcune Microfacies Dell' Afghanistan Occidentale: Riv. Ital., Paleont., v. 67, No. 4, p. 393-404, pl. 31-32, 1 text-fig., [in Italian with very brief English summary].

Late Paleozoic microfacies (Middle-Upper Carboniferous and Permian) from western Afghanistan are illustrated by low-power rock photomicrographs and briefly discussed. The Permian samples show interesting foraminiferal-algal associations which appear to be quite typical for rocks of this age.

Foraminifera reported from the Middle to Upper Carboniferous sequence include: *Millerella, Tuberitina, Ammodiscus, Lituotuba, Globivalvulina, Agathammina, Geinitzina,* and *Endothyra.*

Permian forms include Middle Permian fusulinids with *Colaniella parva* (Colani), *Pachyphloia, Ammodiscus, Permodiscus, Agathammina, Globivalvulina, Climacammina, Monogenerina,* and a questionable *Bradyina.* Associated with this Permian fauna were abundant algae referred under *Vermiporella, Mizzia, Diplopora,* and *Gymnocodium.*

107. WANLESS, H. R., 1958, Pennsylvanian faunas of the Beardstown, Glasford, Havana, and Vermond Quadrangles: Illinois Geol. Survey, Rept. of Invest. No. 205, 59 p., 2 text-fig., 4 tables.

The writer briefly discusses (p. 16) the smaller Foraminifera found in the Pennsylvanian rocks of west-central Illinois and notes that they are represented by 17 genera, none of which are identified specifically. Foraminifera are most abundant in the Gimlet and Brereton Cyclothems.

Mention is made that the encrusting foraminiferal genus *Apterrinella* is found commonly in limestones which are thought to have been deposited slowly so that shells on the sea bottom could be bored into and encrusted before burial by additional sediment.

108. WHITFIELD, R. P., 1882, On the fauna of the Lower Carboniferous limestones of Spergen Hill, Indiana, with a revision of the descriptions of its fossils hitherto published and illustrations of the species from the original type series: Am. Mus. Nat. Hist. Bull., v. 1, No. 3, Art. 5, p. 39-97, pl. 6-9.

Hall's (1856) original description of *Endothyra baileyi* is quoted and additional comments by Whitfield plus three line drawings of the form are also included. This foraminifer is from the Mississippian of Spergen Hill and Bloomington, Indiana, and Alton, Illinois.

109. WILSON, G. M., 1942, Fossiliferous zones of the Upper Pennsylvanian of Vermilion and Edgar Counties, Illinois: Ill. Acad. Sci., Trans., v. 35, p. 146-147.

The writer notes that the following foraminiferal genera are common in the McLeansboro section (Upper Pennsylvanian) of Vermilion and Edgar Counties, Illinois: *Ammodiscus, Tetrataxis, Ammovertella, Polytaxis,* and *Glyphostomella.* It is further noted that *Glyphostomella triloculina* thus far has only been found from the Macoupin.

110. WINSTON, D., 1963, Carbonate cycles: Lower Pennsylvanian Marble Falls Formation, Mason and Kimble Counties, Texas (Abstract): Am. Assoc. Petroleum Geologists, v. 47, No. 2, p. 376.

The writer reports the genera *Calcitornella, Bradyina,* and various palaeotextulariids from the nearshore depositional environment (mottled facies) of the Lower Pennsylvanian, Marble Falls Formation of central Texas. This same microfauna is also noted in the shelf and shelf-edge environments, namely the *Chaetetes* and *Komia* facies, respectively. [Genus *Calcitornella* regarded as invalid; see Henbest, 1963.]

111. WORKMAN, L. E., and GILLETTE, T., 1956, Subsurface stratigraphy of the Kinderhook series in Illinois: Illinois Geol. Survey, Rept. of Investigations 189, 46 p., 2 pl., 20 text-fig.

The writers briefly note the following foraminiferal genera derived from insoluble residues of the Mississippian (Kinderhookian) McCraney Formation of northwestern Illinois: *Ammodiscus, Psammosphaera, Lagenammina, Tolypammina, Bathysiphon,* and *Marsipella*?.

From the Chouteau Formation *Bathysiphon* and *Ammodiscus* are also reported.

112. ZELLER, D. E. N., 1963, *Endothyra bowmani* Brown, 1843, designation of neotype: Jour. Paleontology, v. 37, No. 2, p. 502-503, 1 text-fig.

The writer designates a neotype for the form *Endothyra bowmani* Brown, 1843. The neotype comes from the Lower Carboniferous (Visean) S Zone, from Clints Quarry, Cumberland, England. One photomicrograph of a sagittal section is given; and the neotype is very briefly described. [See Henbest and Rosovskaya, 1962, for formal proposals to the International Zoological Commission regarding *E. bowmani*.]

DISTRIBUTION OF ARTICLES ACCORDING TO GEOLOGIC AGE AND CATEGORY

CAMBRIAN
7, 12, 25, 26, 30

ORDOVICIAN
2, 5, 6, 11, 13, 17, 24

SILURIAN
14, 24

DEVONIAN
1, 3, 8, 9, 10, 15, 16, 18, 19, 20, 21, 23, 27, 28, 29, 31, 32, 33

MISSISSIPPIAN
34, 35, 39, 41, 44, 46, 47, 49, 51, 54, 59, 66, 68, 73, 75, 76, 79, 80, 81, 84, 94, 95, 100, 101, 104, 108, 111

PENNSYLVANIAN
36, 42, 43, 49, 50, 51, 52, 53, 55, 62, 63, 69, 72, 78, 81, 83, 85, 86, 90, 92, 93, 106, 107, 109, 110

PERMIAN
48, 56, 57, 58, 60, 64, 65, 67, 70, 71, 82, 88, 89, 91, 97, 98, 99, 102, 103, 105, 106

GENERAL
4, 7, 22, 37, 38, 40, 45, 61, 74, 77, 87, 96, 112

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291. *ASTEROCYCLINA* FROM UPPER EOCENE OF ASSAM, INDIA

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ABSTRACT

Asterocyclina matanzensis Cole, a well known Indo-Pacific form, is recorded for the first time in the upper Eocene of Garo Hills, Assam. Description and illustrations of the Assam specimens are provided. It is the only species of **Asterocyclina** known from the upper Eocene of the Indian region.

INTRODUCTION

The presence of *Asterocyclina* in Assam has been noted previously by Nagappa (1956). He (Nagappa 1956, p. 197) reported *Asterocyclina* sp. from the Prang Limestone (middle-upper Eocene) of central Assam, but did not describe or illustrate the Assam form. Later, Samanta (1963a) recorded the presence of *Asterocyclina* in the upper Eocene beds of Garo Hills, Assam. A detailed study of the Assam specimens reveals that they belong to *Asterocyclina matanzensis* Cole. This species is widely distributed in the Indo-Pacific area and is recorded for the first time from the Indian region. It is the only representative of the genus *Asterocyclina* in the upper Eocene of the Indian sub-continent. In Garo Hills it is associated with *Discocyclina archiaci* (Schlum.), *D. assamica* Samanta, *D. augustae* Weijden, *D. eamesi* Samanta, *D. omphala* (Fritsch), *D. sella* (d'Arch.), *Nummulities pengaronensis* Verbeek, *Pellatispira* spp. etc.

The author wishes to thank Dr. W. Storrs Cole for his help in identification of the Assam specimens. The figured specimens are deposited in the collections of the Geology Department of University of Calcutta.

SAMPLE LOCALITIES

Asterocyclina matanzensis Cole occurs in the upper part of the Siju Formation and in the overlying Kopili Formation in Garo Hills, Assam. Samples for the present investigation were collected by the author from the following three localities in Garo Hills:

SIJU AREA

Loc. 1 — Simsang river section near Siju Artheka village (90° 41′ E.; 25° 20′ N.)

RONGRENGGIRI AREA

Loc. 2 — Simsang River section about three furlongs downstream from the Old Forest Bungalow (90° 33′ E.; 25° 33′ N.)

TURA AREA

Loc. 3 — Sia River section near Rongathaggiri village (90° 15′ E.; 25° 25′ N.).

OCCURRENCE OF *ASTEROCYCLINA* IN THE INDIAN SUBCONTINENT

The record of *Asterocyclina* in the Indian region is strikingly rare. Although the Paleocene larger foraminiferal deposits are well developed here, authentic reports of the occurrence of stellate discocyclinids in Paleocene rocks are lacking. In the lower Eocene the genus is represented by *Asterocyclina asterifera* (Carter) [that Carter's (1861, pp. 78, 79) *Orbitoides asterifera* is an *Asterocyclina* has been pointed out by Rao (1942, pp. 1, 2) who assigned it to the lower Eocene]. In the absence of illustration of internal structure and adequate description, a restudy of Carter's form seems necessary. *Asterocyclina alticostata* (Nuttall) is widely distributed in the middle Eocene of western India. Recently, a good account of this form has been provided by Sen Gupta (1963). Lastly, in the upper Eocene of this region the genus is represented by *Asterocyclina matanzensis* Cole[1].

Thus, up to the present, only three species of *Asterocyclina* are known to occur in the Indian region. Age and occurrence of these species are given in TABLE I.

TAXONOMIC NOTES

In course of the detailed study of the internal structure of *Asterocyclina alticostata* (Nuttall), Sen Gupta (1963, p. 97) remarked: "That the species is not a *Discocyclina* (*Aktinocyclina*), but an *Asterocyclina,* is proved by the perceptible increase in the thickness of the equatorial layer at the rays, . . . and by the difference in size and form between the equatorial chambers of the interrays and those of the rays . . ." This argument, according to the present author, is not satisfactory and needs discussion.

Asterocyclina alticostata was first described by Nuttall (1926, p. 151) from Kutch, western India, as an *Aktinocyclina*. At the time that he created this species, external features of the test were regarded as the only basis for supraspecific grouping of the discocyclinids. So, Nuttall rightly assigned the Kutch specimens having 'circular shell with 8 to 12 prominent rays' to the subgenus *Aktinocyclina.*

1 Report of the species of **Discocyclina (Aktinocyclina)** from the upper Eocene of western India by Tewari (1949, p. 401; also referred to by Sen Gupta, 1963, p. 98) as a "stellate form" is in contradiction to his description of the form. He (**loc. cit.**) remarks that "in complete specimens radial ridges do not extend beyond the periphery of the test." It may be mentioned here that a stellate test in the discocyclinids is typical of the genus **Asterocyclina.**

TABLE 1
Species of *Asterocyclina* known from the Indian subcontinent

Species	Age EOCENE Lower	Middle	Upper	Occurrence
A. asterifera (Carter)	x			Western Pakistan
A. alticostata (Nuttall)		x		Western India
A. matanzensis Cole			x	Eastern Indian, Indonesia and the islands of the central Pacific.

Brönnimann (1945a, b) showed for the first time that *Discocyclina, Aktinocyclina* and *Asterocyclina* can be distinguished on the basis of the internal structure of the test. One of the most significant observations made by Brönnimann (1945a, pp. 574, 575) is that the radial ridges in *Discocyclina (Aktinocyclina)* are built by lateral chambers only, while those in *Asterocyclina* are produced by equatorial chambers which are *multilayered in the rays.* Later, Schweighauser's investigation on the internal structure of the discocyclinids, too, resulted in several important findings having bearing on their classification. Schweighauser (1953, pp. 42, 43) noted that the two features, namely, arrangement of the equatorial chambers in rays and thickening of the equatorial layer along the rays which were previously assumed to be characteristic of the genus *Asterocyclina,* are present also in several species of *Discocyclina.* Consequently, those two features are not adequate in distinguishing one genus from the other. Multiplicity of the equatorial chamber layer in the rays is, however, not met with in *Discocyclina.* It is, thus, found to be the only distinctive internal structure in *Asterocyclina* which serves to separate it from *Discocyclina.*

Multiplicity of the equatorial chamber layer in *Asterocyclina* occurs usually in the distal part of the rays. Accordingly, this feature is not observed in off-centered vertical sections cutting the rays close to the centre of the test (see Brönnimann, 1945a, p. 574, figs. 14a). That is why multiplicity is not present in the Text Figure 2 of Sen Gupta (1963). However, this feature can be observed in the left side of his figure 1, plate 8.

In this connection, comments on the subgeneric separation of *Discocyclina* s.s. and *Aktinocyclina* would be of considerable interest. The subdivision of the genus *Discocyclina* into *Discocyclina* s.s. and *Aktinocyclina* has been based on external form of the test and the relation of the radial chamber walls in adjacent annuli. Regarding the relation of the septa in adjacent rings, previous workers (Brönnimann, 1945a; Vaughan, 1945; Vaughan and Cole, 1950) remarked that in *Discocyclina* s.s. the radial chamber walls in adjacent annuli mostly alternate, while in *Aktinocyclina* they are usually aligned. But, during the author's recent investigation on Indian discocyclinids the relation of the radial chamber walls in adjacent rings is found to be quite variable. In several species, such as *Discocyclina omphala* (Fritsch), *D. archiaci* (Schlum.), *D. sella* (d'Arch.), *D. pygmaea* Henrici, *D. eamesi* Samanta, both aligned and alternate septa are met with while in certain others, such as *D. assamica* Samanta, the radial walls in adjacent annuli are mostly aligned. Under the remarks for *D. assamica,* Samanta (1963b, p. 661) wrote: ". . . this Assam form is so closely similar to *Aktinocyclina radians* (d'Archiac) . . . that although these two forms can easily be distinguished from each other by external characters, they are identical in the characters of the equatorial chamber layer. If only equatorial sections are available, therefore, it is not possible to separate them. This clearly indicates that in the case of . . . . *Discocyclina* s.s. and *Aktinocyclina,* the arrangement of equatorial chambers in adjacent annuli has no supraspecific taxonomic value."

Therefore, the only criterion to be used in subgeneric separation is the presence of external radiating rays in *Aktinocyclina,* in contrast to *Discocyclina.* But it has been pointed out by Brönnimann (1945a, b) that in the discocyclinids the external form of the test is too variable to be used as a reliable basis for supraspecific classification. Vaughan (1945, pp. 86-88, pls. 33, 34) in his study on American Discocyclinidae, observed that individuals of a single species may grade from those which possess well developed rays on the surface to others which have no rays. The presence of external radiating rays, therefore, in *Aktinocyclina* can not be used as a subgeneric character. In other words, the subgeneric division of *Discocyclina* into *Discocyclina* s.s. and *Aktinocyclina* can not be retained.

SYSTEMATIC DESCRIPTION

Family DISCOCYCLINIDAE
Genus **Asterocyclina** Gümbel, 1868
Asterocyclina matanzensis Cole
Plate 1, figures 1-12

Asterocyclina matanzensis COLE, 1957, U. S. Geol.

Survey Prof. Paper 280-I, p. 350, pl. 117, figs. 6-10; pl. 118, figs. 9-18.—COLE, 1958, U. S. Geol. Survey Prof. Paper 260-V, pp. 777, 778, pl. 249, figs. 1-17.—COLE, 1960, U. S. Geol. Survey Prof. Paper 374-A, p. A-6, pl. 1, figs. 1, 4-9.—COLE, 1962, Bull. Amer. Paleontology, v. 44, no. 203, pp. 350, 351, pl. 68, fig. 8.

Material.—Forty-five specimens of "Form A" were examined externally, thirty specimens were studied in equatorial section and fifteen in vertical section; "Form B" of this species has not been encountered.

Description of "Form A." External characters.—The test is of medium size, composed of a small, distinct, central umbo from which radiate five raised rays. The outline in plan is stellate to pentagonal. The umbo is either inflated or compressed with gradually sloping sides. Small, distinct papillae occur on the umbonal area and the rays. The interray areas are usually devoid of papillae.

Internal characters—equatorial section—The em*bryonic* apparatus is bilocular and of typical nephrolepidine type. The deuteroconch is reniform in shape and embraces up to ½ of the ellipsoidal protoconch. There are two principal auxiliary chambers, one at each end of the wall between the two embryonic chambers. The number of subsidiary auxiliary chambers varies from 5 to 8. Usually one or two periembryonic chambers occur in the interauxiliary space. The periembryonic chambers from which the five rays start are generally larger than the others in the periembryonic ring. Over the protoconch between the principal auxiliaries the arrangement conforms to Brönnimann's type.

The five rays are distinct in equatorial section. They commence from the five auxiliary periembryonic chambers. The rays are narrow near the centre but broaden out at the periphery. The chambers in the rays are rectangular with their radial diameter nearly double the tangential. The interray chambers are either square or tangentially elongate near the centre and radially elongate near the periphery. The radial walls alternate in position in adjacent annuli and the annular stolons seem to be on the proximal side of the chambers.

Internal characters—vertical section.—The embryonic apparatus is small and elongate-oval in cross-section. Its height does not exceed 100μ. The equatorial chamber cavities are 10-15μ high near the centre. Their height increases to about 25μ near the periphery.

The lateral chambers are arranged in regular tiers numbering 16 to 24 on each side of the equatorial layer. The cavities are low between relatively thin roofs and floors. No true pillars are present.

Measurements.—Tables 2 - 4.

Occurrence.—Upper Eocene: eastern India, Indonesia, Saipan, Eniwetok, Viti Levu, Eua, New Zealand.

Discussion.—Cole (1957, p. 350) described *Asterocyclina matanzensis* as a new species from Saipan Island. The original account is rather incomplete as there was no description of the equatorial sections and the embryonic and periembryonic chambers in all of the sections illustrated were destroyed by replacement. Later, Cole (1958, pp. 777, 778) referred specimens from Eniwetok drill holes to this species and provided adequate illustrations showing all the external and internal features. Cole (1960, p. A-6) recognized *A. matanzensis* again in Fiji and then, in 1962, assigned specimens from New Zealand to this species. Further, Cole (1960) pointed out that similar specimens from Indonesia and several central Pacific Islands had previously been referred to the European species, *Asterocyclina lanceolata* Schlumberger, *A. stellata* (d'Archiac), *A. stella* (Gümbel) and *A. stellaris* (Brunner).

This widely distributed species has been demonstrated by Cole to be one of the most variable representatives of the genus *Asterocyclina* in the Indo-Pacific region. It shows considerable variation in external as well as in internal features. The chief variants are shape and size of the test, shape and arrangement of the embryonic and periembryonic chambers and characters of the lateral chamber layers.

The Assam specimens which are apparently quite distinct from those described as *A. matanzensis* from Saipan, are considered by Cole (personal communication) to be within the specific limits of this species. Although the present specimens show a little variation in shape and size of the test, other features, both external and internal, are rather constant.

TABLE 2

Measurements of external features of *Asterocyclina matanzensis* Cole, ("form A")

Dimensions / Specimen No.	1	2	3	4	5
Diameter of test (mm.)	4.8	1.25	5.2	5.0	2.3+
Diameter of umbo (mm.)	0.9	0.5	1.1	0.9	1.2
Width of flange (mm.)	2.3	0.4	2.5	2.2	0.6+
Thickness at centre (mm.)	0.8	0.4	x	x	0.9
Number of rays	5	5	5	5	5

TABLE 3
Measurements of equatorial sections of *Asterocyclina matanzensis* Cole, ("form A")

Dimensions / Specimen No.	1	2	3	4	5
Diameter of test (mm.)	0.7	0.65	1.2	1.9	1.6
Embryonic chambers (μ):					
Diameters of initial chamber	63 x 75	63 x 63	63 x 75	63 x 70	63 x 75
Diameters of second chamber	80 x 130	80 x 120	75 x 130	80 x 130	100 x 138
Distance across both chambers	113	130	113	125	130
Thickness of outer wall	10	8	7	10	7
Equatorial chambers (μ):					
In Rays:					
Radial diameter	25-30	25-30	27-31	25-36	30-50
Tangential diameter	15-17	15-20	12-15	12-15	12-20
In interrays:					
Radial diameter	13-15	13-18	10-15	13-31	18-37
Tangential diameter	13-20	13-15	15-25	13-31	18-31

TABLE 4
Measurements of vertical sections of *Asterocyclina matanzensis* Cole, ("form A")

Dimensions / Specimen No.	1	2	3	4	5
Diameter of test (mm.)	1.25	2.0	4.25	1.9	2.1
Thickness of test (mm.)	0.53	0.56	0.7	1.25	1.0
Diameter of umbo (mm.)	0.8	0.88	1.0	1.25	1.05
Embryonic chambers (μ):					
Length	100	120	163	188	x
Height	70	72	100	100	x
Equatorial chambers (μ):					
Height at centre	18	15	15	13	10
Height at periphery	20	22	20	25	15
Lateral chambers:					
Number	14	16	18	24	22
Length (μ)	25-38	18-30	25-50	25-50	30-60
Height (μ)	13-15	13-15	13-15	13-15	14-18
Thickness of floors and roofs (μ)	7-10	6-8	6-8	6-8	6-8
Surface diameter of pseudopillars (μ)	x	6	6	15	x

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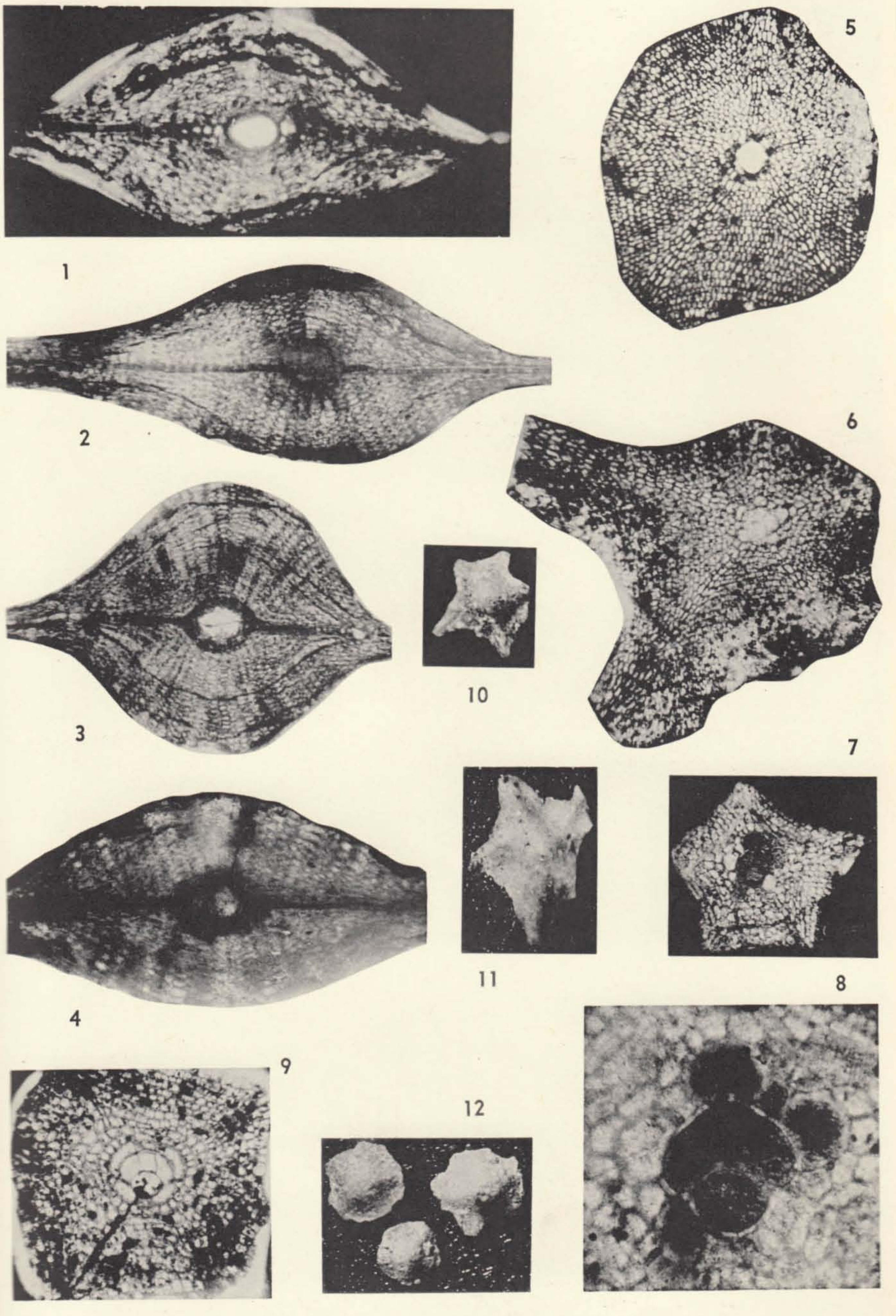
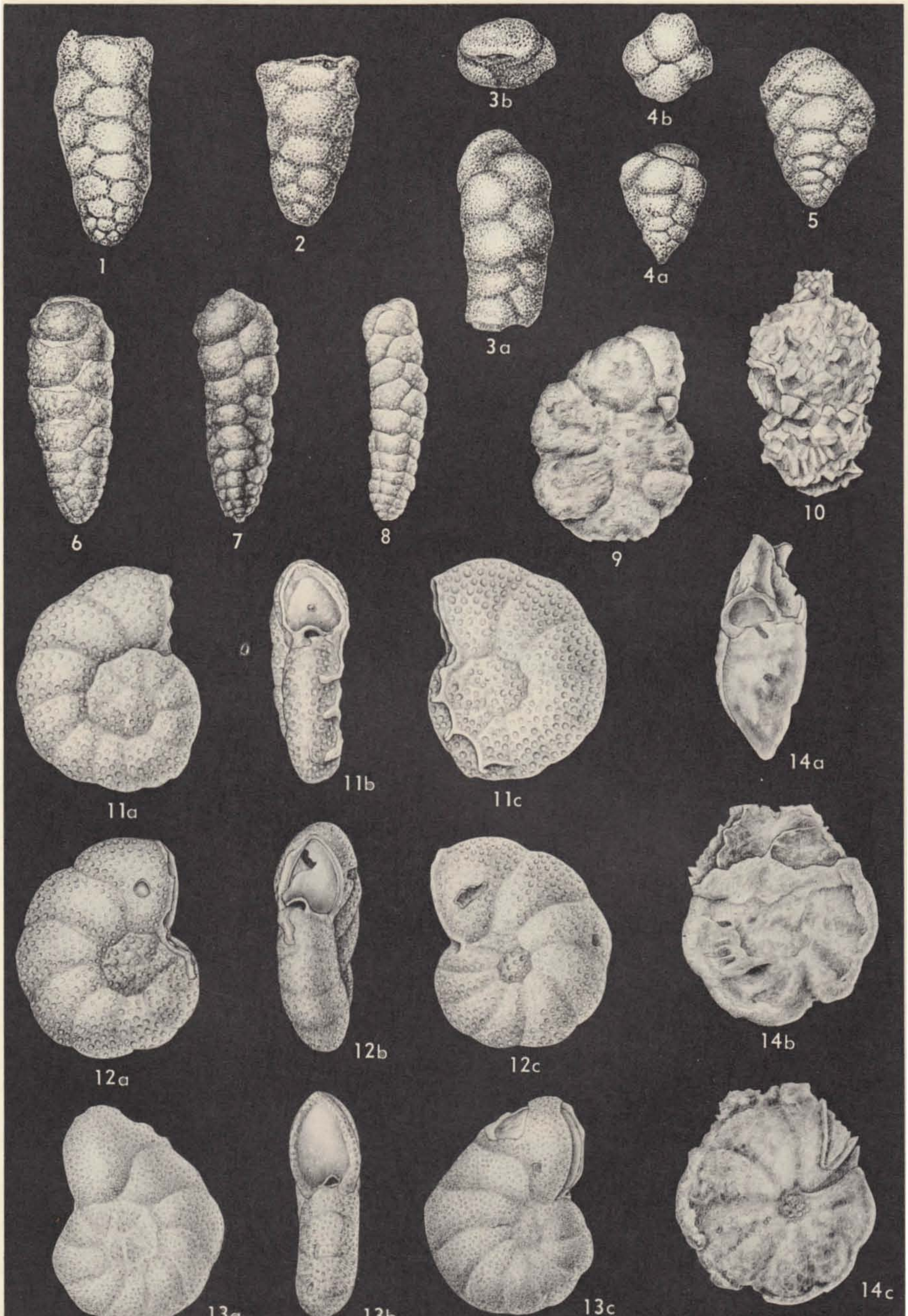
EXPLANATION OF PLATE 1

FIGS.		PAGE
1-12.	*Asterocyclina matanzensis* Cole	23
1-4.	Vertical sections; 1, 2, × 64; 3, × 32; 4, × 40; 1-3, loc. 2; 4, loc. 1.	
5-9.	Equatorial sections; 5-7, × 40; 8, × 160, enlarged central part of the specimen illustrated as fig. 7; 9, × 60; 5, 7-9, loc. 2; 6, loc. 1.	
10-12.	External views; 10, × 15; 11, × 5; 12, × 7.5; loc. 2.	



Samanta: *Asterocyclina* from Assam, India



Blaisdell: Eocene Foraminifera from California
Hornaday: Eocene Faunule from California

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVI, PART 1, JANUARY, 1965

292. TWO NEW EOCENE ARENACEOUS FORAMINIFERA FROM CALIFORNIA[1]

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ABSTRACT

Eggerella elongata n. sp., and **E. subconica** var. **venturaensis**, n. var., are figured and described from the Upper Eocene of the West Coast Ranges.

Two undescribed arenaceous Foraminifera, one representing a new species and one representing a new variety, have been found in rocks of Upper Eocene age in California, Oregon and Washington. The two new forms are herein figured, described, and named *Eggerella elongata* and *Eggerella subconica venturaensis*. The types of both are from the Upper Eocene Cozy Dell formation near Ojai, California. The repository for the holotypes and paratypes is the University of California Museum of Paleontology.

Family VALVULINIDAE
Subfamily EGGERELLINAE
Genus **Eggerella** Cushman, 1933

Eggerella elongata Blaisdell, n. sp.
Plate 2, figures 1-3

Dorothia? sp. CUSHMAN and SIEGFUS, 1942, p. 402, pl. 19, figs. 4-6.

?*Dorothia cylindrica* (Nuttall). CUSHMAN and RENZ, 1947, p. 7, pl. 2, fig. 1.

Eggerella sp. MALLORY, 1959, p. 124, pl. 4, fig. 12, a, b, c.

Eggerella elongata Blaisdell MS. SULLIVAN, 1962, p. 254, pl. 3, figs. 3; 4, a, b.

Eggerella n. sp. Blaisdell MS. WEAVER, 1962, p. 371, pl. 1, fig. 5.

"*Eggerella* sp" Mallory. KLEINPELL and WEAVER, 1963, p. 168, pl. 4, fig. 1.

Test large, elongate, gradually tapering so that the greatest width is at the apertural end; earliest whorls with four or five chambers, remainder of the test triserial; chambers numerous, weakly inflated: sutures fairly distinct, not much depressed; wall arenaceous, often with much calcareous cement, surface roughened; aperture in a depression at the inner margin of the last formed chamber; the test as a whole quite compressed, especially near the apertural end to give the test an oval shape in cross-section. Dimensions of the holotype: length .55 mm, width .25 mm.

Holotype UCMP 44217; paratypes UCMP 44218, and 44221, loc. B-1483.

This form has often been thought to have a biserial adult stage and therefore has been classified as a *Dorothia*. The species differs from *Eggerella arctica* Höglund in being compressed to the point of being ovoid in cross-section, in having a much more extended earlier stage with four and five chambers to the whorl, and in its much larger size. At maturity it may attain to approximately twice the size of *Eggerella arctica* Höglund.

Eggerella subconica var. **venturaensis** Blaisdell, n. var.
Plate 2, figures 4-5

?*Eggerella subconica* Parr. MALLORY, 1959, p. 124.

[1] A contribution from the University of California Museum of Paleontology.

EXPLANATION OF PLATE 2

FIGS.		PAGE
1-3.	*Eggerella elongata* Blaisdell, n. sp. 1. Holotype 44217, U.C.M.P. loc. B-1483, × 59; 2. Paratype 44221, U.C.M.P. loc. B-1483, × 59; 3. Paratype 44218, U.C.M.P. loc. B-1483, × 59. 1, 2, 3a. side views; 3b. apertural view.	27
4-5.	*Eggerella subconica* var. *venturaensis* Blaisdell, n. var. 4. Holotype 44219, U.C.M.P. loc. B-1490, × 59; 5. Paratype 44220, U.C.M.P. loc. B-1483, × 59. 4a, 5. side views; 4b. apertural view.	27
6-8.	*Eggerella elongata* Blaisdell 6. Hypotype 44196, × 45; 7. Hypotype 44197, × 35; 8. Hypotype 44198, × 24.	35
9.	*Cyclammina* (?) sp. Hypotype 44191, × 45	35
10.	*Reophax* (?) sp. Hypotype 44204, × 42	35
11-13.	*Anomalina rosana* Hornaday, n. sp. 11. Holotype 44185, × 67; 12. Paratype 44187, × 72; 13. Paratype 44186, × 72. 11a, 12a, 13a. dorsal views; 11b, 12b, 13b. apertural views; 11c, 12c, 13c. ventral views.	37
14.	*Cibicides* sp. Hypotype 44190, × 72 14a. peripheral view; 14b. dorsal view; 14c. ventral view.	37

?*Eggerella subconica* Parr. SULLIVAN, 1962, p. 254, pl. 3, fig. 7.

Eggerella subconica n. var. Blaisdell MS. WEAVER, 1962, p. 371, pl. 1, fig. 1, a, b, c.

Differs from *Eggerella subconica* Parr in having a more finely arenaceous test with a much higher calcareous constituent, in the greater number of chambers throughout the test, and in the larger size of the mature test.

Holotype UCMP 44219, loc. B-1490; paratype 44220, loc. B-1483.

Variation in this form is quite marked. Much seeming variability, however, is due to distortion upon burial. Some specimens show a very low spire and others show quite a high spire.

LOCALITY DESCRIPTIONS

The samples were collected from road cuts along U. S. highway 399 (now California state highway 33) near Matilija Springs which is northwest of Ojai, California. Consult the U.S.G.S. map of the Matilija Quadrangle, Ventura County, California, scale 1-24000, edition of 1952.

B-1483 is about 610 feet stratigraphically above the base of the Cozy Dell formation in the almost black shales of that formation.

B-1490 is about 1440 feet stratigraphically above the base of the Cozy Dell formation and also from that formation. It was collected from exposures on Ojala road, a side road to highway 399.

More complete locality descriptions are on file at the Museum of Paleontology, University of California.

LITERATURE CITED

Papers cited are, with two exceptions, included under Literature Cited in the immediately following paper (by Hornaday). The two exceptions are:

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVI, PART 1, JANUARY, 1965

293. AN EOCENE FORAMINIFERAL FAUNULE FROM THE NORTHWESTERN SANTA YNEZ MOUNTAINS, CALIFORNIA

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ABSTRACT

A distinctive foraminiferal faunule of late Eocene age from the Santa Ynez Mountains of southern California is described and compared to contemporary assemblages from elsewhere in California. A striking resemblance is noted between this faunule and the Sidney Flat shale fauna of northern California. It is shown that these two assemblages are part of a distinctive facies phenomenon quite different from other contemporaneous faunas of the West Coast Ranges. It is a cool, clear-water, shelf sea facies occurring within the **Amphimorphina jenkinsi** Zone of the Narizian Stage. One new species, **Anomalina rosana**, is described.

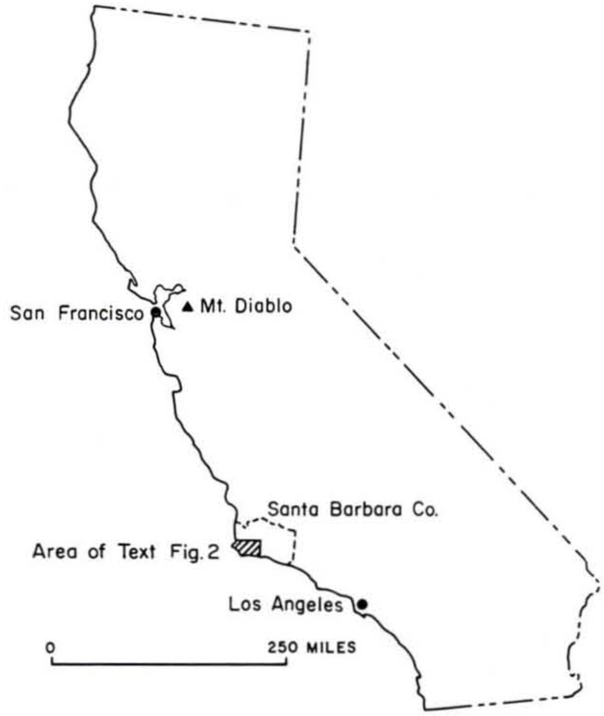
INTRODUCTION

The faunule described herein was obtained from exposures among the most northerly for upper Eocene strata in the western Santa Ynez Mountains of southern California. It was collected from rocks mapped as undifferentiated Sacate-Gaviota by Dibblee (1950), exposed at the northern margin of the Santa Rosa Hills, a northern spur of the Santa Ynez Range. The locality is two miles north of the area in the Santa Rosa Hills from which Molander and Weaver (1964 MS) have described a foraminiferal sequence from the Cozy Dell, Sacate, and Gaviota formations.

The principal reasons for interest in the Santa Rosa Road faunule (as it shall be termed) are twofold. Regionally it is from the most northerly of the Sacate-Gaviota outcrops exposed in this area, and it bears a striking resemblance to the fauna of the Sidney Flat shale of the Markley Formation in the Mt. Diablo area of northern California. In the first instance it is of potential local paleogeographic significance. In the second instance it demonstrates that the widespread, although rare and certainly discontinuous, Sidney Flat shale facies is present in the western Santa Ynez Mountains some 250 miles south of Mt. Diablo (the type area).

LOCALITY DESCRIPTION

U.C.M.P. locality D971: Light tan, silty shale exposed in a road cut on the Santa Rosa road between Buellton and Lompoc, along the south side of the Santa Ynez River. Overlies coarser tan siltstone and sandstone dipping about 30°. Mapped as undifferentiated Sacate-Gaviota by Dibblee (1950). Sample from southern end of road cut on west side of road, locality about 4 miles west along road from its junction with U. S. highway 101. Grid coordinates (U. S. Army Map Service Grid Zone G) are 1075700-1284000 in yards. Los Olivos Quadrangle, 1943, 1:62500, Santa Barbara County, California.



TEXT FIGURE 1
Outline of California showing geographic location of Santa Rosa Road locality (Santa Barbara County) and Mount Diablo.

ACKNOWLEDGEMENTS

I gratefully acknowledge the support of the University of California Museum of Paleontology in providing for the accompanying illustrations, the time necessary to complete the paper, and for the use of its facilities. I express my appreciation also to the members of the Museum staff for their encouragement and assistance, and to Mary E. Taylor who drew the specimens figured.

SANTA ROSA ROAD FAUNULE

The faunule under discussion is not a particularly rich one in number of species (16) but several of the species are individually very abundant. Composition of the faunule (A-abundant, C-common, F-few, R-rare, VR-very rare; * also occurs in Sidney Flat shale) is as follows:

**Amphimorphina jenkinsi* (Church)-F
Anomalina rosana n. sp.-R
**Bulimina microcostata* Cushman and Parker-A

Cibicides sp.-VR
Cyclammina (?) sp.-R
**Dentalina communis* (d'Orbigny)-VR
Eggerella elongata Blaisdell-A
**Globigerina ampliapertura* Bolli-C
Globigerina nitida Martin (?)-VR
**Nodogenerina bradyi* Cushman-VR
**Nodosaria pyrula* d'Orbigny-R
**Planularia crepidula* (Fichtel and Moll) var.-VR
Reophax (?) sp.-VR
**Robulus coaledensis* Detling-C
**Valvulineria involuta* Cushman and Dusenbury-VR
**Valvulineria tumeyensis* Cushman and Simonson-A

Two additional samples were collected from U.C.M.P. localities D-969 and D-970 in the underlying and generally more coarse-textured strata exposed in the same road cut. Locality D-969 contained a poor but—in terms of facies—a characteristically Narizian fauna as that Stage is represented elsewhere in the Santa Ynez Mountains (Hornaday-1961, Weaver-1962, Weaver and Weaver-1962, Kleinpell and Weaver-1963, Molander and Weaver-1964 MS). Sample D-970 was collected over several feet of strata and yielded an assemblage containing all the elements of D-971 (the Santa Rosa Road faunule) plus more typical Santa Ynez Narizian forms. Neither of these two samples will be considered further here except to note in passing that three specimens from D-970 have been figured (pl. 3, fig. 4 and pl. 4, figs. 3, 4) along with those from locality D-971. The additional species from D-969 and D-970 including *Bathysiphon eocenica, Cyclammina* spp., *Bulimina* aff. *B. reussi, Robulus inornatus, Uvigerina garzaenensis, Spiroplectammina* sp., etc. have been amply discussed and figured in the several recent publications alluded to earlier in this paragraph.

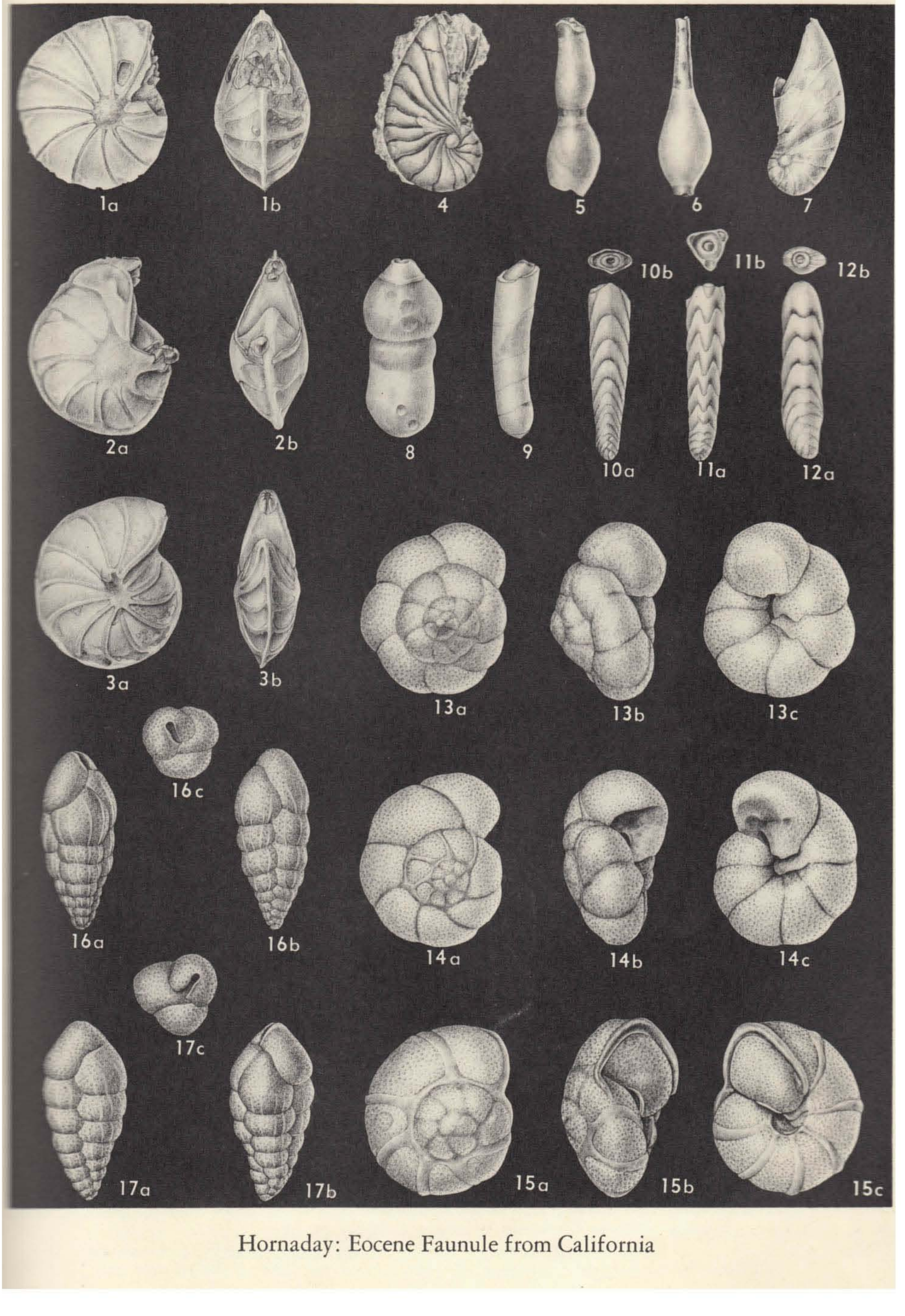
AGE AND CORRELATION

It is readily apparent that the Santa Rosa Road faunule is of Narizian age in Mallory's (1959) terminology. *Robulus coaledensis* ranges no higher than Narizian and *Valvulineria tumeyensis* no lower than Narizian. *Bulimina microcostata* is restricted to the Narizian and published records of *Amphimorphina jenkinsi* are restricted to the upper Narizian—the *Amphimorphina jenkinsi* Zone. *Globigerina nitida* is reported by Mallory to occur no higher than the lower Narizian but the questionable identification of a single individual can hardly be considered as a weighty argument against late Narizian age. All of the other species with established ranges occur in the upper Narizian. This faunule thus may be assigned to the *Amphimorphina jenkinsi* Zone of the Narizian Stage, and to the A-1 Zone of Laiming (1939, 1940, 1941). The Narizian Stage of the Pacific Coast sequence is considered to be within the upper part of the Eocene Series.

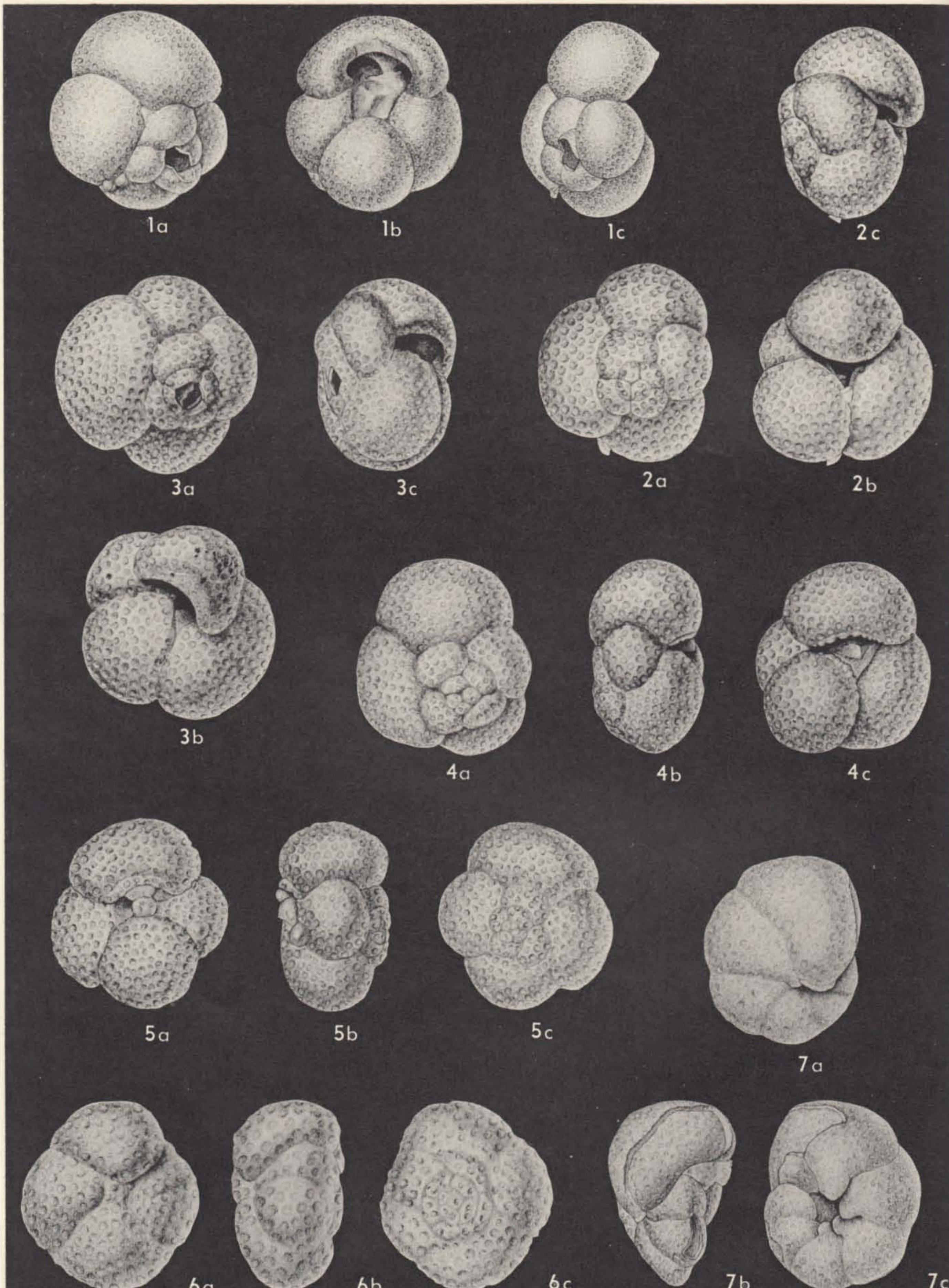
The Sacate formation as found nearby in the Santa Ynez Mountains is late Narizian in age. The lowermost Gaviota formation in the same area also has been shown to be of late Narizian age and not Refugian as previously believed [see Kleinpell and Weaver (1963)]. Thus the late Narizian age of this faunule does not permit differentiation of the undifferentiated Sacate-Gaviota. The uppermost Cozy Dell shale, which conformably underlies the Sacate in this same western Santa Ynez region, may also be late Narizian. Further to the east in the Santa Ynez Range, around Ojai and upper Sespe Creek, part of the Cozy Dell shale and, in all probability, part at least of the Coldwater formation which conformably overlies the Cozy Dell in that region, are of late Narizian age. Elsewhere in California portions of the Kreyenhagen, of the Tejon, and of the San Lorenzo formations were deposited during late Narizian time as was the Sidney Flat shale mem-

EXPLANATION OF PLATE 3

FIGS.		PAGE
1-3.	*Robulus coaledensis* Detling 1. Hypotype 44205, × 44; 2. Hypotype 44207, × 35; 3. Hypotype 44206, × 23. 1a, 2a, 3a. side views; 1b, 2b, 3b. peripheral views.	35
4.	*Planularia markleyana* Church. Hypotype 44216 × 12	35
5-6.	*Nodosaria pyrula* d'Orbigny 5. Hypotype 44192, × 56; 6. Hypotype 44193, × 60.	35
7.	*Planularia crepidula* (Fichtel and Moll) var Hypotype 44215, × 41	35
8.	*Nodogenerina bradyi* Cushman. Hypotype 44195, × 100	36
9.	*Dentalina communis* (d'Orbigny). Hypotype 44194, × 45	35
10-12.	*Amphimorphina jenkinsi* (Church) 10. Hypotype 44183, × 32; 11. Hypotype 44184, × 31; 12. Hypotype 44182, × 41. 10a, 11a, 12a. side views; 10b, 11b, 12b. apertural views.	36
13-15.	*Valvulineria tumeyensis* Cushman and Simonson 13. Hypotype 44209, × 90; 14. Hypotype 44210, × 82; 15. Hypotype 44211, × 90. 13a, 14a, 15a. dorsal views; 13b, 14b, 15b. peripheral views; 13c, 14c, 15c. ventral views.	36
16-17.	*Bulimina microcostata* Cushman and Parker 16. Hypotype 44188, × 69; 17. Hypotype 44189, × 75. 16a, 16b, 17a, 17b. side views; 16c, 17c. apertural views.	35



Hornaday: Eocene Faunule from California



Hornaday: Eocene Faunule from California

ber of the Markley formation. It is the last unit with which we are most concerned.

SIDNEY FLAT SHALE FAUNA

Church (1931; 1941) illustrated and discussed Foraminifera from the "Kreyenhagen shale." His usage of the term Kreyenhagen was much more inclusive than that in effect today. Among the formations included under that designation was the Markley formation at Mt. Diablo in northern California. An especially good foraminiferal fauna was obtained from a light grey diatomaceous interval now included in the Sidney Flat shale member of the Markley. In his 1931 paper Church figured several species of Foraminifera from this diatomaceous shale. Subsequently (1941) he described those new species illustrated in 1931. Radiolaria and silicoflagellates are also common in this interval as well as diatoms. Indeed, the radiolaria and diatoms have been much more completely described than the Foraminifera, a rather unusual situation. First Hanna (1931) and then Kanaya (1957) discussed and described diatoms from the Sidney Flat shale, and Clark and Campbell (1942) have described the radiolaria. Hanna (1931) also described silicoflagellates from this unit. Since Church's papers no further published work on the foraminifers of the Sidney Flat member of the Markley has appeared; however, the fauna as found in various areas, subsurface as well as surface, is well known to California commercial micropaleontologists and formed the basis for the A-1 Zone of Laiming's 1939 zonal classification of the California lower Tertiary. An unpublished Ph.D. dissertation at the University of California by C. V. Fulmer (1956) describes the Sidney Flat shale Foraminifera as well as those from the Nortonville formation and the Kellogg shale. This work is currently being prepared for publication. It was Fulmer (1954, 1956) who proposed the term Sidney Flat shale to replace Clark and Campbell's earlier (1942) and preoccupied "Sidney shale."

The Sidney Flat shale samples of Hanna, Church, Clark and Campbell, Fulmer, and Kanaya all were collected from the old Antioch Quarry on the north side of Mt. Diablo (northeast ¼ sec. 2, TIN, R1E-MDB&M). Slides of foraminiferal assemblages from the samples described (in terms of radiolarian content) by Clark and Campbell (1942) are on deposit at the U.C.M.P. It is these assemblages which have formed the basis for comparison between the Santa Rosa road assemblage and the Sidney Flat shale fauna.

COMPARISON OF THE TWO FAUNAS

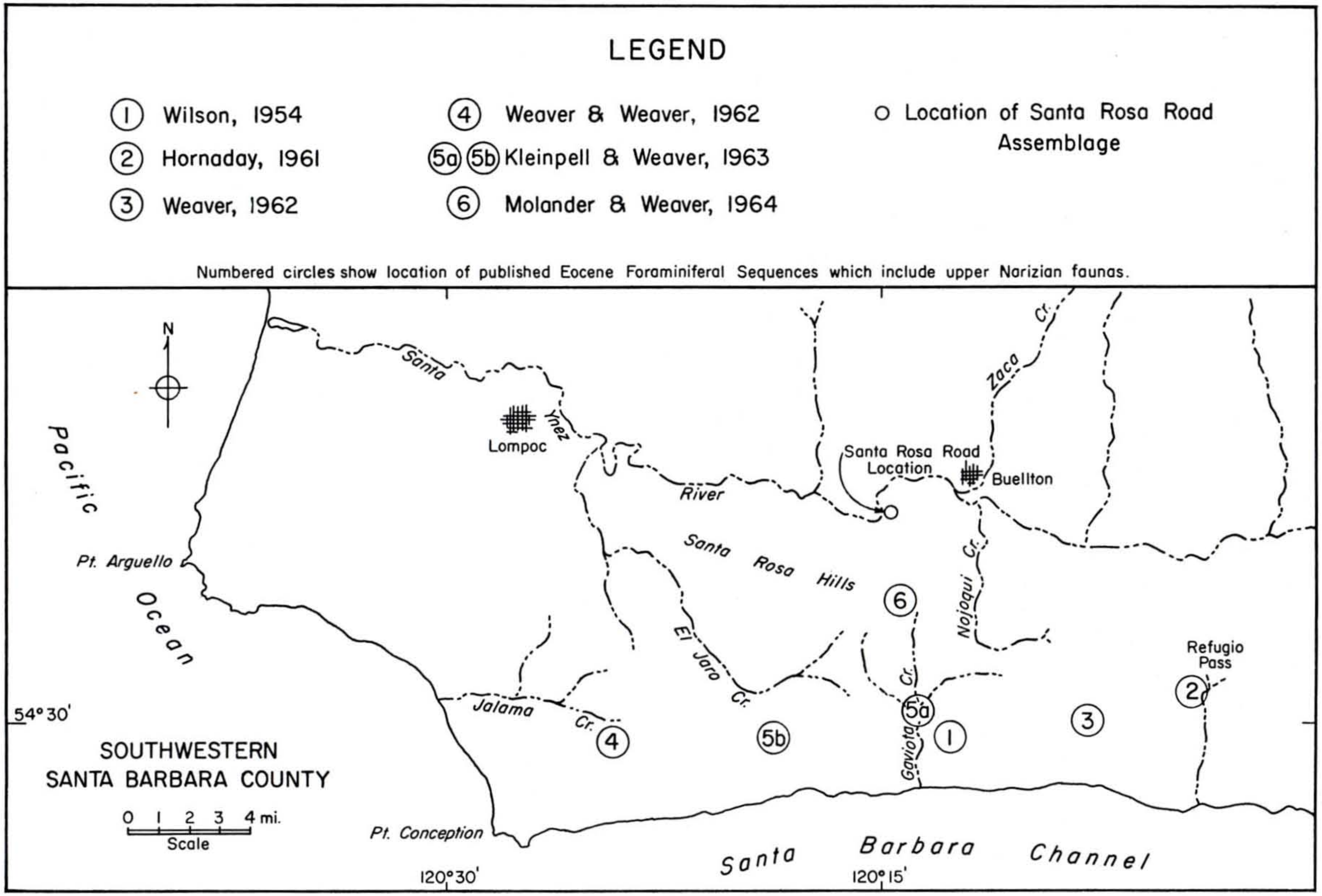
Of the 16 species in the Santa Rosa Road assemblage 10 are present in the Sidney Flat shale fauna. This is a much higher percentage of forms in common than is obtained when the Santa Rosa Road faunule is compared to the described faunas of the same age from elsewhere nearby in the Santa Ynez Range (see Text Fig. 2 for references).

The resemblance between assemblages from the two much more widely separated localities becomes all the more striking when detailed comparison is made. The principal difference is the presence of an arenaceous element in the Santa Rosa Road faunule. Arenaceous species are virtually non-existent in the Sidney Flat shale fauna. Of the six Santa Rosa Road faunule species not present in the Sidney Flat shale three are arenaceous. The other three are rare or very rare. Of those six species at all frequent (A, C, F) in the Santa Rosa Road faunule four are frequent in the Sidney Flat shale and one (*Globigerina ampliapertura*) while rare, is present in several samples. The sixth is the arenaceous form *Eggerella elongata*. The four species frequent in both areas are *Amphimorphina jenkinsi, Bulimina microcostata, Robulus coaledensis* and *Valvulineria tumeyensis*. Rare in the Santa Rosa Road faunule but fairly common in the Sidney Flat shale, is *Nodosaria pyrula*. The specimens of *V. tumeyensis* which are found in both areas are very similar morphologically, although whether or not this morphologic similarity reflects similar direct ecologic control or whether it indicates that a particular distinct variety or subspecies is involved is not clear at this time. In any event it further reflects the similarity between the two faunas.

The Sidney Flat shale fauna contains a few species not found in the Santa Rosa Road faunule. This would seem natural for it has been collected much more extensively. The most characteristic Sidney Flat species not present in the Santa Rosa

EXPLANATION OF PLATE 4

FIGS.		PAGE
1-5.	*Globigerina ampliapertura* Bolli 1. Normal mature specimen. 2-3. Specimens with "abnormal" ultimate chambers. 4-5. Immature specimens. 1. Hypotype 44201, × 69; 2. Hypotype 44214, × 82; 3. Hypotype 44213, × 100; 4. Hypotype 44212, × 90; 5. Hypotype 44200, × 90. 1a, 2a, 3a, 4a, 5c. spiral views; 1b, 2b, 3b, 4c, 5a. umbilical views; 1c, 2c, 3c, 4b, 5b. peripheral views.	36
6.	*Globigerina nitida* Martin (?) Hypotype 44199, × 113. 6a. umbilical view; 6b. peripheral view; 6c. spiral view.	37
7.	*Valvulineria involuta* Cushman and Dusenbury Hypotype 44208, × 100. 7a, ventral view; 7b. peripheral view; 7c. dorsal view.	36



TEXT FIGURE 2

Location of Santa Rosa Road locality in relation to nearby localities from which other Upper Eocene foraminifer faunas have been recorded.

Road assemblage are *Planularia markleyana* and *Robulus welchi*. The first, however, is present in sample D-970 and *R. welchi* has been reported from nearby areas.

The Sidney Flat shale fauna, like the Santa Rosa Road faunule, is not rich in number of species but frequently two or three species in a sample are very abundant. As in most faunas there is variation in specific content from sample to sample but only within the context of the fauna as a whole. When the arenaceous element of the Santa Rosa faunule is disregarded it differs from individual samples of Sidney Flat shale only as much as they differ from one another.

This close similarity between assemblages from localities as distant from each other as Mt. Diablo and the Santa Rosa Road locality (see Text Figure 1) would seem certainly to be due to similar ecologic conditions as other contemporaneous faunas from nearby areas are in aspect not as similar to these two as they (the two under consideration) are to each other. It is true that most of the species found in the two assemblages are found occasionally or often in other faunas of late Narizian age but the association together in some abundance of the more characteristic forms of the two faunas seems to represent a particular faunal facies. It seems furthermore altogether likely that this facies phenomenon is not simply a matter of position on the bathymetric curve as, again, contemporaneous faunules that are environmentally of probable bathymetric equivalency are different from the faunules under discussion.

PALEOECOLOGY

The most abundant form in the Santa Rosa Road faunule is *Bulimina microcostata*. This small finely costate species probably had its bathymetric optimum at lower neritic (or at deepest upper bathyal) depths. The second most abundant species is *Eggerella elongata*. Our knowledge of the bathymetric distribution of most arenaceous Foraminifera (including those of this genus) is not adequate for purposes of paleoecologic interpretation, so no conclusions as to bathymetry can be based on this form. The next most abundant benthonic forms, *Valvulineria tumeyensis* and *Robulus coaledensis*, indicate medium depths, again most probably upper bathyal or lower neritic. The ubiquitous uniserial lagenids offer little additional help. *Amphimorphina jenkinsi* belongs to an extinct group. Its presumed closest relatives in the Tertiary are usually associated with assemblages interpreted as deep water in origin, but morphologically it seems quite different from these blood-relatives, and ecologic relationships do not necessarily follow directly from phyletic relationships *per se*. No firm conclusion as to paleoecology can be based on this species. The sum and total of the evidence points to a lower neritic-upper bathyal (that is shelf sea or upper slope) depositional environment for the Santa Rosa Road faunule.

An interpretation of the temperature that prevailed during the time the Santa Rosa Road faunule lived is even more difficult. No direct evidence is available in terms of forms, genera, or species present in the faunule. The best that can be said is that the relatively small number of species present combined with the relative abundance of a few of them is more representative of temperate or cool water faunas than of tropic or subtropic faunas. Only two species of planktonic Foraminifera are present in the faunule and one of these is very rare. When compared with the Ulatisian (California middle Eocene) faunas from stratigraphically lower in the local column this is particularly striking: in reference to both benthonic and planktonic forms, the rich Ulatisian faunas lend themselves readily to being considered of tropical origin. Even other late Narizian faunas are quite generally much more varied than the two under consideration here. It should be noted that the one planktonic species common here might well be split into three or four taxa by some workers. However, whether one is a "splitter" or a "lumper" the fact remains that the planktonic element of this assemblage is specifically much less varied than that found in the Ulatisian. No globorotaloids whatsoever are present in the Santa Rosa Road faunule. Bandy (1960) has stated that tropical isotherms retreated to their present position beginning in the middle Eocene, basing his conclusions in this matter on the distribution of keeled globorotaloids. The climate of the California late Eocene is generally considered to have been of tropic or subtropic aspect on the basis of molluscan, vertebrate and paleobotanical evidence, but these conclusions all stem from land, strandline, or near-strandline phenomena. The author has no particular quarrel with a general interpretation of subtropic climes at this time but a pronounced cooling at some point or points within Narizian time has been suggested earlier (Hornaday, 1961; Weaver, 1962; Weaver and Weaver, 1962) on evidence from benthos of deeper-water origin.

Further evidence for *relatively* cool temperature conditions during the time of the Santa Rosa Road faunule is yet more indirect. Its ecologic and time correlative, the fauna of the Sidney Flat shale, also exhibits little specific diversity among its planktonic foraminifers in spite of the fact that the highly diatomaceous Sidney Flat shale contains abundant radiolarians and silicoflagellates. Radiolarians are probably the most truly pelagic organisms commonly preserved as fossils. Why then are there so few planktonic foraminifers in the Sidney Flat shale assemblages? Clark and Campbell (1942) regard the Sidney Flat shale radiolarians as tropical or subtropical in origin and representative of surface waters to perhaps "pellucid zone" depths. "Pellucid zone" depths mean in essence neritic-upper bathyal depths. I am not in a position to comment on their conclusions as to temperature arrived at through an interpretation of the radiolaria; indeed, the basis upon which this conclusion was reached is not very clearly elucidated. However, the paucity of specific diversity in planktonic Foraminifera in an obviously pelagic environment, and the great abundance of diatoms, suggest temperate-zone rather than tropical conditions, with reference to temperature at least. Again, the benthonic fauna is not rich in species but two or three species per sample are usually represented by numerous individuals.

It should be emphasized that the suggestion made here of cooler temperature applies only to some part or parts of the Narizian Age in California. Whether or not the cooler water phase suggested by Hornaday (1961) for the Narizian from south of Refugio Pass is actually synchronous with the time of deposition of the Santa Rosa road faunule is unknown. Both situations occurred within the late Narizian but just precisely when within it is not clear. In general Narizian time itself saw cooler temperature conditions than those of the next older age—the Ulatisian—as evidenced by the foraminiferal faunas. The strata of the lower Narizian Stage do contain a fairly diverse group of planktonic forms but in any event most of these are gone by late Narizian time, indicating possible climatic change, as well as purely local cooling, within this time interval.

In conclusion it can be said that molluscan evidence indicates subtropic or tropic conditions during Narizian time which, on foraminiferal evidence, was distinctly cooler than the preceeding tropical Ulatisian time. In aspect, the foraminiferal fauna of the Narizian is not, in general, incompatible with subtropical surface conditions. However, there is evidence that at one or more places in space and one or more points in time during the late Narizian there were water temperatures cooler than this, perhaps approaching temperate conditions. It may be speculated that cold (or cool) oceanic currents, sweeping in from the north and varying in position through time, were responsible for this situation. It may be that the inshore waters were not much affected and thus subtropic molluscan faunas flourished. Upwellings may have played a role. All of this remains speculation and it should be borne in mind that the coolings referred to are relative, that the changes in temperature may not have been great in terms of actual degrees Centigrade or Fahrenheit.

In closing the paleoecologic discussion some note should be taken of the bottom sediment conditions. The chief difference between the Santa Rosa Road faunule and the Sidney Flat shale fauna is the arenaceous element in the former. The Sidney Flat shale is a rock highly biogenetic in origin. The undifferentiated Sacate-Gaviota of Santa Rosa Road has an appreciable fine sand and silt content in strongly biogenetic (?) shale matrix. This seems to control, or at least allow, the existence of the arenaceous elements present. It may be that the highly distinctive Sidney Flat shale facies is controlled by a relatively non-clastic and highly organic bottom mud. It is true that all of the species in it are found individually in non-organic clastic rocks but it is only in organically rich rocks that the facies is fully developed and with the characteristic species present together in abundance. The Sidney Flat shale seems to have been deposited some distance from shore although not in particularly deep water. Either that, or if near shore, the land supplied very little sediment. The undifferentiated Sacate-Gaviota of the northern Santa Rosa Hills seems to have been deposited closer to a source area of terrigenous sediments, yet still well offshore.

SUMMARY

The Santa Rosa Road faunule lived during late Narizian (*Amphimorphina jenkinsi* Zone) time. It lived at moderate depths—a shelf sea or upper continental slope bathymetric environment. Temperature seems to have been cooler than subtropic—probably warm temperate, possibly temperate. The temperature conditions seem not to have been a function of depth, for that is not great; the evidence seems to reflect a cooler water column generally, from surface to bottom, than that of Ulatisian and older Narizian times. An offshore position under temperate water oceanic currents is probable since the inshore molluscan faunas of this time are subtropical in character.

The great faunal similarity of the Santa Rosa Road faunule and the fauna of the Sidney Flat shale justify regarding them both as belonging to a Sidney Flat shale facies, a facies controlled by the ecologic factors discussed above plus an apparent bottom sediment factor. The one significant difference between the two faunas discussed is apparent in that the silty Sacate-Gaviota shale of Santa Rosa Road carries an arenaceous foraminiferal component not present in the Sidney Flat shale of Mount Diablo; and in this the Sidney Flat fauna seems to have preferred a bottom even richer in organic debris and with much less land-derived sediment, than the otherwise very similar one that flourished at the present site of Santa Rosa Road far to the south.

SYSTEMATICS

All type material has been deposited in the micropaleontology collections of the Museum of Paleontology at the University of California. All type numbers refer to those collections.

The synonomies are intended to be fairly complete for California publications; however, lists are not included, nor are unfigured citations, except where the types themselves have been examined at first hand. Primary types of the following authors have been examined: Cushman and Schenck (1928), Church (1931 and 1941), Wilson (1954), H. P. Smith (1956), B. Y. Smith (1957), Mallory (1959), Hornaday (1961), Sullivan (1962), D. W. Weaver (1962), W. R. Weaver and D. W. Weaver (1962), Kleinpell and D. W. Weaver (1963), R. C. Blaisdell (1965). Where synonymy is made with identifications of other authors it is based on comparison of the figures and descriptions listed.

Order FORAMINIFERA
Family REOPHACIDAE
Genus **Reophax** Montfort, 1808
Reophax(?) sp.
Plate 2, figure 10

Hypotype 44204.

Some very rare broken and crushed specimens are questionably referred to this genus. More and better preserved material would be necessary for a positive identification.

Family LITUOLIDAE
Genus **Cyclammina** Brady, 1876
Cyclammina(?) sp.
Plate 2, figure 9

Hypotype 44191.

Some rare crushed specimens are tentatively placed here.

Family VALVULINIDAE
Genus **Eggerella** Cushman, 1933
Eggerella elongata Blaisdell
Plate 2, figures 6-8

Eggerella elongata Blaisdell MS. SULLIVAN, 1962, p. 254, pl. 3, figs. 3, 4. (No formal description presented).

Eggerella elongata BLAISDELL, 1965, p. 27, pl. 2, figs. 1-3.

Hypotype 44196, 44197, 44198.

For a complete synonymy of this common and widespread species, the reader is referred to the preceding paper in this journal (Blaisdell, 1965, p. 27).

Family LAGENIDAE
Genus **Robulus** Montfort, 1808
Robulus coaledensis Detling
Plate 3, figures 1-3

Robulus coaledensis DETLING, 1946, p. 353, pl. 48, fig. 1; MALLORY, 1959, p. 136, pl. 7, fig. 11.

Robulus sp.? CHURCH, 1931, pl. B, figs. 7, 9.

Robulus inornatus CUSHMAN, STEWART, and STEWART, 1949 (not d'Orbigny), pl. 130, pl. 14, figs. 4, 5.

Hypotypes 44205, 44206, 44207.

A highly variable species.

Genus **Planularia** Defrance, 1824
Planularia crepidula (Fichtel and Moll) var.
Plate 3, figure 7

Lenticulina cf. *crepidula* Fichtel and Moll. CHURCH, 1931, pl. C, figs. 8-11.

Hypotype 44215.

Fulmer (1956) regards this form as a new variety of *P. crepidula* (Fichtel and Moll).

Planularia markleyana Church
Plate 3, figure 4

Planularia markleyana CHURCH, 1931, pl. A, fig. 6, pl. B, figs. 1, 10; CHURCH, 1941, p. 182; MALLORY, 1959, p. 147, pl. 9, fig. 5; WEAVER and WEAVER, 1962, p. 25, pl. 6, fig. 4.

Hypotype 44216.

The figured specimen is from sample D-970. Specimens of this large species are commonly destroyed in sample preparation. The individual figured here was "teased" out of the rock with a biology needle.

Genus **Dentalina** d'Orbigny, 1826
Dentalina communis (d'Orbigny)
Plate 3, figure 9

Dentalina communis (d'Orbigny). MALLORY, 1959, p. 162, pl. 12, fig. 11; WEAVER and WEAVER, 1962, p. 26, pl. 7, fig. 6.

Hypotype 44194.

Only a single specimen of this ubiquitous species was found. The same species probably appears in the literature under many different names.

Genus **Nodosaria** Lamarck, 1812
Nodosaria pyrula d'Orbigny
Plate 3, figures 5-6

Nodosaria pyrula d'Orbigny. CUSHMAN and SCHENCK, 1928, p. 308, pl. 43, figs. 1, 2; WILSON, 1954, p. 136, pl. 14, fig. 14; MALLORY, 1959, p. 172, pl. 13, fig. 19, pl. 41, fig. 2; HORNADAY, 1961, p. 185, pl. 4, fig. 6; SULLIVAN, 1962, p. 265, pl. 10, figs. 3, 4; WEAVER and WEAVER, 1962, p. 28, pl. 7, fig. 18; KLEINPELL and WEAVER, 1963, p. 171, pl. 7, figs. 5, 6.

Nodosaria cf. *N. pyrula* d'Orbigny. BECK, 1943, p. 599, pl. 105, figs. 19-21; SMITH, 1956, p. 91, pl. 11, fig. 9.

Hypotypes 44192, 44193.

This is another ubiquitous species. The two specimens figured show the wide variation in chamber elongation.

Family BULIMINIDAE
Genus **Bulimina** d'Orbigny, 1826
Bulimina microcostata Cushman and Parker
Plate 3, figures 16-17

Bulimina microcostata CUSHMAN and PARKER, 1936, p. 39, pl. 7, fig. 2; MALLORY, 1959, p. 194, pl. 16, fig. 9; HORNADAY, 1961, p. 188, pl. 6, fig. 2; SULLIVAN, 1962, p. 274, pl. 14, fig. 6; WEAVER, 1962, p. 379, pl. 4, figs. 2, 4; KLEINPELL and WEAVER, 1963, p. 175, pl. 9, fig. 13.

Bulimina cf. *semicostata* Nuttal. CHURCH, 1931, pl. B, figs. 4-6.

Hypotypes 44188, 44189.

This is a very common and widespread Narizian species. As indicated in the synonomy the form figured from the Sydney Flat shale by Church as "*B.* cf. *semi-costata* Nuttall" also belongs here.

Genus **Amphimorphina** Neugeboren, 1850

Amphimorphina jenkinsi (Church)

Plate 3, figures 10-12

Plectofrondicularia jenkinsi CHURCH, 1931, pl. A, figs. 5, 7-9; CHURCH, 1941, p. 182, fig. 67-47.

Amphimorphina jenkinsi (Church). MALLORY, 1959, p. 216, pl. 18, fig. 5; SULLIVAN, 1962, p. 272, pl. 13, fig. 15; WEAVER and WEAVER, 1962, p. 31, pl. 9, fig. 2.

Amphimorphina cf. *A. jenkinsi* (Church). SULLIVAN, 1962, p. 272, pl. 13, fig. 16.

Hypotypes 44182, 44183, 44184.

Tests of this species are rather fragile. Complete specimens are very rare. This fragility may play a role in the general scarcity of reported occurrences, but the species does seem to be genuinely rare as well as spotty in its geographic distribution. As suggested in the text it seems to have lived only under very particular environmental conditions. Its limited stratigraphic range combined with its general fragility thus render it a rare, although a very distinctive and biochronologically a very diagnostic, species.

Genus **Nodogenerina** Cushman, 1927

Nodogenerina bradyi Cushman

Plate 3, figure 8

Nodogenerina bradyi Cushman. CHURCH, 1931, pl. C, figs. 6, 7; MALLORY, 1959, p. 216, pl. 18, fig. 12.

Hypotype 44195.

This form probably has appeared in the literature under other names.

Family ROTALIIDAE

Genus **Valvulineria** Cushman, 1926

Valvulineria involuta Cushman and Dusenbury

Plate 4, figure 7

Valvulineria involuta CUSHMAN and DUSENBURY, 1934, p. 63, pl. 8, fig. 12; SMITH, 1956, p. 97, pl. 14, fig. 4.

?*Valvulineria involuta* Cushman and Dusenbury. WEAVER, 1962, p. 382, pl. 5, fig. 6.

Hypotype 44208.

A single specimen was found. Although the final chamber of this specimen is somewhat higher and larger and the periphery somewhat narrower than the specimen figured by Cushman and Dusenbury and also the specimen figured by Smith, hypotype 44208 agrees in those and all other characteristics with many topotypic specimens of *V. involuta* from the Poway conglomerate. The specimen figured as *V. involuta* Cushman and Dusenbury by Weaver (1962) agrees in most respects with the present specimen and those synonomized as well as topotypic material but is much larger in size. That and its poor preservation have led to its being questionably placed in synonomy.

Valvulineria tumeyensis Cushman and Simonson

Plate 3, figures 13-15

Valvulineria tumeyensis CUSHMAN and SIMONSON, 1944, p. 201, pl. 33, figs. 13, 14; MALLORY, 1959, p. 232, unfigured; HORNADAY, 1961, p. 191, pl. 9, figs. 1-4; SULLIVAN, 1962, p. 280, pl. 17, figs. 3-6; WEAVER, 1962, p. 383, pl. 5, fig. 8; WEAVER and WEAVER, 1962, p. 36, pl. 12, fig. 1; KLEINPELL and WEAVER, 1963, p. 178, pl. 11, fig. 2.

Eponides cf. *E. pygmea* Hantken. CHURCH, 1931, pl. A, figs. 1-3, pl. C, fig. 12.

Valvulineria chirana Cushman and Stone. SMITH, 1957, p. 180, pl. 27, fig. 2; MALLORY, 1959, p. 230, pl. 37, fig. 8.

Hypotypes 44209, 44210, 44211.

The *V. chirana* Cushman and Stone of Smith and of Mallory certainly belong here. Whether or not *V. chirana* itself (see Cushman and Stone, 1947, p. 22, pl. 3, fig. 3) should also be synonomized is uncertain at this time. It is true that *V. tumeyensis*, as represented in the above synonomy, constitutes a rather variable species and it may prove possible to recognize varietal distinctions within this species. *V. chirana* may prove to be one such. Many of the specimens in this Santa Rosa Road faunule approach *V. tumeyensis conica* Sullivan (Sullivan, 1962, p. 280, pl. 17, figs. 1, 2) but none are quite as high-spired. Hypotype 44209 (pl. 3, fig. 13) is one such and many other specimens in the sample are even more high-spired. The three specimens figured here show a considerable range of variation in the degree to which the sutures are limbate and the degree to which they are depressed. Height of spire varies considerably also.

Family ORBULINIDAE

Genus **Globigerina** d'Orbigny, 1826

Globigerina ampliapertura Bolli

Plate 4, figures 1-5

Globigerina ampliapertura BOLLI, 1957a, p. 108, pl. 22, figs. 4-7; BOLLI, 1957b, p. 164, pl. 36, fig. 8; EAMES et al, 1962, p. 83, pl. XI, figs. a-d; WADE, 1964, pl. 1, figs. 13-15, 17-18.

Hypotypes 44200, 44201, 44202, 44203, 44212, 44213, 44214.

The specimens included here exhibit considerable variation and a number of names could have been applied to them. However when taken together they constitute a completely intergrading sequence. Normal mature specimens seem to fall within Bolli's species as is herein indicated.

The variation encountered is principally of two sorts. One involves a developmental sequence from smaller "youthful," specimens to larger, "mature," specimens. When the last chamber of the mature test is added it is placed at a pronounced angle to the previous line of chamber addition: an angle which projects the apertural face in toward and, often, over the umbilicus. The mature test tends to have a sub-rounded outline in plan view with four chambers in the last whorl whereas immediately prior to the addition of the ultimate chamber some tests have only three and one-half—some even as few as three—chambers in the last whorl and tend to have a sub-triangular outline in plan view. Other immature tests do have as many as four chambers in the last whorl and are sub-quadrate in plan view. The earliest whorls of the test generally consist of 4 chambers. The other principal variation is that the ultimate chamber of the mature test varies greatly in size. In the majority of specimens it is of what would appear to be normal size but many other specimens have a much reduced final chamber. One specimen even has a greatly enlarged final chamber which almost completely covers the umbilical area (pl. 4, fig. 2). These "abnormal" final chambers appear to be of normal wall thickness.

The globigerinids have been grossly oversplit in recent years. As indicated above a number of different names could have been applied to various individual specimens included here. However all the specimens seem to belong to a single variable species. Hofker's (1959) discussion of the possible role in reproduction played by bulla of various shapes and sizes and the attendant possibility of dimorphism or trimorphism clearly illustrates not only the need for biologic studies of the life cycles of living globigerinids but also the need for restraint in setting up new taxa at the specific, generic or familial levels.

Globigerina nitida Martin (?)

Plate 4, figure 6

(?)*Globigerina nitida* MARTIN, p. 25, pl. 7, fig. 1.

Hypotype 44199.

A single specimen is questionably assigned to Martin's species. It is very small and may be an immature individual.

Family ANOMALINIDAE

Genus **Anomalina** d'Orbigny, 1826

Anomalina rosana n. sp.

Plate 2, figures 11-13

Test coarsely perforate, medium sized, subcircular, compressed, approaching planispiral condition, dorsal side about two-thirds evolute—each whorl covering one-third of previous test, ventral side about two-thirds involute—each whorl covering about two-thirds of previous test; in peripheral view dorsal side flat to slightly convex, ventral side flat to slightly concave, rarely dorsal side flat to slightly concave with ventral side slightly convex; dorsal side generally with slightly depressed earlier whorls but usually with flush surface due to additional shell material deposited over earlier whorls, ventral side generally broadly but very shallowly umbilicate, occasionally additional perforate shell material also added to ventral side creating flush surfaces on both sides of test and giving impression of parallel or subparallel sides in peripheral view; periphery rounded, very slightly lobate; sutures gently curving, slightly depressed on ventral side, slightly depressed to flush on dorsal side, rarely mildly limbate on dorsal side and/or very slightly so on ventral side; chambers little inflated, increasing gradually and uniformly in size, about nine to a whorl, two and one-half to three whorls in specimens observed; aperture at base of apertural face, on dorsal side of median line, small but distinct, asymmetrically arch shaped with highest part of arch toward median line, lowest part of arch trails out toward dorsal periphery, not extending beyond apertural face, about twice as long as high, slight lip. Ratio of greatest length of test to greatest width varies from 1.2:1 to 1.4:1, ratio of greatest length of test to greatest thickness from 2.6:1 to 2.8:1, ratio of greatest width to greatest thickness from 2.1:1 to 2.2:1, ratio of greatest thickness below aperture to greatest thickness above aperture in peripheral view from 1:1.2 to 1:1.3 (values calculated from types). Dimensions of types: holotype no. 44185—length 0.45 mm, width 0.37 mm, thickness below aperture 0.14 mm, thickness above aperture 0.17 mm, aperture 0.02 mm x 0.05 mm; paratype no. 44186—length 0.42 mm, width 0.31 mm, thickness below aperture 0.13 mm, thickness above aperture 0.15 mm, aperture 0.02 mm x 0.03 mm; paratype no. 44187—length 0.41 mm, width 0.34 mm, thickness below aperture 0.12 mm, thickness above aperture 0.16 mm, aperture 0.02 mm x 0.05 mm.

Holotype 44185; paratypes 44186, 44187.

Among described species this form seems closest to *A.* aff. *A. umbonata* Cushman, Mallory (1959, p. 263) and to *A.* aff. *A. umbonata* Cushman (?), Hornaday (1961, p. 194, pl. 12, fig. 3).

Genus **Cibicides** Montfort, 1808

Cibicides sp.

Plate 2, figure 14

Hypotype 44190.

Very rare specimens of a *Cibicides* are present. They are too poorly preserved to identify specifically.

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294. SYMBIOSIS, WALL STRUCTURE AND HABITAT IN FORAMINIFERA

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ABSTRACT

Much recent work on the wall structure of foraminifera has been undertaken on the assumption that it is a non-adaptive character and thus of particular value in classification. While it is certain that wall structure is a character of great taxonomic significance it does not follow that it is not adaptive. Work on the dominant living foraminifera of the Dovey Estuary, Wales, suggests that symbiosis and radial hyaline wall structure may be connected. This provides an important clue towards an understanding of the reasons for the rise of the radial group and perhaps also the reasons for the striking modifications in chamber shape and arrangement seen in the large Rotalidea and, also, in other larger foraminifera.

In recent decades there have been considerable advances both in knowledge of the ecologic relationships of foraminifera, summarized in the important book by Phleger (1960), and also in knowledge of the fundamental nature of the test wall.

Studies of wall structure have proceeded apace since the seminal work of Wood (1949). One of the most recent of these is the paper by Hay, Towe and Wright (1963), beautifully illustrated with electron micrographs showing 'submicronic structures' of the wall in a number of important families.

In spite of this activity there has been little attempt to relate fundamental wall structure to general life habit. Indeed, much of this work has proceeded on the assumption that the structure of the wall is not of adaptive value and is thus a 'reliable' character for use in classification. Thus, Hay, Towe and Wright state, 'the wall structure having no adaptive significance, should be of prime importance in taxonomy'. If this is true it is certainly surprising from the point of view of neo-Darwinian orthodoxy.

Although it is certainly true that wall structure was or has become a stable character in many well defined families, such as the Fusilinidae, layered granular, or the Nodosariidae, radial hyaline, we must surely assume that the original appearance and persistence of the new kind of wall structure was in adaptive response to selection pressures. This would appear to be supported by the tendency of many groups regarded as primitive to show variation in wall structure. Thus the early members of the *Discorbis* groups show variation in wall structure at the specific level, some being granular, whereas, in contrast, all the higher rotalids are radial. Wall structure varies similarly in the Nonionidae. As pointed out (Haynes 1956), this is what would be expected in primitive root stocks before radial hyaline structure became firmly established. Radial forms appear to have arisen many times from granular ancestors. This, again, is to be expected if wall structure is a progressive, adaptive evolutionary character.

To find a reason for the possible adaptive significance of the appearance of semi-translucent and glassy shells in foraminifera we must consider their ecologic relationships and in particular the tendency for many thin walled, near shore species to contain green algae. Observations on symbiotic algae in foraminifera go back in the last century but have not been given the importance they deserve. They are, however, mentioned in Jepps (1956). These observations have been brought up to date by Boltovskoy (1963). Symbiotic algae are now known to be present in planktonic foraminifera as well as in many near shore forms including *Buliminella, Rotalia, Ammonia, Buccella, Nonion* (*Protelphidium*) and *Elphidium*. Green colour has also been noted in *Bolivina, Nonionella* and *"Virgulina"* by Frances Parker (personal communication). Algae are also known in large members of the Peneroplidae and Rotalidae. Perhaps the most striking observations were made by Cushman (1922) in his study of recent foraminifera from the Tortugas. He found brown algae in both *Iridia* and *Orbitolites* and made the important observation that although the algae occurred within the tests when the foraminifera were at rest they were carried *outside* when the pseudopodia were active in the case of the arenaceous *Iridia*. Cushman also noted green algae in larger foraminifera from the Philippines, including *Cycloclypeus*.

Studies carried out in this Department on the foraminifera of the Dovey Estuary, Cardiganshire, over the past three years by Haynes and Adams reveal that the dominant living foraminifera on the intertidal muds of the marshes are *Elphidium excavatum* (Terquem) and *Protelphidium depressulum* (Walker and Jacob). Living specimens of these species colour brightly with rose bengal and the majority, at all seasons, contain green algae. As noted by Boltovskoy, in his living specimens from the Patagonia coast, the stained protoplasm is almost invariably confined to the last chamber, the rest of the outer whorl of chambers being filled with algae which appear as a green mosaic coating the inner surfaces. The mosaic appears when the unstained internal protoplasm has dried up. Very few dead shells occur with algae still in them which strongly indicates that a true symbiotic relationship exists.

The foraminifera inhabit the muddy, intertidal area of the marshes where small grain size impedes drainage to the extent that thin sheets of water are left behind between tides. Although the mud flats dry out almost completely during neaps, in summer, foraminifera may be recovered, still in good condition, from the upper surfaces of the damp mud. Association with the living protoplasm of the foraminifera is undoubtedly of benefit to the algae as during attempts to photograph these foraminifera in colour the heating and drying effect of intensity lamps was found to cause rapid bleaching. So we may suppose that possible damage caused to the algae by drying out on the marshes during neaps is avoided by close association with the foraminifera. When it is considered that both these species of foraminifera are radial in wall structure it is difficult to avoid the conclusion, that besides benefitting from the metabolic activity of these minute plants and giving some protection to them from the hostile environment of the open flats, they also provide the algae with a natural glasshouse. This would seem to represent a positive advance over the relationship seen in *Iridia*. The adaptive significance of a thin walled glassy test is also underlined by figures given by Cooper and Milne (1938) for light penetration in the Tamar Estuary, Devon. They found incident daylight reduced to 1% within 4 metres and within half a metre during floods. It is very significant that this appears to affect the zonation of algae on buoys. Figures for clear waters in the open sea are given by Harvey (1963). The average daily light at the surface of the sea in the tropics and at 50°N during May and June is 600 kilolux hours with an average energy flux of 0.15 g. cal. per cm^2. per min. This quantity falls to one ninth in December and January at 50°N. Blue light is scattered more than red but is absorbed less. Photosynthesis in marine algae and phytoplankton is closely related to light energy and on a sunny summer day in the English Channel the depth of the compensation point, where respiration begins to exceed photosynthesis in diatoms, is 150 feet. Between 150′ and 50′ the light energy increases from 0.002 g. cal. per cm^2. per min. to 0.03 g. cal. per cm^2. per min. and photosynthesis with oxygen production increases in proportion. Between 50′ and 15′ light energy is between 0.03 and 0.06 g. cal. per cm^2. per min. and photosynthesis is at a maximum. Between 15′ and the surface there is a marked fall off in photosynthesis which becomes increasingly inhibited as the light becomes stronger until at 0.16 g. cal. per cm^2. per min. there is contraction of the chloroplasts. This appears to be due to the effect of the short wave length, ultra-violet, as photosynthesis continues when this light is filtered out. In view of these facts it cannot be an accident that the genera known to be symbiotic with algae, such as *Buliminella*, *Buccella* and *Elphidium* are nearly all radially built. It is also very striking that the planktonic foraminifera are all radial.

The porcellaneous Peneroplidae might appear to be an exception but the wall structure in this group may be an adaptation to the extremely well lit waters of near shore tropical and sub-tropical seas where they characteristically inhabit sea weeds on shallow bottoms, often immediately below the surface. It is the shorter wave lengths of light that are most effected by scatter so the arrangement of the crystals in the wall of a genus such as *Peneroplis* may cut out some of the ultra-violet. In addition, the characteristic brown colouring (? carotenoid) seen in transmitted light may absorb the shortest wave lengths.

The dense perforation of most radial and granular genera is also, perhaps, more readily explicable when we consider that in the Dovey species the algae plaster the inner surface of the chambers. The pores thus allow direct interchange with the outer protoplasm or seawater and facilitate metabolism. The evolution of complex canals may also be connected with problems of metabolism caused when symbiotic algae are stored entirely within the test.

The problem of chamber shape and arrangement may also be illuminated by a consideration of the possible effects of adaptation to a symbiotic life. This is a problem which has advanced very little from the mechanistic interpretations of the 19th century. Shape and arrangement in the symbiotic groups can be considered from the point of view of the advantage acruing from any modification which leads to greater surface exposure to light. This gives added significance to the view of Smout (1954) that in the larger foraminifera shapes tend to those which give maximum surface to volume ratio. It may also explain the tendency towards a planispiral and compressed form in both the *Elphidium* and the *Peneroplis* groups.

The *Nonion-Elphidium* group is 'difficult' taxonomically. Splitting can be done satisfactorily only on wall structure which tends to support the idea that they are a linking group between granular ancestors and higher, radial rotalids such as *Nummulites*. *Protelphidium* appears at the Cretaceous-Palaeocene boundary, *Nummulites* in the Upper Palaeocene. The sequence *Rotalia* to *Dictyoconoides* occurred over the same period. Whatever the precise relationships it must be admitted that there is a strong possibility that the larger rotalids, such as *Rotalia,* contained symbiotic algae. Smout, in his consideration of morphological sequences in the Rotalidea shows that the effect of the introduction of chamberlets, as well as annular and cyclical growth, is to reduce the tendency to pile up laminae of shell material into a thick mass. In *Nummulites,* although the successive instars build up a massive marginal cord, thinning of the side walls is achieved by the introduction of meandrine filaments. In *Dictyoconoides* thinning is achieved by the introduction of intercalary whorls. In *Miogypsina* the laminae become buckled to form chamberlets. Smout followed Tan Sin Hok in considering that these modifications arose in the test due to increase in size leading to the more 'efficient' orbitoidal habit and supposes that the morphology of the test has 'little significance in its final state.' However, this trend so strongly developed in different lines of the higher lamellar, radial Rotalidea appears to be directly related to the adaptation of the test as a natural, algal greenhouse. The shapes of these larger foraminifera can be explained as a compromise between hydrodynamic factors and the requirements of metabolism involving symbiosis. The perfect adaptation to current swept reefal conditions with maximum sphericity is seen in *Gypsina* and *Baculogypsina*. Here, however, as in *Orbulina* the ratio of surface to volume is low. The majority of larger foraminifera show much lower sphericities and it is very striking, how, when compared with the classification of pebble shapes by Zingg (1935), they are found to fall mainly between the .5 and .7 intercept sphericities with discs, flattened spheres and rollers. Although very different to the eye these shapes are of equal hydrodynamic stability. Increased stability, without changing the shape, can be achieved by adding to the mass (which also strengthens the test in a strong current situation). This would explain the remarkable tendency of the large Rotalids to both deposit secondary calcite in the form of pillers at the corners of the lateral chambers and within the septa, or as umbilical bosses, while at the same time thinning the outer chamber walls.

It is significant that the roller shaped Fusilines and Alveolines show similar evolutionary trends. Dunbar (in Koenigswald 1963) finds that the largest members of the Schwagerininae show the "surprising" tendency to both thinning of the outer wall, by honeycombing of the keriotheca, and to deposition of axial deposits. It is noteworthy, also, that the Alveolines which also show trends to fusiform and globular shapes show deposition of secondary calcite on the chamber floors while again, the outer walls remain thin. In the smaller foraminifera there is similarly a tendency for the accumulation of secondary calcite, in this case as surface ornament. Hendrix (1958) has shown that increased shell thickness and ornament, in *Bolivina* and other genera, correlates with increasing grain size in the Ventura Basin, and is particularly marked in the turbidites. These changes appear to be related to current strength and possibly to frequent burial. In many Jurassic *Lingulina* and *Frondicularia* there are analagous trends to increased ornament but in many species the walls remain relatively thin because the later chambers are not completely lamellar and investing but thin out and disappear over previous chambers. So in the smaller foraminifera too there is a marked tendency for restriction of secondary calcite to certain areas of the test while the walls between are kept as thin as possible.

The idea that the test wall is adaptive also gets some support from the stratigraphic evidence which would seem to connect the rise of the Rotalidae and Peneroplidae with times during the early Tertiary when rhythmic transgressions onto the continental margins brought shallow water and lagoonal environments to a maximum in mid-latitudes, particularly along the east and west shorelines of Tethys. This would undoubtedly favour the evolution of foraminifera with algal symbionts. Granular genera, including the Fusilines, and the first radial genera, *Archaediscus* and *Rastidiscus* arose in the Carboniferous, possibly under somewhat similar conditions.

Stratigraphical evidence similarly gives clues to the possible adaptive nature of the wall in the arenaceous foraminifera. There is a correspondence in time between the rise of the main arenaceous families and certain phases of the chief mountain building movements. This type of wall structure appears to be preferred in cool, acid environments with oxygen deficiency such as commonly occur in geosynclines, or on their borders. Here, tectonic controls, such as the rise of geanticlines, lead to the wide extension of restricted marine, black shale environments. Thus the Astrorhizidae appear during the Caledonian movements, becoming particularly abundant during the Silurian. Early members of the Lituolidea flourished in the Carboniferous while the Verneulinidae and Valvulinidae show explosive development in the lower Cretaceous, particularly in sediments representing the infilling of the Cordilleran "foredeep," connected with the Laramide orogeny. Similarly, rich arenaceous faunas characterised the developing troughs of the Eastern Alps and Carpathians, particularly during the Eocene, and those of the Appennines during the Oligo-Miocene. Today this group tends to be most abundant either in the cooler, deeper parts of the open ocean or where extreme ecologic conditions prevail, as in partially enclosed basins like the Black Sea or in near shore, transitional marine environments, Phleger (1960).

In conclusion the closing sentence of Wood's classic paper may be quoted: "The review here presented of the varied types of test wall suggests that evolution within the foraminifera has sometimes followed curiously devious paths." This may be expected if changes in wall structure are strongly adaptive and a feature of groups which adopted symbiotic life in shallow water at different times, to be replaced by others later. For instance, the Buliminidae and Nodosariidae may have arisen during the Mesozoic as shallow water groups with a symbiotic habit, as is suggested by the fact that *Buliminella* is still symbiotic. By the Tertiary it may be supposed that these groups were replaced by the rotalids, becoming largely restricted to deeper habitats. This would resemble the case of the Phaeodarina among the Radiolaria. This group now lives below the light floor of the sea and only the presence of 'dark bodies' reveals the former presence of symbiotic algae. We must be prepared for equally complex relations in the arenaceous foraminifera, perhaps not excluding the secondary assumption of an arenaceous wall by calcareous genera. There is, after all, the case of *Quinqueloculina agglutinans* d'Orb. and also the vexed question of the origin of the 'Silicinidae.'

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295. ESTUDIO SISTEMATICO DE LOS FORAMINIFEROS QUITINOSOS, MICROGRANULARES Y ARENACEOS, BY PEDRO JOAQUIN BERMUDEZ AND FRANCES CHARLTON DE RIVERO

REVIEW BY H. M. BOLLI[1]
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Estudio sistematico de los Foraminiferos quitinosos, microgranulares y arenaceos, by Pedro Joaquin Bermudez and Frances Charlton de Rivero, Universidad Central de Venezuela, 1963, 402 pages. Available at Librería de la Organización de Bienestar Estudiantil, Universidad Central de Venezuela, Caracas, Venezuela; Price Bs 30,00 or $6.75.

Only a few months after the publication of de Rivero and Bermudez' "Micropaleontologia General" we have the pleasure to be presented by the same authors with the first part of their systematic study on Foraminifera: "Estudio sistematico de los foraminiferos quitinosos, microgranulares y arenaceos." As the title implies the book deals with the chitinous, microgranular and arenaceous Foraminifera. The calcareous ones remain reserved for a second part now in preparation. Written especially as a textbook for the Spanish speaking student of Foraminifera it may be regarded as complementary to "Micropaleontologia General" in which the Foraminifera were, due to the nature of that book, given only a rather cursory treatment.

In all 398 genera are described and figured. Four of these are new. Genera erected up to approximately 1960 are included with the exception of those published in Russian literature which was not taken into account.

After a short introduction there follow descriptions of the superfamilies Lagynidea, Astrorhizidea, Endothyridea and Lituolidea, and of families, subfamilies and genera. On the subfamily and generic level one finds included in addition to the description, stratigraphic distribution and synonyms. A short, selected bibliography and an index complete the book.

Though the authors claim to adhere in general to the classifications of Galloway, Cushman and Glaessner, they go their own way in quite a number of cases. In the Lagynidea they follow closely Galloway's classification while the Astrorhizidea are largely arranged according to Cushman. Here, Bermudez and Rivero introduce the new subfamily Tholosininae replacing Webbinellinae. Under the superfamily Endothyridea the authors distinguish the families Endothyridae, Fusulinidae (with subfamilies Fusulininae, Schwagerinae) and Verbeekinidae (with subfamilies Verbeekininae, Neoschwagerinae). In the Lituolidea which occupy close to two-thirds of the book the new genera *Conglophragmium, Alvarezina* and *Neocuneolina* are introduced. The new genus *Asterotrochammina* Bermudez and Seiglie is also included here.

Under the Lagynidea Bermudez and Rivero include a number of genera that are characterized by their often extremely small size and fresh water habitat. It appears that the authors took over this group largely from Galloway's manual. They include *Lecythium, Plagiophrys, Pseudodifflugia, Diaphoropodum, Pleurophrys, Clypeolina, Amphitrema* and *Diplophrys*. In the reviewer's opinion these genera should be removed from the Foraminifera. At least some of them apparently belong to the fresh water Thecamoebina.

Further, there is strong evidence that the genotypes of the genera *Milletella* and *Leptodermella* of the Astrorhizidea belong in fact to the Thecamoebina genera *Centropyxis* (*Centropyxis*) and *Centropyxis* (*Cyclopyxis*) respectively (Bolli and Saunders, 1954). These two genera are, without reservation, still included in the Astrorhizidea by Bermudez and Rivero. Bolli and Saunders in their 1954 paper also listed a number of species erroneously assigned to the foraminiferal genera *Proteonina, Lagunculina* and *Urnulina* that in fact do belong to thecamoebian genera. With regard to the genus *Proteonina* it may be added that Loeblich and Tappan (1955) recognized the genotype as being multilocular and uniserial and for these reasons place *Proteonina* into synonymy with *Reophax*.

Each genus belonging to the superfamilies Lagynidea, Astrorhizidea and Lituolidea is figured by drawings made from those of the genotype. Those of the superfamily Endothyridea are directly copied photographically. Although the drawings are well executed and show the essential details, the reviewer would, for easier identification, have preferred them reproduced somewhat larger. The photographic reproductions of the genera belonging to Endothyridea are not only also on the small side but in addition of a rather poor quality that renders many unsatisfactory. Because the book is largely written

1 Caracas, March 24, 1964.

for students for whom clear and good illustrations are essential, this is particularly regrettable.

Despite this shortcoming in some of the illustrations Bermudez and Rivero's book represents a good account of the included foraminiferal families. It will prove to be useful not only for the student of Foraminifera but also for the professional micropaleontologist. Though the textbook is written in Spanish the nature of its contents renders it also of interest to readers little or not familiar with that language.

REFERENCES

BOLLI, H. H. and SAUNDERS, J. B.: Discussion of some Thecamoebina described erroneously as Foraminifera. Contrib. Cushman Found. Foram. Res., vol. 5, pt. 2, 1954.

LOEBLICH, A. R., JR. and TAPPAN, H.: Revision of some Recent foraminiferal genera. Smithsonian Inst. Misc. Coll., Washington D. C., vol. 128, N° 5, 1955.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVI, PART 1, JANUARY, 1965

RECENT LITERATURE ON THE FORAMINIFERA

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

AKIMEZ, V. S. Novye Dannye po Stratigrafii i Foraminiferam Verkhnemelovykh Otlozhenij Vostochnoj Chasti Belorussii, *in* Paleontologija i Stratigrafija BSSR.—Akad. Nauk Belorusskoj SSR, Minsk, Instit. Geol. Nauk, Sbornik 4, 1963, p. 190-215, pl. 1, text figs. 1, 2 (maps). —Five new species from the Upper Cretaceous.

ALBANI, A. D. Photography of microfossils.—Micropaleontology, v. 10, No. 3, July 1964, p. 396-398, pl. 1, text figs. 1-4.

AOKI, NAOAKI. Upper Miocene Foraminifera from the Kiyosumi Formation, Boso Peninsula.—Trans Proc. Paleont. Soc. Japan, n. ser., No. 53, April 10, 1964, p. 163-169, pl. 25.—Illustrations and descriptions of 17 species, 5 new.

APPLIN, ESTHER R. A microfauna from the Coker Formation, Alabama, *in* Studies of pre-Selma Cretaceous core samples from the outcrop area in western Alabama.—U. S. Geol. Survey Bull. 1160-D, Aug. 14, 1964, p. 65-70, pl. 2.—*Saccammina eolinensis* n. sp., interpreted as indicative of shallow, quiet, muddy bottom and low salinity.

AUBERT, JEANNE. Les *Globorotalia* de la region Prerifaine (Maroc Septentrional).—Notes du Service Géologique du Maroc, Tome 21, Micropaléontologie, Notes et Memoires du Service Géologique No. 156, 1962 (June 1963), p. 41-91, pls. 1-7, text fig. 1.—Descriptions and illustrations of 22 species (1 new), 5 varieties, and 1 subspecies from Paleocene to Miocene in Northern Morocco.

BANDY, ORVILLE L. Foraminiferal biofacies in sediments of Gulf of Batabano, Cuba, and their geologic significance.—Bull. Amer. Assoc. Petr. Geol., v. 48, No. 10, Oct. 1964, p. 1666-1679, text figs. 1-7 (maps, areal plots, graphs).—On a shallow (0-40 feet) back-reef platform, 3 faunas are recognized: miliolid-*Elphidium*, miliolid-*Elphidium*-*Discorbis*, and *Archaias*. Specimens are more abundant in mud than on a coarse-grained bottom. The primary reef is characterized by *Archaias*, *Amphistegina lessonii*, *Asterigerina carinata*, and *Rotorbinella rosea*. The platform fauna is exclusively benthonic and almost entirely calcareous, but beyond the platform edge planktonics make up more than 80 percent of the fauna. Facies from the platform are displaced into deeper water as far as 40 miles from the platform.

BARBIERI, F., and MOSNA, S. *Bolivina apenninica* nuova specie del Pliocene Italiano.—Atti Istit. Geol. Univ. Pavia, v. 14, 1963/64, p. 17-19, pl. 2 (1).

BÉ, ALLEN W. H., and LOTT, LEROY. Shell growth and structure of planktonic Foraminifera.—Science, v. 145, No. 3634, Aug. 21, 1964, p. 823-824, text figs. 1-3.—Secondary thickening by a calcite crust added to the original bilamellar test wall is found on specimens of *Globorotalia truncatulinoides* from plankton tows deeper than 500 meters.

BIELECKA, WANDA, and STYK, OLGA. Micropalaeontological Upper Jurassic stratigraphy in the Kcynia I, II and IV Bore-holes (English summary of Polish text).—Poland Instyt. Geol., Biul. 175, tom 9, 1964, p. 129-152, pls. 8-10 (range and abund. charts).

BIGNOT, G. Foraminifères planctoniques et Foraminifères Remaniés dans la Formation de Varengeville.—Bull. Soc. Géol. Normandie, v. 53, Année 1963, p. 1-12, 1 pl.—The Ypresian planktonic species *Globorotalia intermedia* (Subbotina) in association with redeposited Cretaceous specimens.

BOGUSH, O. I. Foraminifery i Stratigrafija Srednego i Verkhnego Karbona Vostochnoj Chasti Alajskogo Krebta.—Akad. Nauk SSSR, Sibirskoe Otdel., Instit. geol. geofiz., 1963, p. 1-132, pls. 1-11, text figs. 1-3 (map, range charts, columnar sections), tables 1-5.—Includes illustrated systematic catalog of 80 species (17 new and 14 indeterminate) and 12 varieties (8 new) from Middle and Upper Carboniferous.

BRANSON, CARL C. Sessile Foraminifera in the Pennsylvanian of Oklahoma.—Oklahoma Geology Notes, v. 24, No. 8, Aug. 1964, p. 188-190, text fig. 1.—Additional specimens of *Minammodytes*.

BRUN, LÉLIO. La repartition stratigraphique des *Pseudocyclammina lituus* (Yokoyama) dans le sud-ouest Marocain.—Notes du Service Géologique du Maroc, Tome 21, Micropaléontologie, Notes et Memoires du Service Géologique No. 156, 1962 (June 1963), p. 93-99, pls. 1, 2, drawings, columnar section.

CHANG, LIN-HSIN. Middle and Upper Carboniferous Fusulinids from Jiangyou district, northwestern Szechuan.—Acta Palaeont. Sinica, v. 12, No. 2, 1964, p. 228-235, pls. 1, 2.—Four new species.

COLEMAN, P. J., and MCTAVISH, R. A. Association of larger and planktonic Foraminifera in single samples from middle Miocene sediments, Guadalcanal, Solomon Islands, southwest Pacific.—Jour. Royal Soc. Western Australia, v. 47, pt. 1, April 24, 1964, p. 13-24, pls. 1, 2, text figs. 1-3 (maps, geol. section, graph).—The larger Foraminifera indicate Burdigalian or early Vindobonian age and the planktonic species, late Vindobonian or later (Tortonian-Sarmatian). The conclusion that in 3 samples the association was probably contemporaneous (transport of life-assemblages of shallow-water benthonics by slumping or turbidity flow into deeper water) requires the upwards extension of range, well into the Vindobonian, of several species of larger Foraminifera, at least in this part of the Indo-Pacific.

CONIL, RAPHAËL. Interpretation micropaléontologique de quelques sondages de Campine.—Bull. Soc. Belge Géol. Paléont. Hydrol., tome 72 (1963), fasc. 2, Feb. 15, 1964, p. 123-136, pl. 1, text figs. 1, 2 (drawings, map and geol. section).—Foraminifera from the Visean.

CONIL, R., and PIRLET, H. Sur quelques Foraminifères caractéristiques du Viséen supérieur de la Belgique (Bassins de Namur et de Dinant).—Bull. Soc. Belge Géol. Paléont. Hydrol., tome 72 (1963), fasc. 2, Feb. 15, 1964, p. 183-204, pls. 1-3, text fig. 1 (correl. diagram), table 1.—Mostly of the families Archaediscidae and Endothyridae.

COPELAND, CHARLES W. Eocene and Miocene Foraminifera from two localities in Duplin County, North Carolina.—Bull. Am. Paleontology, v. 47, No. 215, June 30, 1964, p. 205-324, pls. 23-43, text figs. 1-3 (map, graphs, correl. charts), tables 1-4.—Illustrated systematic catalog of 59 species (13 new) from the Eocene Castle Hayne Formation and 44 species (10 new) from the Miocene Duplin Marl.

DROOGER, C. W. Problems of mid-Tertiary stratigraphic interpretation.—Micropaleontology, v. 10, No. 3, July 1964, p. 369-374, text figs. 1, 2 (map, phylogenetic diagram).—Includes discussion of the hazards in assigning stage names to deposits without reference to the respective type localities of the stages.

ERICSON, DAVID B., EWING, MAURICE, and WOLLIN, GOESTA. The *Pleistocene* epoch in deep-sea sediments.—Science, v. 146, No. 3645, Nov. 6, 1964, p. 723-732, text figs. 1-5 (map, graphs).—Validity of boundary recognized in 1963 is reaffirmed and supported by 3 additional cores. A composite climatic record, based on relative numbers of warm- and cold-water planktonics found in overlapping sections of 26 cores, is correlated with the Pleistocene time scale. Dating by radiocarbon and related methods to 175,000 years ago, plus extrapolation backward by means of average rate of accumulation of sediment, permits the setting up of a time scale for the entire Pleistocene going back 1½ million years.

GALHANO, MARIA HELENA. Foraminíferos da costa de Portugal (Algarve).—Instit. Zool. "Dr. Augusto Nobre," Fac. Ciencias do Porto, Publ. 89, 1963, p. 1-110, pls. 1-9.—Illustrated systematic catalog of 160 species and 18 subspecies, none new. Study based on 41 bottom samples from 3 to 459 meters depth off the coast of southern Portugal.

GIANNELLI, L., SALVATORINI, G., and TONGIORGI, M. Studio micropaleontologico dei depositi marini Neogenici del complesso neoautoctono di Perolla (Massa Marittima-Grosseto).—Atti Soc. Toscana Sci. Nat., ser. A, v. 70, fasc. 1, 1963, p. 152-201, pls. 1-3, text figs. 1-3 (geol. section, photographs), range chart.—Partially illustrated catalog of 138 species and subspecies (none new) from 6 samples in a lower Pliocene sequence of beds, littoral at the base and deepening toward the top of the sequence.

GOWDA, SOMANAHALLI SAMBE. The Foraminifera of the South Indian Cretaceous-Eocene.—Eclogae Geol. Helvetiae, v. 57, No. 1, July 31, 1964, p. 299-313, table 1 (correl. chart).—Foraminifera listed from lithotopes between upper Albian and middle Eocene.

GRIFFON, JEAN-CLAUDE, and MUYLAERT, JEAN. Les grands Foraminifères du Jebel Gorques (Dorsale Calcaire, Rif).—Notes du Service Géologique du Maroc, Tome 21, Micropaléontologie, Notes et Memoires du Service Géologique No. 156, 1962 (June 1963), p. 105-129, pls. 1-5, text figs. 1-14 (drawings, graph), A, B (geol. sections).—Illustrations and descriptions of 7 species of nummulites, assilines, and discocyclines from the upper Cuisian.

GRIGSBY, RONALD D. *Hedbergella,* an Oklahoma genus of Foraminifera.—Oklahoma Geology Notes, v. 24, No. 6, June 1964, p. 130-136, text fig. 2 (range chart), table 1; correction in v. 24, No. 8, Aug. 1964, p. 184.—Translation of N. I. Maslakova's 1963 article "On the classification of the genus *Hedbergella.*"

GROISS, JOSEF TH. Eine Mikrofauna aus der albüberdeckenden Kreide der südlichen Frankenalb. —Erlanger geol. Abhandl., Heft 53, July 15, 1964, p. 1-23, pls. 1-6, text figs. 1-3.—Illustrated systematic catalog of 70 species (4 new) from lower Turonian in the Franconian Alps.

HAYNES, JOHN, and EL-NAGGAR, Z. R. M. Reworked Upper Cretaceous and Danian planktonic Foraminifera in the type Thanetian.—Micropaleontology, v. 10, No. 3, July 1964, p. 354-356.—Evidence that all the planktonics in the Thanetian are derived.

HILLEBRANDT, AXEL VON. El Terciario Bajo de la zona del Monte Perdido (Huesca).—Notas y Comunicaciones Instit. Geol. Min España, No. 73, 1964, p. 61-97, pls. 1-6, text figs. 1-3 (map, columnar sections).—Includes illustrations of foram-bearing thin sections mostly from the Ilerdian.

HOFKER, J., JR. Note sur *Orbitolina conulus* Douvillé.—Revue de Micropaléontologie, v. 7, No. 1, June 1964, p. 72-76, pls. 1, 2, text figs. 1-3 (drawings, graph).

HORNIBROOK, N. DE B. The foraminiferal genus *Astrononion* Cushman and Edwards.—Micropaleontology, v. 10, No. 3, July 1964, p. 333-338, pl. 1.—A neotype for the type species is selected from Las Palmas, and the species are grouped into 3 subgenera on the basis of whether they are umbilicate or non-umbilicate and whether they possess sutural tubes or sutural plates.

KEIJ, A. J. Recent "Lagena"-X from the South China Sea.—Revue de Micropaléontologie, v. 7, No. 1, June 1964, p. 65-67, pl. 1, text fig. 1 (map).—This Recent occurrence lends hope to the possibility of solving the problematica through finding the structure as a living organism.

DE KLASZ, IVAN, LE CALVEZ, YOLANDE, and RÉRAT, DANIEL. Deux importantes espèces de Foraminifères du Miocène inférieur de l'Afrique occidentale.—C. R. S. Soc. Géol. France, fasc. 5, May 4, 1964, p. 194-195, text figs. 1-3.—*Bolivina tenuicostata* and *Nonion centrosulcatum,* both new.

Deux nouveaux genres de Foraminifères du Gabon (Afrique Equatoriale).—C. R. S. Soc. Géol. France, fasc. 6, June 1, 1964, p. 236, 237, text figs. 1-3.—*Labiostoma* (type species *L. cretacea* nov. sp.) and *Pseudobuliminella* (type species *P. triserialis* nov. sp.) plus one other new species.

KNAUFF, WOLFGANG. Zur Mikrofauna im Oberkarbon der Bohrung Münsterland 1 und den Möglichkeiten ihrer Stratigraphischen Auswertung.—Fortschr. Geologie von Rheinland u. Westfalen, band 11, Krefeld, Sept. 1963, p. 113-122, pl. 1, table 1.

KOROVINA, G. M. Mikropaleontologicheskaja Kharakteristika Oligothenovykh i Nizhnemiothenovykh Otlozhenij Zapadnogo Kopet-Daga, Severnogo Prikarabugaz'ja i Gornogo Mangyshlaka, *in* Novye Dannye po Geologii i Neftegazonosnosti Srednej Azii.—Moscow, Vses. nauchnoissl. geol. neft. instit. (VNIGNI), Trudy, vyp. 39, 1964, p. 165-179, pls. 1-7, text fig. 1 (map), 1 table (correl. chart).—An illustrated systematic catalog of 23 species (2 new) and 1 new subspecies from the Oligocene and lower Miocene.

KRINSLEY, D., and SCHNECK, M. The palaeoecology of a transition zone across an Upper Cretaceous boundary in New Jersey.—Palaeontology, v. 7, pt. 2, July 1964, p. 266-280, text figs. 1-4 (map, columnar sections, drawings, graphs), tables 1-3.—In a study of samples at 1-foot intervals across the Mount Laurel-Navesink boundary, interpretations of rate of sedimentation and of depth and stability of depth of water are based on number of specimens of Foraminifera, benthonic/planktonic ratio, and family composition of benthonics. Post-depositional sorting of *Gümbelina* is deduced from similarity of size frequency of sand grains and of specimens.

KUWANO, YUKIO. Foraminiferal biocoenoses of the seas around Japan, a survey of Pacific-side biocoenoses. III. Biocoenoses off the Boso Peninsula.—Misc. Repts. Research Instit. Nat. Resources, No. 60, May 25, 1963, p. 29-51, text figs. 11-14 (map, range and abund. chart, graphs), tables 7-14.—Study based on 3 traverses extending outward from the coast of the peninsula into the waters where the warm Kuroshio meets the cold Oyashio current. Depths range from 59 to 378 meters, divisible (by appearance of new forms) into 5 intervals. Seven biocoenoses are discriminated. A total of 355 forms are distinguished; 23 of them (all eurybathyal) prove to be useful indicators as chief components of biocoenoses. Paucity of characteristic species at shallow depths together with high frequency is attributed to rapid postglacial transgression. Compared with the previous study of Kagoshima Bay, total numbers of species and of living specimens are low.

LEHMANN, ROGER. Etude des Globotruncanidés du Crétacé Supérieur de la province de Tarfaya (Maroc Occidental).—Notes du Service Géologique de Maroc, Tome 21, Micropaléontolo-

gie, Notes et Memoires du Service Géologique No. 156, 1962 (June 1963), p. 133-179, pls. 1-10, text figs. 1-3 (map, drawings of thin sections, zonation diagram).—Illustrations and descriptions of 35 species (3 new). The interval Cenomanian to Santonian is subdivided into 5 zones based on globotruncanids.

LISZKA, STANISLAW. Stratigraphic importance of the Foraminifera of the Carboniferous system of Poland (English summary of Polish text). Acad. Mining and Metallurgy in Cracow, Sci. Bull. No. 63, Trans. Bull. 13, 1962, p. 1-50, pl. 1, table 1.—Occurrence is indicated for 87 species; 10 are illustrated.

LOEBLICH, ALFRED R., JR., and TAPPAN, HELEN. Four new Recent genera of Foraminiferida.—Jour. Protozoology, v. 10, No. 2, 1963, p. 212-215, figs. 1-9.—*Phlegeria* (type species *P. hyalina* sp. nov.), *Tomaculoides* (type species *T. lucidum* sp. nov.), *Francesita* (type species *Virgulina*? *advena* Cushman) and *Montfortella* (type species *M. bramlettei* sp. nov.).

The species and stratigraphic distribution of *Caucasina* and *Aeolomorphella*, new genus (Foraminiferida).—Tulane Studies in Geol., v. 2, No. 3, June 30, 1964, p. 69-88, pls. 1, 2, text figs. 1, 2 (map, range chart).—Eleven species (2 new) of *Caucasina* and 1 new species of *Aeolomorphella*, which genus differs in having a biserial rather than triserial later stage. The genus ranges from Upper Cretaceous to Miocene and may have originated from some rotaliform genus having a granular microstructure of the wall.

LUCZKOWSKA, EWA. The micropaleontological stratigraphy of the Miocene in the region of Tarnobrzeg-Chmielnik (in Polish with English and Russian summaries).—Polska Akad. Nauk, Kom. Nauk Geol., Prace Geol., No. 20, 1964, p. 1-72, pls. 1-4, tables 1-12.—Quantitative study based on samples from 7 drill holes results in zonation of Tortonian and Sarmatian by 8 foram zones with local correlations between holes. Nearly 350 species were determined and their distribution and abundance plotted. Foraminifera assemblages illustrated.

LUTZE, G. F. Unter-Oxford im Hildesheimer Jurazug.—Zeitschr. Deutschen Geol. Gesell., Hannover, Jahrgang 1962, Band 114, teil 2, Nov. 1963, p. 360-377, text figs. 1-8 (map, geol. section, columnar sections, graph, range chart), table 1.—*Gaudryina heersumensis* is typical of oolithic facies.

MAGNÉ, J., and DUFAURE, G. Une méthode nouvelle pour l'extraction rapide des microfossiles. —Revue de Micropaléontologie, v. 7, No. 1, June 1964, p. 77-79.

MARGEREL, JEAN-PIERRE. *Miliola gouetensis* n. sp., nouvelle espèce de Foraminifère des sables du Bois-Gouët (bassin de Saffré, Loire-Atlantique). —C. R. S. Soc. Géol. France, fasc. 6, June 1, 1964, p. 239, 240, text figs. A-F.—From the upper Lutetian.

MCGUGAN, ALAN. Upper Cretaceous zone Foraminifera, Vancouver Island, British Columbia, Canada.—Jour. Paleontology, v. 38, No. 5, Sept. 1964, p. 933-951, pls. 150-152, figs. 1-4 (map, correl. chart, distrib. and abund. chart, occur. table).—Three zones are recognized in the sequence Santonian? to Maestrichtian. Forty-three species (2 new) and one variety are described and illustrated.

MINATO, MASAO, and KOCHANSKY-DEVIDÉ, VANDA. Über die Axialseptula einiger Neoschwagerinen-Arten aus Jugoslawien.—Bull. Géol., Instit. pour les Recherches Géol. à Zagreb et Soc. Géol. Croate, tome 17, 1963 (1964), p. 143-147, text fig. 1, tables 1, 2.

MITJANINA, I. V. Foraminifery Verkhnego Oksforda Belorussii, *in* Paleontologija i Stratigrafija BSSR.—Akad. Nauk Belorusskoj SSR, Minsk, Instit. Geol. Nauk, Sbornik 4, 1963, p. 122-189, pls. 1-9, text figs. 1-18 (map, outline drawings).—Illustrated systematic catalog of 34 species of upper Oxfordian Foraminifera, 7 new.

DI NAPOLI ALLIATA, ENRICO. Il Miocene Superiore nella Valle dell'Orte presso Bolognano (Pescara).—Geologica Romano, v. III, 1964, p. 3-32, pls. 1-3, text figs. 1-14 (columnar section, photographs, graphs).—Quantitative analyses of Foraminifera (as genera and families) in four units provide a basis for paleoecological interpretations of subsidence, shoaling, turbidity currents, lagoonal conditions, and high salinity from Tortonian into Messinian. Morphological changes in *Bulimina* (increase in size and degree of ornamentation and degeneration to biseriality) as well as decrease in number of species are attributed to increased salinity and temperature.

NAYUDU, Y. R. Carbonate deposits and paleoclimatic implications in the northeast Pacific Ocean.—Science, v. 146, No. 3643, Oct. 23, 1964, p. 515-517, text figs. 1-4 (maps, diagrams of cores).—*Globigerina-rich* sediments are found in certain deep-sea cores taken off the coast from Oregon to British Columbia. Tops of the cores show a decrease in Foraminifera and increase in silts and clays. The lo-

cations of these cores mark an elongate area paralleling and about 480 km. off the coast. Radiocarbon dating of the cores show the *Globigerina*-rich portion to have been deposited between about 27,000 and 12,000 years ago, dates roughly coincident with the Vashon (late Wisconsin) glaciation.

NEUMANN, MADELEINE. A propos des genres *Cyclolina* d'Orbigny et *Cyclopsinella* Galloway. —Revue de Micropaléontologie, v. 7, No. 1, June 1964, p. 47-56, pls. 1, 2, text figs. 1-4.— Differences in internal structure exemplified by thin sections of *Cyclolina cretacea* and *Cyclopsinella steinmanni.*

RIEDEL, WILLIAM REX, and FUNNELL, BRIAN MICHAEL. Tertiary sediment cores and microfossils from the Pacific Ocean floor.—Quart. Jour. Geol. Soc. London, No. 479, v. 120, pt. 3, Aug. 14, 1964, p. 305-368, pls. 14-32 (photographs of cores [pls. 14-27], maps [pls. 28-32]), text figs. 1-5 (sea-floor topography), tables 1-4.—Tertiary microfossils (Radiolaria, planktonic Foraminifera, and/or calcareous nannoplankton) were found in 85 cores. Maps show locations of cores and kinds of fossils, whether or not fossils were in situ, and reliability of the interpretation, for the Pliocene, Miocene, Oligocene, and Eocene. For most of the cores, species are listed and evaluated.

RISDAL, DAG. The bathymetrical relation of Recent foraminiferal faunas in the Oslo Fjord, with a discussion of the foraminiferal zones from Late Quaternary time (English summary of Norwegian text).—Norges Geol. Unders., Nr. 226, 1964, p. 1-142, text figs. 1-4 (maps), diagrams 1-50 (graphs), tables 1-12.—Distribution of species is controlled by bottom topography, kind of sediments, current activity, nutrients, predator relations, temperature, and salinity. Five bathymetric zones are distinguished: 3-4 meters, 4-6 meters, 10-30 meters, 30-100 meters, and below 100 meters. Study is based on 50 core samples from depths between 3 and 330 meters. Composite fauna totals 110 species. Quantitative faunal composition at each station is shown graphically.

RUGGIERI, G., and SPROVIERI, R. *Streblus punctatogranosus* (Seg.) del Tortoniano della Calabria, Neotipo.—Riv. Ital. Paleont. Stratig., v. 70, No. 1, 1964, p. 131-136, pl. 8, text figs. 1, 2.—A neotype is chosen and the species placed in *Streblus.*

SAAVEDRA, JOSE LUIS. Datos para la interpretacion de la estratigrafia del Terciario y Secondario de Andalucia.—Notas y Comunicaciones Instit. Geol. Min. España, No. 73, 1964, p. 5-50, text figs. 1-25 (paleogeographic maps, geol. sections), tables 1-3.—In the Tertiary, age is based on planktonic Foraminifera.

SACAL, V. Microfaciès du Paléozoïque Saharien. —Notes et Memoires, No. 6, Compagnie Française des Pétroles, Paris, Dec. 20, 1963, p. 1-30, microphotographs 1-100, 4 text figs. (correlated columnar sections, map).—Foraminifera in thin sections of Carboniferous rocks.

SACHS, K. N., JR. Multilocular embryonts in *Lepidocyclina (Eulepidina) undosa* Cushman from Puerto Rico.—Micropaleontology, v. 10, No. 3, July 1964, p. 323-329, pls. 1, 2.—Specimens possessing multilocular embryonts are variants; thus this feature has no taxonomic, stratigraphic, or geographic significance.

SACHS, K. N., JR., CIFELLI, RICHARD, and BOWEN, VAUGHAN T. Ignition to concentrate shelled organisms in plankton samples.—Deep-Sea Research, v. 11, No. 4, Aug. 1964, p. 621-622, fig. 1.—A method for eliminating soft-bodied organisms from plankton samples.

SAID, RUSHDI, and SABRY, HASSAN. Planktonic Foraminifera from the type locality of the Esna Shale in Egypt.—Micropaleontology, v. 10, No. 3, July 1964, p. 375-395, pls. 1-3, text figs. 1, 2 (map, columnar section), tables 1, 2.—Illustrated catalog of 55 species, 5 subspecies, and 1 variety from a section encompassing 7 planktonic zones from Maestrichtian to Ypresian.

SAMANTA, B. K. The occurrence of Indo-Pacific *Discocyclina* in eastern India.—Micropaleontology, v. 10, No. 3, July 1964, p. 339-353, pls. 1-4, tables 1-9.—Three species (none new), two recorded for the first time in India.

SCHUTZKAJA, E. K. Pogranichnye Sloi Eothena i Oligothena Bakhchisarajskogo Rajona i Opisanie Kharakternykh Anomalinid.—Moscow Vses. nauchno-issl. geol. neft. instit. (VNIGNI), Trudy, vyp. 38, 1963, p. 174-205, pls. 1-4, text figs. 1-3 (occur. chart, drawings), 1 table.— Descriptions and illustrations of 20 Eocene and Oligocene species of *Anomalina* and *Cibicides,* 7 new.

SMITH, PATSY B. Recent Foraminifera off Central America: Ecology of benthonic species.— U. S. Geol. Survey Prof. Paper 429-B, July 7, 1964, p. B1-B55, pls. 1-7, text figs. 1-23 (map, graphs, drawings, correl. chart), tables 1-8.— The study is based on 18 alcohol-preserved bottom samples taken from depths between 20 and 3200 meters in an 80-mile traverse perpendicular to the coast of El Salvador. Numbers of living and dead specimens are recorded for about 150 species and subspecies. Six faunal

zones are recognized with their lower boundaries at 30, 60, 150, 600, 1300 and more than 3200 meters. For 56 of the species comparisons of depth ranges of living and dead specimens are made with 8 other areas along the Pacific coast.

SNAVELEY, P. D., JR., RAU, W. W., and WAGNER, H. C. Miocene stratigraphy of the Yaquina Bay area, Newport, Oregon.—The Ore Bin, v. 26, No. 8, Aug. 1964, p. 133-151, pl. 1 (geol. map), text figs. 1-3 (columnar section, outcrop photographs), tables 1-4.—Occurrence and abundance of Foraminifera recorded in a section extending out into the ocean.

SOHN, I. G., and REISS, ZEEV. Conodonts and Foraminifera from the Triassic of Israel.—Nature, v. 201, No. 4925, March 21, 1964, p. 1209.

SORGENFREI, THEODOR, and BUCH, ARNE. Deep tests in Denmark 1935-1959.—Geol. Survey Denmark, ser. III, No. 36, 1964, p. 1-146, pls. 1-22 (fossils, drilling rigs, maps, columnar sections), tables 1-3.—About 70 species of Foraminifera, stratigrapically useful in the Lower Jurassic to Pleistocene sections of 31 deep test holes, are illustrated and described.

STSCHEDRINA, Z. G. Foraminifery (Foraminifera) Vysokikh Shirot Arkticheskogo Bassejna, *in* Nauchnye Rezul'taty Vysokoshirotnykh Okeanograficheskikh Ehkspedithij v Severnuju Chast' Grenlandskogo Morja i Prilegajushchie Rajony Arkticheskogo Bassejna v 1955-1958 gg.—Arkticheskogo i Antarkticheskogo Nauchno-issl. Instit., Glavnogo Uprav. Gidrometeorol. Sluzhby pri Sovete Ministrov SSSR, Trudy, tom 259, 1964, p. 79-119, pls. 1, 2, text figs. 1-4 (drawings, map), table 1.—A study based on collections from north of Spitzbergen and Franz Josef Land. Species are recorded and tabulated as to depth. Eight species (7 new) and a new subspecies are described and illustrated, including *Triloculinoides magnum* gen. et sp. n.

Foraminifery (Foraminifera) Severnoj Chasti Grenlandskogo Morja, *in* Nauchnye Rezul'taty Vysokoshirotnykh Okeanograficheskikh Ehkspedithij v Severnuju Chast' Grenlandskogo Morja i Prilegajushchie Rajony Arkticheskogo Bassejna v 1955-1958 gg.—Arkticheskogo i Antarkticheskogo Nauchno-issl. Instit., Glavnogo Uprav. Gidrometeorol. Sluzhby pri Sovete Ministrov SSSR, Trudy, tom 259, 1964, p. 120-142, tables 1-10.—Tabulation of 114 species in numerous samples taken between 51 and 3835 meters around Greenland.

SUBBOTINA, N. N. (with the collaboration of others). Foraminifera Melovyk i Paleogenovykh Otlozhenij Zapadno-Sibirskoj Nizmennosti.—Vses. Neft. Nauchno-Issl. Geol. Instit. (VNIGRI), Trudy, vyp. 234, 1964, 456 p., 66 pls., 5 text figs. (map, drawings), 3 tables.—Systematic catalog, beautifully illustrated, includes about 150 species and subspecies (52 species and 8 subspecies new). Zonation is indicated and numerous foram zones, subzones, and beds are designated for the interval between Valanginian and Miocene.

SZTEJN, JANINA. Lower Cretaceous micropalaeontological stratigraphy in the bore holes Kcynia II and III (English summary of Polish text). —Poland Instyt. Geol., Biul. 175, tom 9, 1964, p. 153-161, pls. 11, 12 (range and abund. charts).

TALEV, B. Cenomanische Orbitolinen aus dem Gebiet von Kotel (German summary of Russian text).—Acad. Bulgare des Sci., Instit. Geol. "Strachimir Dimitrov," Sofia, Travaux sur la Geologie de Bulgarie, sér. paléont., v. 6, 1964, p. 5-15, pl. 1, text figs. A-C, fig. 1 (columnar section).

TAUGOURDEAU-LANTZ, J., and POIGNANT, ARMELLE. La membrane chitinoïde de quelques Foraminifères.—Revue de Micropaléontologie, v. 7, No. 1, June 1964, p. 68-71, pl. 1, text fig. 1.—Possibility of generic determination of Foraminifera from their chitinous linings in palynological residues.

TAYLOR, D. J. Foraminifera and the stratigraphy of the Western Victorian Cretaceous sediments. —Proc. Roy. Soc. Victoria, v. 77, pt. 2, June 12, 1964, p. 535-603, pls. 79-86, text figs. 1-7 (map, columnar section, distrib. chart, range chart, graph, fence diagram, block diagram), tables 1, 2.—Five Foraminifera assemblages are recognized, 3 combined to form zonule A of Santonian age and 2 to form zonule B of Turonian age. Fifty-three species (6 new) are described and illustrated.

TODD, RUTH. Planktonic Foraminifera from deep-sea cores off Eniwetok Atoll, *in* Bikini and nearby atolls, Marshall Islands.—U. S. Geol. Survey Prof. Paper 260-CC, Aug. 10, 1964, p. 1067-1100, pls. 289-295, text figs. 319-320 (map, correl. diagram), tables 1-3.—Description and illustration of 32 species, 9 subspecies, and 1 variety, none new, from 5 short cores from a guyot adjoining the atoll. The cores penetrated through an unconsolidated cover of Quaternary organic debris into semiconsolidated sediment tentatively dated by forams as early Pliocene in its upper part (characterized by presence of *Globigerinoides sacculifer fistulosa* and absence of *Globorotalia truncatuli-*

noides) and late Miocene in its lower part (characterized by presence of *Globoquadrina altispira*).

TODD, RUTH, and LOW, DORIS. Cenomanian (Cretaceous) Foraminifera from the Puerto Rico Trench.—Deep-Sea Research, v. 11, July 1964, p. 395-414, pls. 1-4.—Several limestone pieces dredged from 3200-3500 fathoms on the north slope of the Puerto Rico Trench contain Foraminifera of probably middle Cenomanian age. This population (being from about 1000 fathoms below the present-day critical depth for solution of $CaCO_3$) is predominantly planktonic (14 species, 1 new), but very rare benthonic specimens (19 species) also occur. The temperature of the Cenomanian ocean was enough warmer than the present-day ocean that the limestone could have been deposited as deep as where found.

TSCHUVASHOV, B. I. Contribution to the ecology of Late Frasnian foraminifers and algae (in Russian).—Akad. Nauk SSSR, Paleont. Zhurnal, No. 3, 1963, p. 3-9, text figs. 1, 2 (map, chart).

VELLA, PAUL. The type species of the foraminiferal genus *Proxifrons;* a correction.—New Zealand Jour. Geol. Geophys., v. 7, No. 2, May 1964, p. 402.

Foraminifera and other fossils from late Tertiary deep-water coral thickets. Wairarapa, New Zealand.—Jour. Paleontology, v. 38, No. 5, Sept. 1964, p. 916-928, text figs. 1-3 (maps, geol. sections), tables 1-3.—Foraminifera listed from samples within and adjacent to a late Miocene thicket (interpreted by the Foraminifera as not less than 1500 meters depth) and a late Pliocene one (likewise interpreted as between 200 and 300 meters depth) show the fauna somewhat richer within the thickets than outside them.

WADE, MARY. Application of the lineage concept to biostratigraphic zoning based on planktonic Foraminifera.—Micropaleontology, v. 10, No. 3, July 1964, p. 273-290, pls. 1, 2, text figs. 1-3 (map, correl. table, distrib. chart), table 1.—In three basins in southeastern Australia, in the temperate province, four lineages of planktonic species are described and found to be useful for interprovincial correlation. They are the *Globigerina bulloides* lineage, the *Globigerina ampliapertura* to *G. apertura* lineage, the *Globigerinoides quadrilobatus* to *Orbulina* lineage, and the *Globorotalia fohsi* lineage.

WALTON, WILLIAM R. Recent Foraminiferal Ecology and Paleoecology, *in* Approaches to Paleoecology, edited by John Imbrie and Norman Newell.—New York, John Wiley and Sons, Inc., 1964, p. 151-237, text figs. 1-31 (locality maps, distrib. maps, diagrams, graphs, geol. section).—An important paper in which the area from the Mississippi delta eastward to Cape San Blas, Florida, serves to illustrate numerous conclusions about ecology of Foraminifera. Generic associations in 3 subdivisions of marginal-marine (fresh water to 2-10 fathoms) and 5 subdivisions of open-marine areas (2-10 fathoms to more than 300 fathoms) are described and plotted on maps. Living populations, species residual from previous environments, and nonindigenous species are distinguished. Faunal variability is inversely proportional to variability of the environment, but faunal dominance is directly proportional to it. As a result marginal-marine conditions are characterized by few species, dominated by one, while the shelf edge is characterized by many species, without a dominant one. Thus approach of the marginal-marine area may be detected along any time plane. The Anahuac Shale is used as an example of paleoecologic interpretation in the subsurface Oligocene using criteria developed from modern faunas.

ZANFRA, SILVANA. I Foraminiferi di due Lembi del Pliocene Superiore della Riviera di Ponente (Imperia-Ventimiglia).—Boll. Soc. Geol. Ital., v. 80, fasc. 3, 1961 (1962), p. 275-282, pl. 1, text fig. 1 (pie diagram).—Species listed.

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