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220. ANNOTATED BIBLIOGRAPHY OF PRECARBONIFEROUS FORAMINIFERA

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ABSTRACT

This annotated bibliography includes 96 references pertaining to Precarboniferous Foraminifera, and may be considered reasonably complete through the year 1959. The bibliography has three distinct aims: (1) to summarize briefly the contents of each article, (2) to list all new genera and species described therein, and (3) to denote, by brackets, all taxonomic changes noted from later publications, thus making the bibliography a more useful working tool for specialists.

INTRODUCTION

In conjunction with work on Precarboniferous Foraminifera, an extensive search of the literature was undertaken. This has yielded a bibliography of 71 references containing original descriptions of genera and species, and taxonomic nomenclature of Precambrian through Devonian Foraminifera. An additional 25 references, with mention of foraminiferal names, incidental occurrences and corrections of earlier errors, are included for sake of completeness.

The 96 references have been annotated by the compiler, except for the most recent publications in which the author included a comprehensive abstract. 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 genera and species described, and comments in brackets on taxonomic changes noted from later publications.

The bibliography may be considered reasonably complete through 1959 with the exception of the Soviet references, which due to their general unavailability may be assumed to be only partially complete.

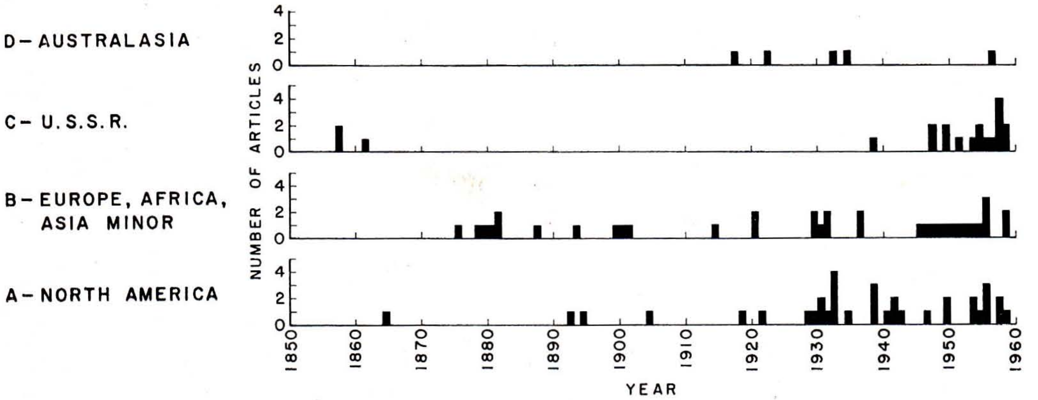
It will be greatly appreciated if any significant omissions in this bibliography are brought to the attention of the compiler.

EVALUATION OF ARTICLES

To date there are relatively few publications devoted to Precarboniferous Foraminifera, and only within the last twenty-five years has the literature pertaining to this group become enriched with valid systematic descriptions of genera and species.

Text Figure 1 is an attempt to show chronologically the distribution of articles relating to Precarboniferous Foraminifera according to designated geographic regions.

In North America (A), genuine interest and valid



TEXT FIGURE 1

Distribution of articles pertaining to Precarboniferous Foraminifera

articles did not evolve until the late 1920's; this interest has continued until the present day and shows healthy signs of continuing to do so. However, it is to be noted that there is to date no American publication devoted to a thin-section study of Precarboniferous Foraminifera but, instead, almost all of the forms described from North America are so-called "arenaceous" forms liberated from carbonate rocks by the dilute acid insoluble residue technique. This is in direct contrast to the work of the Soviet paleontologists who, almost exclusively, rely on thin-section methods. Seemingly, this might account for the somewhat artificial and unrealistic separation that is presumed to exist between the European and North American faunal realms. Rauser-Chernoussova and Reitlinger (1957) have noted:

"This seems to delineate two zoogeographical regions: the European one, with a poorer complex of Foraminifera, but in which the secretion forms, sometimes highly organized, already play a definite role, and the American region with a very rich complex of agglutinated forms."

It is to be hoped that in the future all workers will utilize both insoluble residue and thin-section techniques in studying Precarboniferous Foraminifera and, perhaps in this way, more effort will be applied, somewhat indirectly, towards an overall approach to an apparent need of a thorough petrographic study of the microstructure of the foram test wall.

In Europe, Africa, and Asia Minor (B), publications, for all practical purposes, can be separated into two categories: (1) those from 1876-1920 in which the authors seemed to be totally preoccupied with describing faunas which were intended to push back, as far as possible, the time of foraminiferal evolutionary development, and (2) those articles since 1920, mainly by Wood and Cummings in England, which have reexamined the earlier records and have found that in most cases the supposed Paleozoic faunas are either much younger in age or are of inorganic origin. On the continent, the excellent works by Eisenack, Beckmann, Pokorny, and Prantl have described Precarboniferous Foraminifera from rocks of the Baltic region and central Europe, and have added appreciably to our knowledge of Precarboniferous Foraminifera.

The Soviets (C) received an early start in the late 1850's and early 1860's through the work of Ehrenberg, but, apparently, there was a general lack of interest until after World War II; at that time, the directional goal of Soviet paleontologists was clarified and ultimately resulted in a burst of activity which is still in the apex of expansion. It should be pointed out that recent Soviet articles are large monographs, which, for the most part, are of excellent quality. The fact that most of the Soviet references are generally unavailable to western workers undoubtedly hampers the progress of the science, and it is hoped that this situation will be remedied in the future.

In Australasia (D), very little has been done, and no trend has been established.

ANNOTATED BIBLIOGRAPHY

1. Amsden, T. W., 1956, Catalog of Hunton fossils: Oklahoma Geol. Survey, Circ. 38, 63 p., (Foraminifera: p. 7-15, 39).

Lists all Foraminifera previously described from the Silurian Hunton group of Oklahoma.

2. Antropov, I. A., 1950, New species of Foraminifera in the Upper Devonian of certain areas in the eastern part of the Russian Platform: Akad. Nauk S.S.S.R., Kazanskii Filial, Kazan, Izvest., Ser. Geol. no. 1, p. 21-33, 3 pl., [in Russian].

From the Upper Devonian rocks of the eastern part of the Russian Platform, a fauna of eighteen species, of which seven genera, sixteen species, and two varieties are new, is described and illustrated by thin-section photomicrographs. The new forms are *Vicinesphaera squalida* n. gen., *V. angulata, Parathurammina dagmarae* Suleimanov var. *crassitheca, P. cushmani* Suleimanov var. *minima, P. gekkeri, P. magna, P. radiata, P. lipinae, Corbis nodosus* n. gen., *C. depressus, Lagenammina sheshmae, Rauserina notata* n. gen., *Caligella borovkensis n.* gen., *Tscherdyncevella acervulinoides* n. gen., *Shuguria flabelliformis* n. gen., *Syniella tortuosa,* and *S. tenuis.*

3. Bagg, R. M., 1919, The Foraminifera of the Bonaventure cherts of Gaspé: Fifteenth Rept. Director New York State Museum for 1918, p. 149-192, 6 pl.

Forty-five previously described species and varieties of Foraminifera from thin-sections of chert pebbles from the Bonaventure conglomerate of Gaspé are described and illustrated by drawings. There is some question as to the age and validity of the fauna, and evidently it needs to be restudied. [Miller and Carmer (1933, p. 426) state: "This conglomerate was regarded at that time as either Late Devonian or Early Mississippian in age, but it has since been shown to be Mississippian. Furthermore, the Foraminifera, occurring as they do in the pebbles and not the matrix of the conglomerate, are obviously older than the conglomerate, and they were regarded by both John M. Clarke, who collected the material, and R. M. Bagg, who described it, as being either Cambrian or Ordovician in age."]

4. Bartenstein, H., 1937, Neue Foraminiferen-Funde Im Mittel-Devon Der Eifel: Senckenbergiana, v. 19, p. 334-338, 8 text-fig., [in German].

From the Middle Devonian rocks of the Eifel region of western Germany, a fauna of five species is briefly described and illustrated by whole-specimen photomicrographs. The fauna includes *Lagena* sp., *Hyperammina* sp. [both forms = *Vasicekia moravica;* see Pokorny, 1951], *Lituotuba* sp. [= *Moravammina segmentata* Pokorny; see Bykova and Polenova, 1955], *Cristellaria* (*Lenticulina* sp.), and *Trochammina* sp.

5. Beckmann, H., 1950, *Rhenothyra,* eine neue Foraminiferen gattung aus dem rheinischen Mitteldevon: Neues Jahrb. Geol. Pal., p. 183-187, 5 text-fig., [in German].

From the upper part of the Middle Devonian of Refrath, on the Rhine, a planispiral, convolute lituolid, *Rhenothyra refrathiensis* n. gen., is described in detail and illustrated by drawings. The author maintains that *Rhenothyra* is the primitive ancestor of *Endothyra* and *Haplophragmoides.*

6. Beckmann, H., 1953, *Palachemonella torleyi* n. gen. et n. sp., eine neue Foraminifere aus den Schleddenhofer Schichten (Mitteldevon): Geol. Jahrb., v. 67, p. 259-272, 2 pl., 6 text-fig., [in German].

From the upper part of the Middle Devonian rocks of the Ruhr Basin, Western Germany, one new encrusting genus and species, *Palachemonella torleyi*, is described and illustrated by whole specimen and thin-section photomicrographs. A discussion of the test wall microscopy and some paleoecologic observations are also included. [Throughout the text the new form is consistently given as "*Palachemonella;*" this was derived from *Aschemonella* Brady, 1879, which Beckmann gives as "*Achemonella,*" hence "*Palachemonella*" is evidently a *lapsus calami* for *Palaschemonella.*]

7. BILLINGS, E., 1865, Notes on some of the more remarkable genera of Silurian and Devonian fossils: Canadian Naturalist & Geologist, n.s., v. 2, p. 192, 198.

Erroneously refers such forms as *Receptaculites*, *Pasceolus* [= *Cyclocrinites*], and *Calcisphaera* [= *Trochiliscus*] to the order Foraminifera.

8. BIRINA, L. M., 1948, New species of calcareous algae and Foraminifera from the transitional (Devonian-Carboniferous) beds of the Moscow Basin: Russian State Geological Symposium, Moscow, no. 28, p. 154-159, 2 pl., [in Russian].

From the transitional Devonian-lower Carboniferous rocks of the Moscow basin, a fauna of one new genus and three new species is described and illustrated by rather poor photomicrographs. The new forms are *Hyperammina minima, Bisphaera malevkensis* n. gen., and *B. irregularis.*

9. BLAKE, J. F., and LEBOUR, G. A., 1876, Lower Silurian Foraminifera: Geol. Mag., n.s., d. 2, v. 3, p. 134-135.

Reports from the Lower Silurian rocks of Aberystwith, England, dentaline Foraminifera referable to the form *Dentalina communis.* [Re-examination of Blake's material (see Wood, 1949) indicates that the supposed Foraminifera are inorganic markings.]

10. BRADY, H. B., 1888, Notes on some Silurian Lagenae: Geol. Mag., n.s., d. 3, v. 5, p. 481-484, pl. 13.

From the Silurian Wenlock shale of England, a collection of Lagenae is described in detail and referred to four Recent species: *Lagena globosa* Montagu, *L. clavata* D'Orbigny, *L. laevis* Montagu, and *L. sulcata* Walker and Jacob. All of the above forms are illustrated by whole-specimen drawings, and one drawing of a longitudinal section is also included. [Restudy of the collection (see Cummings, 1952) showed that the specimens defined by Brady as *Lagena* are *Saccamminopsis fusulinaformis* (M'Coy).]

11. BYKOVA, E. V., 1952, Devonian Foraminifera of the Russian Platform and Cis-Urals: Microfauna S.S.S.R., Sbornik no. 5, 64 p., 14 pl., [in Russian].

From the Devonian rocks of the Russian Platform and Cis-Urals, a fauna of thirty-five species, of which six genera and thirty-two species are new, is described and illustrated by line drawings and whole specimen and thin-section photomicrographs. The new forms are: *Uralinella bicamerata* n. gen., *Parathurammina paulis, Saccammina ingloria* [now referred to genus *Saccamminopsis;* see Sollas, 1921], *Rectocornuspira siratchoya, Evlania transversa* n. gen., *E. devonica, Geinitzina indigena* [changed to *Eogeinitzina indigena* (Bykova); see Konolipina, 1959, p. 32], *G. reperta, Frondilina devexis* n. gen., *F. sororsis, Multiseptida corallina* n. gen., *Tikhinella measpis* n. gen., *T. fringa, T. pirula, T. cannula* [changed to *Paratikhinella cannula* (Bykova); see Konolipina, 1959, p. 36], *Semitextularia oscoliensis, S. semilukiensis, S. sigillaria, S. natiopsis, S. minuta, S. inartia, S. palmuliensis, S. platicera, Pseudopalmula fragaria, P. variocellata, P. ovata, P. extremitata, P. gyrinopsis, P. scheda, Cremsia inclebrata* n. gen., [Bykova & Polenova (1955) state that *Cremsia* = *Paratextularia* Pokorny, 1951], *Nanicella porrecta,* and *N. bella.* The genera *Semitextularia* and *Pseudopalmula* have been emended by the author. *Semitextularia thomasi* = *S. sigillaria.*

12. BYKOVA, E. V., 1956, Foraminifera of the Ordovician and Silurian of the Soviet Baltic: All-Union Petroleum Scientific-Research Geol. Exploration Inst., Trans., n.s., Publ. 98, p. 6-27, 5 pl., [in Russian].

From the Ordovician and Silurian rocks of the Russian Baltic region, a fauna of twenty-one species, of which two genera and eleven species are new, is described and illustrated by line drawings. The new forms are: *Cochleatina plavinensis* n. gen., *Lagena areaea, L. pressula, L. glomerosa, L. luxa, L. ventricosa, L. tuberosa* [*ventricosa* and *tuberosa* are both homonyms; see Thalmann, 1959], *L. panucella, Nodosaria? mediana, Illigata annae* n. gen., and *I. mensis.*

Taxonomic changes include the following: *Ammodiscus brevitubus* Dunn, 1942 = *Bifurcammina brevitubus* (Dunn); *Lagena globosa* Brady, 1888 = *L. luxa; Lagena sulcata* Brady, 1888 = *L. ventricosa; Lagena clavata* Brady, 1888 = *Nodosaria? mediana;* and *Rotalia?* sp. Keeping, 1882 = *Aristerospira octarchaea Ehrenberg.* [Restudy of Brady's collection of Lagenae indicates that the forms described as *Lagena globosa, L. sulcata,* and *L. clavata* should now be referred to *Saccamminopsis fusulinaformis* (M'Coy); see Cummings, 1952.]

13. BYKOVA, E. V., 1958, On a find of chitinoid Foraminifera in the Ordovician deposits of north Kazakhstan: Akad. Nauk S.S.S.R., Doklady, v. 120, no. 4, p. 879-881, 11 text-fig., [in Russian].

From the Ordovician Karmola formation of North Kazakhstan, Russia, a new family, Alexandrellidae, of chitinoid Foraminifera is described and illustrated by high-power thin-section photomicrographs. This new form is similar to the chitinoid Foraminifera described by Eisenack from the Ordovician and Silurian rocks of the Baltic region. To this new family belong the genera *Alexandrella, Ordovicina* Eisenack, 1937 (*pars*), and *Blastammina* Eisenack, 1932 (*pars*).

14. BYKOVA, E. V., and POLENOVA, E. N., 1955, On the Foraminifera, Radiolaria, and Ostracoda in the Devonian period of the Volga-Ural region: Trans. All-Union Petroleum Research Scientific-Investigations, Geol. Explor. Inst., no. 87, 141 p., 24 pl., [in Russian].

From the Devonian rocks of the Volga-Ural region of Russia, a fauna of sixty-seven species, of which four genera, forty-nine species, and nine varieties are new, is described and illustrated by line drawings and thin-section photomicrographs. The new forms are *Saccammina petinensis* [now referred to the genus *Saccamminopsis;* see Sollas, 1921], *Parathurammina subvasta, Bisphaera parva, Irregularina tcheslavkaensis, I. intermedia, Tuberitina teplovkaensis, Cornuspira semilukiana, Moravammina fragilis, Litya sizranensis* n. gen., *Pseudoglomospira devonica* n. gen., *Ammovertella angulata, Saccorhina trivirgulina* n. gen., *Nodosaria micra, N. tricostata, Hipporina hastila* n. gen., *Umbella baschkirica, U. grandis, U. patella, U. bella, U. pugatchovensis, U. ollaria, U. ornata, U. famena, U. rotunda, U. saccamminiformis, Pseudopalmula lata, P. fragaria* var. *triangularia, P. subangusta, P. squatina, P. magna, P. karaukensis, P. minima, P. scheda* var. *scapha, P. evlaniensis, P. lanceolata, P. palmuloides* Cushman and Stainbrook var. *crispa, P. lanceolata* var. *semimestria, Semitextularia raja, S. virgulina* var. *hispida, S. sigillaria* var. *voronozhensis, S. sigillaria* var. *undata, S. sigillaria* var. *curta, S. thomasi* Miller and Carmer var. *uchtensis, S. pansa, S. natica, S. notha, S. harenga, S. tomae, Paratextularia sollenia, P. phlebotoma, P. latifolia, P. gibbera, P. quasigibbera,* and *P. arguta.* The following taxonomic changes are also included: *Lituotuba* sp. Bartenstein, 1937 = *Moravammina segmentata* Pokorny; *Hyperammina elegans* Rauser and Reitlinger, 1940 = *Earlandia longa* (Vissarionova); and *Semitextularia thomasi* Miller and Carmer *pars,* 1943 = *S. sigillaria* var. *voronezhensis.* One new family, Parathuramminidae, is erected, and two genera, *Archaesphaera* and *Umbella,* are emended. The genus *Cremsia* = *Paratextularia* Pokorny, 1951 .

15. CAYEUX, M. L., 1894, Sur la présence de restes de Foraminifères dans les terrains précambriens de Bretagne: Acad. Sci., C. R., p. 1433-1435, 6 text-fig., [in French].

["In the pre-Cambrian? quartzites of France, Cayeux has recorded microscopic objects (*Cayeuxina* Galloway) which he has referred to the Foraminifera, although noting that the structure is obliterated and that some of them may be equally well referred to the Radiolaria. The size of the chambers, 0.01 mm. in diameter, is much smaller than the microspheric proloculum of known forms, and there is nothing about the specimens as figured to suggest Foraminifera as much as yeast cells, or many other microscopic objects."; *fide,* Cushman, 1955, p. 47.]

16. CHAPMAN, F., 1900, Foraminifera from an Upper Cambrian horizon in the Malverns; together with a note on some of the earliest-known Foraminifera: Geol. Soc. London, Quart. Jour., v. 56, p. 257-263, pl. 15.

From an Upper Cambrian horizon in the Malverns, England, eight species of Foraminifera, of which one species is new, are described and illustrated by drawings. The new form is *Spirillina groomii.* [Later work (see Wood, 1946) indicates that the Foraminifera described from this horizon are of Jurassic age.]

17. CHAPMAN, F., 1901, On some fossils of Wenlock age from Mulde, near Klinteberg, Gothland: Ann. Mag. Nat. Hist., 7th ser., v. 7, p. 141-160, pl. 3.

From the Silurian rocks near Klinteberg, Gothland, two new species of Foraminifera are described and illustrated by whole-specimen drawings. The new forms are *Hyperammina ramosissima* [obviously misidentified; specimen is a branching adherent form of tolypamminid affinity] and *Stacheia stomatifera.*

18. CHAPMAN, F., 1918, Devonian Foraminifera; Tamworth District, New South Wales: Linnean Soc., Proc., v. 43, p. 385-391, pl. 39-41.

From the Tamworth district, New South Wales, Australia, the author describes and illustrates, with line drawings and thin-section photomicrographs, a fauna of five species, of which three species are regarded as new. The new forms are *Psammosphaera neminghensis, Valvulina oblonga,* and *Pulvinulina bensoni.* [Later work (see Wood, 1957) indicates that the above supposed Foraminifera are oolite grains, more or less affected by dolomitization and by mechanical distortion.]

19. CHAPMAN, F. 1921, On Ostracoda, Foraminifera, and some organisms related to Calcisphaerae from the Devonian of Germany: Roy. Microscopical Soc., Jour., Trans. for 1921, no. 14, p. 329-340, pl. 8.

From limestone fragments of macrofossils from the Middle Devonian of Germany (*Stringocephalus* limestone,) a fauna of six species, of which three species are new, is described and illustrated by rather archaic drawings. The new forms are *Cassidulina devonica, Polymorphina archaica,* and *P. seminis.*

20. CHAPMAN, F., 1923, Report on fossils from an Upper Cambrian horizon at Loyola, near Mansfield, Australia: Geol. Survey Victoria, Bull. 46, p. 34-46, pl. 11-14.

From an Upper Cambrian fossil horizon at Loyola, Australia, one new species of Foraminifera, *Reophax antiquorum,* is described and illustrated by rather poor thin-section photomicrographs.

21. CHAPMAN, F., 1933, Some Palaeozoic fossils from

Victoria: Proc. Roy. Soc. Victoria, v. 45, n.s., pt. 2, art. 17, p. 245-248, pl. 11.

From the Silurian rocks of Australia, two new species of Foraminifera are described and illustrated by rather poor whole-specimen photomicrographs. The new forms are *Hemigordius lilydalensis* and *Trochammina bursaria.*

22. COPELAND, M. J. and KESLING, R. V., 1955, A new occurrence of *Semitextularia thomasi* Miller and Carmer, 1933: Contrib. Mus. Paleontology Univ. of Michigan, v. 12, no. 7, p. 105-112, 1 pl.

The foraminifer *Semitextularia thomasi* Miller and Carmer, 1933, is reported from the Middle Devonian Hamilton group of New York. This marks the first reported occurrence from Middle Devonian rocks of North America. Numerous specimens are illustrated by thin-section photomicrographs. Study of the specimens furnished additional information as to the ontogeny of the species and indicates that the genus *Semitextularia* should be assigned to the subfamily Textulariinae of the family Textulariidae.

23. CRONEIS, C., DUNN, P. H., and HUNTER, D., 1932, Pre-Carboniferous Foraminifera: Science, n.s., v. 75, no. 1935, p. 138-139.

Briefly summarizes the published occurrences of Precarboniferous Foraminifera in North America and lists additional formations from which insoluble residues have yielded arenaceous foraminiferal suites.

24. CUMMINGS, R. H., 1952, *Saccamminopsis* from the Silurian: Proc. Geol. Assoc., v. 63, pt. 3, p. 220-226, 9 text-fig.

The specimens from the Woolhope and Wenlock horizons (Silurian) of England, defined by Brady and others as *Lagena,* are redescribed and identified with *Saccamminopsis fusulinaformis* (M'Coy), already known to exist in the Ordovician rocks of the Girvan area. Comparative line drawings of Brady's *"Lagena"* and *Saccamminopsis* are also included.

25. CUSHMAN, J. A., and STAINBROOK, M. A., 1943, Some Foraminifera from the Devonian of Iowa: Contrib. Cushman Lab. Foram. Research, v. 19, pt. 4, p. 73-79, pl. 13.

From the Upper Devonian Independence shale of Iowa, a fauna of eight species, of which one genus and three species are new, is described and illustrated by whole-specimen photomicrographs. The new forms are *Proteonina pseudospiralis, Textularia? proboscidea* [now the genoholotype of *Paratextularia;* see Pokorny, 1951], and *Pseudopalmula palmuloides* n. gen. [The form identified as *Semitextularia thomasi* Miller and Carmer (Fig. 27) = *S. sigillaria* var. *voronezhensis;* see Bykova and Polenova, 1955.]

26. DAWSON, J. W., 1883, *Saccammina? (Calcisphaera) eriana:* Paleontological Notes, Canadian Nat. Mus., n.s., v. 10, no. 1, p. 5-8, text-fig. 3.

From the Devonian limestone of Kelly's Island, near Sundusky, Ohio, one new species, *Saccammina eriana,* is described and illustrated by drawings. Appended to the article is an excerpt from a letter by Brady dated March 14, 1881, which states: "The more I examine your little fossil the more confident I am that it bears no relation to any rhizopod type that I know."

27. DUNN, P. H., 1933, Microfaunal techniques in the study of older Paleozoics: Illinois State Acad. Sci., Trans., v. 25, no. 4, p. 140-141.

The author strongly recommends and describes in detail the procedures employed in the preparation of dilute hydrochloric acid insoluble residues to obtain arenaceous Foraminifera from older Paleozoic carbonate rocks.

28. DUNN, P. H., 1942, Silurian Foraminifera of the Mississippi Basin: Jour. Paleontology, v. 16, no. 3, p. 317-342, pl. 42-44.

Seventy-nine species of arenaceous Foraminifera are described from hydrochloric acid insoluble residues of the Silurian rocks of the Mississippi Basin. One subfamily, four genera, fifty-seven species, and two varieties are new. The fauna is illustrated by whole-specimen photomicrographs. The new forms are *Pseudastrorhiza irregularis, P. regularis, Bathysiphon parallelus, Psammosphaera arcuata, P. conjunctiva, P. excerpta, P. gigantea, P. minuta, P. subsphaerica* [homonym; new name, *P. compressa, fide* Thalmann, 1950], *Sorosphaera bicella, S. multicella, S. subconfusa, Stegnammina cylindrica* var. *brevis,* Thekammininae new subfamily, *Thekammina quadrangularis* n. gen., *T. moremani, Proteonina jolietensis, P. acuta, P.? ovata* [homonym; new name *P.? devexa, fide* Thalmann, 1950], *Lagenammina bulbosa, L. urniformis, Shidelerella bicuspidata* n. gen., *S. cylindrica, S. elongata, Thurammina coronata, T. echinata, T. foerstei, T. hexagona, T.? hexactinellida, T. inflata, T. jubata, T. limbata,* var. *disciformis, T. magna, T. melleni, T. parvituba, T.? seminaformis, T. slocomi, T. splendens* [homonym; new name *T. elegans, fide* Thalmann, 1950], *T. stelliformis, T. tributa, T. quadrata, T. quadritubulata, Croneisella typa* n. gen., *Ammosphaeroides scotti, Gastroammina williamsae* n. gen., *Colonammina bituba, Tholosina? dubia, Hyperammina sublaevigata, Ammodiscus constrictus, A. brevitubus* [now referred to *Bifurcammina brevitubus* (Dunn); see Bykova, 1956], *A. minutus* [homonym; new name *A. diminutivis, fide* Thalmann, 1950; genus *Ammodiscus* emended to *Involutina;* see Loeblich and Tappan, 1954], *Lituotuba salinensis, L.? furca, L. elongata, Turritellella fischeri, T. workmani, T. osgoodensis,* and *Tolypammina tortuosa.*

29. DUSZYNSKA, S., 1956, Foraminifers from the Middle Devonian of the Holy Cross Mountains: Acta Palaeont. Polonica, v. 1, no. 1, p. 23-34, 2 pl., 3

text-fig., [in English with Polish and Russian summary].

Description is given of three species of Devonian (Givetian) Foraminifera (*Moravammina segmentata* Pokorny, 1951, *Semitextularia thomasi* Miller & Carmer, 1933, and *Textularia? proboscidea* Cushman & Stainbrook, 1945) never before collected in Poland. These specimens represent forms with a wide geographical and stratigraphic range. Identical or similar forms have been found in rocks of Middle and Upper Devonian age in Europe and from the Upper Devonian of North America. The described forms are illustrated by line drawings.

30. DUSZYNSKA, S., 1959, Devonian Foraminifers from Wydryszow (Holy Cross Mountains): Acta Palaeont. Polonica, v. 4, no. 1, p. 71-89, 8 text-fig., [in English with Polish and Russian summary].

From the Devonian rocks (Couvinian) of the Holy Cross Mountains in the Lysogory region of Poland a fauna of seven species, of which four are new, is described and illustrated by whole specimen and thin-section drawings. The new forms are: *Hyperammina couviniana, Ammodiscus similis* [now referred to genus *Involutina;* see Loeblich and Tappan, 1954], *Reophax wydryszowiensis,* and *Pseudopalmula palmuloides.* The fauna is derived from marls. The Foraminifera have a varied wall structure; the wall of *Reophax* is composed of large angular quartz grains cemented by a siliceous matrix. In *Hyperammina* and *Ammodiscus* the siliceous matrix cement consists of very fine-grained quartz grains and treatment in HCl has demonstrated the lack of carbonates. The walls of *Semitextularia* and *Pseudopalmula* are made up of extremely fine carbonate particles and the tests are readily dissolved in HCl.

31. EHRENBERG, C. G., 1858a, Über fortschreitende Erkenntniss massenhafter mikroskopischer Lebensformen in den untersten silurischen Tonschichten bei Petersburg: Monatsberichte der K. Preuss. Akad. der Wissenschaften zu Berlin, p. 303-304, 311, [in German.]

["In 1858 and again in 1862, Ehrenberg referred to the foraminifer genus *Miliola* some small, subspherical, straight, and spirally ribbed, hollow, calcareous fossils from the Lower Devonian shales near Leningrad; these are now generally regarded as doubtful oogonia and are referred to several genera, which are probably related to the modern *Chara.*"; *fide,* Miller and Carmer, 1933, p. 424.]

32. EHRENBERG, C. G., 1858b, Weitere Mittheilungen über andere massenhafte Mikroskopische Lebensformen der ältesten Siluischen Grauwacken-Thone bei Petersburg: Monatsberichte der K. Preuss. Akad. der Wissenschaften zu Berlin: p. 324-337, pl. 1, [in German].

From the Silurian rocks near St. Petersburg (Leningrad), Russia, a fauna of fourteen forms is described and illustrated by drawings. The fauna includes *Vaginulina?, Nodosaria?, Textilaria initiatrix, Polymorphina abavia, P. avia, Guttulina silurica, Rotalia palaeotrias, R. palaeotetras, R. palaeoceros, Dexiospira triarchaea, D. hexarchaea, Aristerospira octachaea, Nonionina archetypus,* and *Spirocerium priscum.* [Both the fauna and the stratigraphy of the region obviously need restudying.]

33. EHRENBERG, C. G., 1862, Über die obersilurischen und devonischen microskopischen Pteropoden, Polythalamien und Crinoiden bei Petersburg in Russland: Monatsberichte der K. Preuss. Akad. der Wissenschaften zu Berlin: p. 599-601, text-fig. 7-11, [in German].

[Essentially the same as the 1858a article.]

34. EISENACK, A., 1932, Neue Mikrofossilien des baltischen Silurs. Pt. 2. Paleont. Zeit., v. 14, p. 257-277, pl. 11, 12, 13, text-fig., [in German.]

From the Silurian rocks of the Baltic region of Europe, a fauna of five species of Foraminifera, of which two genera and four species are new, is described and illustrated by line drawings and whole-specimen photomicrographs. The new forms are *Pseudastrorhiza silurica* n. gen., *Psammosphaera micrograna, Blastammina polymorpha* n. gen., and *B. polyedra.*

35. EISENACK, A., 1937, Neue mikrofossilien des baltischen Silurs, Pt. 4: Paleont. Zeit., v. 19, p. 217-243, pl. 15-16, 22 text-fig., [in German].

From the Silurian rocks of the Baltic region of Europe, a fauna of nine species of Foraminifera, of which four genera and eight species are new is described and illustrated by whole-specimen photomicrographs. The new forms are *Saccammina silurica, S. micrograna* [now referred to the genus *Saccamminopsis;* see Sollas, 1921], *Psammatodendron? glauconiticum, Ordovicina oligostoma* n. gen., *Amphitremoida citroniforma* n. gen., *Chitinodendron bacciferum* n. gen., *C. longicarpus,* and *Xenotheka klinostoma* n. gen.

36. EISENACK, A., 1954, Foraminiferen aus dem baltischen Silur: Senckenbergiana, v. 35, p. 51-72, 5 pl., 1 text-fig., [in German].

From the Silurian rocks of the Baltic region of Europe, a fauna of twenty-four species, of which twelve species and one genus are new, is described and illustrated by line drawings and whole-specimen and thin-section photomicrographs. The new forms are *Astrorhiza erratica, Amphitremoida? pachytheca, Ordovicina monostoma, Archaeochitinia gotlandica* n. gen., *A. hyalina, Psammosphaera rugosa, Blastammina fenestrata, Sorosphaera geometrica, Stegnammina moremani, Thurammina asymmetrica, Hyperammina baltica,* and *Ammolagena silurica.* Discussion and relationship of this fauna to that described from the Silurian rocks of North America are also given.

37. EISENACK, A., 1955, Chitinozoen, Hystrichosphären, und andere Mikrofossilien aus dem *Beyrichia*-Kalk: Senckenbergiana, v. 36, no. 2, p. 157-188, 5 pl., 13 text-fig., [in German].

From the European Silurian *Beyrichia* chalk beds, one previously described species of Foraminifera, *Blastammina polymorpha* Eisenack, 1932, is described and illustrated by whole-specimen and thin-section photomicrographs.

38. EISENACK, A., 1959, Chitinöse Hüllen aus Silur und Jura des Baltikums als Foraminiferen: Paleont. Zeit., v. 33, p. 90-95, pl. 9, 1 text-fig., [in German].

From the Silurian rocks of Gotland and England, one new genus and two new species of chitinoid Foraminifera are described and illustrated by high-power whole-specimen photomicrographs. The new forms are *Archaeochitosa lobosa* n. gen. and *A. clausa*.

39. ELIAS, M. K., 1950, Paleozoic *Ptychocladia* and related Foraminifera: Jour. Paleontology, v. 24, no. 3, p. 287-306, pl. 43-45, 2 text-fig.

Transfers the form *Chabakovia ramosa*, originally described by Vologdin (1939) as a Cambrian alga, to the adnate Foraminifera. The foraminifer is illustrated by a whole-specimen line drawing and a thin-section photomicrograph. The author indicates that the stratigraphic position of the foraminifer is Middle Cambrian of European Russia.

40. FURSENKO, A. V., 1958, The chief stages in foraminiferal evolution; the geologic past: Akad. Nauk Belorussia S.S.R., Inst. Geol. Sci., No. 1, Minsk, p. 10-29, [in Russian].

The author presents a very general résumé of over-all foraminiferal evolution in the U.S.S.R. from Ordovician to Quaternary time. [See Rauser-Chernoussova and Reitlinger (1957) for a more thorough treatment regarding the evolution of Paleozoic Foraminifera.]

41. GRUBBS, D. M., 1939, Fauna of the Niagaran nodules of the Chicago area: Jour. Paleontology, v. 13, no. 6, p. 543-560, pl. 61-62.

From Niagaran (Silurian) siliceous nodules of the Chicago, Illinois region, a fauna of one new genus and seven new species is described and illustrated by whole-specimen photomicrographs. The fauna is derived from dilute acid insoluble residues. The new forms are *Arenosiphon gigantea* n. gen., *Sorosphaera irregularis, Lagenammina cornuta, Thurammina unitubula, T. cylindrica, T. globula,* and *Placopsilina? lineata*.

42. HENBEST, L. G., 1935, *Nanicella,* a new genus of Devonian Foraminifera: Washington Acad. Sci., Jour., v. 25, no. 1, p. 34-35.

Restudy of the type material of *Endothyra gallowayi* Thomas, 1931, indicates that this form belongs to a new genus. The author has proposed the new genus *Nanicella,* inasmuch as it is considerably more advanced than *Endothyra* in regard to the degree of chamber subordination.

43. HOVASSE, M. R., 1956, *Arnoldia antiqua, gen nov., sp. nov.,* Foraminifère probable du Précambrien de la Côte-d'Ivoire: Acad. Sci. Paris, C.R., v. 242, p. 2582-2584, 5 text-fig., [in French].

From Precambrian metamorphic rocks found on the African Ivory Coast, sessile Foraminifera consisting of several chambers in linear arrangement have been described under *Arnoldia antiqua* and illustrated by thin-section photomicrographs. The test is arenaceous with fine grains and amorphous cement; no aperture is apparent. Of 250 measured tests the size ranged from 36-770 microns. [See Cayeux, 1894, for other reported Precambrian Foraminifera; generic name *Arnoldia* preoccupied, see Thalmann, 1959].

44. HOWELL, B. F., 1931, Study of the oldest Foraminifera: Appendix E, Exhibit A, Rept. Natl. Res. Counc. Sub. Comm. Micropaleontology, April 1931, p. 6-7.

Urges micropaleontologists to search for microfossils in the older sedimentary rocks and to continue to investigate published records of Precarboniferous Foraminifera.

Reports that the author in conjunction with Cushman and Sandidge have re-examined Matthew's (1895) so-called Cambrian "Foraminifera" from New Brunswick and have concluded that they are not the remains of protozoans, but are tiny phosphatic concretions.

45. HOWELL, B. F., and DUNN, P. H., 1942, Early Cambrian "Foraminifera"; Jour. Paleontology, v. 16, no. 5, p. 638-639, pl. 91.

Globular objects, believed to be Foraminifera, are described from the Lower Cambrian Ella Island formation of east Greenland. Assigned by Poulsen in 1932 to an unnamed species of *Lagena,* they are here described as the new species *Psammosphaera? greenlandensis*. Similar objects from the Lower Cambrian Forteau formation of Labrador, probably also fossil Foraminifera, are figured but not described or named. The forms are illustrated by whole-specimen photomicrographs.

46. HOWELL, B. F., and SANDIDGE, J. R., 1933, Cambrian Foraminifera: Chapman's species from the Dolgelly beds of England: Wagner Free Inst. Sci. Bull., v. 8, p. 59-62, 2 pl.

Restatement and re-illustration of Chapman's "Cambrian" fossils from the Malvern Hills of England. [Later work (see Wood, 1946) indicates that Chapman's supposed "Cambrian" Foraminifera were derived from a loose rock fragment of Jurassic age.]

47. IRELAND, H. A., 1939, Devonian and Silurian Foraminifera from Oklahoma: Jour. Paleontology, v. 13, no. 2, p. 190-202, 75 text-fig.

From hydrochloric acid insoluble residues of Silurian and Devonian rocks of the Arbuckle Mountains and central Oklahoma, a large fauna is described and illustrated by line drawings. The descriptions include one new genus, twenty-one new species, and three new varieties from the Silurian, and one new genus and six new species from the Devonian. Twenty-six other species were identified and listed, of which seventeen are illustrated. The new forms are *Bathysiphon curvis* var. *gracilis*, *B. rugosus*, *Psammosphaera angularis*, *P. gracilis*, *Psammophax bipartita*, *Stegnammina elongata*, *Ceratammina cornucopia* n. gen., *Saccammina moremani* [now referred to the genus *Saccamminopsis;* see Sollas, 1921], *Lagenammina distorta*, *Thurammina delicata*, *T. globosa*, *T. papillata*, Brady var. *monticulifera*, *T. polygona*, *T. sphaerica*, *T. subpapillata*, *T. transversalis*, *Webbinella bipartita*, *W. coronata*, *W. gibbosa*, *Tholosina sedentata*, *Hyperammina harrisi*, *Ammodiscus abbreviatus*, *A. exsertus* var. *minutus* [emended to genus *Involutina;* see Loeblich and Tappan, 1954], *Glomospira westgatei*, *G. siluriana*, *Lituotuba inflata*, *Psammonyx maxwelli*, *Bifurcammina bifurca* n. gen., *B. conjuncta*, and *B. parallela*.

48. Ireland, H. A., 1958, Microfauna of Wenlockian and Ludlovian Silurian beds in western England (Abstract): Program Annual Meetings, Geol. Soc. America, Nov. 6-8, St. Louis, Mo., p. 88.

From insoluble residues of the Silurian Wenlockian and Ludlovian beds in western England, eight genera (one new) and nineteen species (sixteen new) were identified. Evolutionary changes show ancestral relationships going upward from *Webbinella* to *Wenlockia*, *Saccammina*, *Tholosina*, and *Thurammina*. Related branches lead to *Psammosphaera* and *Psammophax*. The changes are recorded by the character of attachment, development toward detachment, and the changes in apertures and their position on the tests.

49. Keeping, W. A., 1882, On some remains of plants, Foraminifera and annelida, in the Silurian rocks of central Wales: Geol. Mag., n.s., d. 2, v. 9, p. 485-491, pl. 11.

The author briefly discusses the occurrence of three foraminiferal genera from the Silurian rocks of central Wales and illustrates the forms with rather poor line drawings. The illustrated forms are *Rotalia*, *Textularia*, and *Dentalina*. [Re-examination of the "Foraminifera" from Cardiganshire (see Wood, 1949) indicates that the material should be considered as inorganic markings.]

50. Konolipina, O. R., 1959, Upper Devonian Foraminifera of the Oleska-Lvovsk section of the Ukraine: Akad. Nauk Ukrain, R.S.R., Kiev, Inst. Geol. Nauk, Trudy, Ser. Strat. & Paleo., v. 26, 48 pp., 7 pl., [in Russian].

From the Upper Devonian rocks of the Ukraine, a fauna of forty-six species, of which seven are new, is described and illustrated by thin-section photomicrographs. The new forms include: *Irregularina longa*, *I. angulata*, *Tuberitina oleskensis*, *Eonodosaria insignis*, *E. solida*, *Tikhinella aequalis*, and *Umbella radiata*. Taxonomic changes are as follows: *Geinitzina indigena* Bykova, 1952 = *Eogeinitzina indigena* (Bykova); *Tikhinella cannula* Bykova, 1952 = *Paratikhinella cannula* (Bykova); synonomy under *Eonodosaria rauserae* (Tschern.) is confused.

51. Le Maitre, D., 1930, Sur la Présence d'Algues et de Foraminifères du genre *Endothyra* dans des calcaires d'âge dévonien: Des Séances Acad. Sci., C. R., p. 763-765, [in French].

Records the presence of the genus *Endothyra* in Middle Devonian rocks of Asia Minor in what is called "le calcaire de la Zone d'Etroeungt."

52. Le Maitre, D., 1930, Observations sur les Algues et les Foraminifères des calcaires dévoniens: Soc. Géol. du Nord, Annals, v. 55, p. 42-50, pl. 3, [in French].

In thin-sections of Middle Devonian limestone from near Bartin, Turkey, the author recognized the presence of numerous Foraminifera, among which are representatives of *Endothyra*, *Archaediscus*, and *Globigerina?*. Of these, only the first is abundantly represented, and at least two forms of it are present. One plate of thin-section photomicrographs is also included.

53. Le Maitre, D., 1931, Foraminifères des terrains dévoniens de Bartine (Turquie): Soc. Géol. Nord, Annals, v. 56, p. 17-24, pl. 1, [in French].

From thin sections of Middle Devonian limestone from near Bartin, Turkey, five foraminiferal genera are recognized and illustrated by thin-section photomicrograhs. The described genera are *Glomospira*, *Ammovertella?*, *Nodosinella?*, *Hyperammina?*, and Textulariidae (cf. *Climacammina*).

54. Lipina, O. A., 1950, Foraminifera from the Upper Devonian of the Russian Platform: Akad. Nauk. S.S.S.R., Trudy, Geol. Inst. no. 119, p. 110-132, 3 pl., [in Russian].

From the Upper Devonian rocks of the Russian Platform, a fauna of twenty species, of which two genera, thirteen species, and six varieties are new, is described and illustrated by thin-section photomicrographs. The new forms are *Parathurammina spinosa*, *P. tuberculata*, *P. paradagmarae*, *P. suleimanovi* var. *stellata*, *Archaesphaera crassa*, *A. grandis*, *Nanicella tchernyschevae*, *Eogeinitzina devonica* var. *rara* n. gen., *E. alta*, *Eonodosaria evlanensis* var. *longa* n. gen., *E. evlanensis* var. *saratovensis*, *E. stalinogorski* var. *donensis*, *E.? multiformis*, and *Dentalina irregularis* var. *aequalis*.

55. Lipina, O. A., 1955, Foraminifera of the Tournaisian stage and uppermost Devonian of the Volga-Ural region and western slope of the central Urals:

Akad. Nauk S.S.S.R., Trudy, Inst. Geol., no. 163, 96 p., 13 pl., [in Russian].

Primarily concerned with describing lower Carboniferous Foraminifera of the Volga-Ural region of Russia. Mention is made that the uppermost part of the Devonian is sharply divisible into two zones: The *Septatournayella rauserae* n. sp. zone and the zone of frequent *Endothyra communis* Rauser-Chernoussova. Correlation of this unit with a smiliar unit in the Moscow basin is suggested. All forms are illustrated by thin-section photomicrographs.

56. Lipina, O. A., 1959, Occurrence of Foraminifera in the Silurian and Ordovician of Siberia: Akad. Nauk S.S.S.R., Doklady, v. 128, no. 4, p. 823-826, 25 text-fig., [in Russian].

From the Silurian and Ordovician rocks of Siberia a fauna of seven species, of which one genus and four species are new, is described and illustrated by thin-section photomicrographs. The new forms are: *Hyperammina sibirica, Syniella silurica, S. lucida,* and *Eolagena minuta* n. gen.

57. Loeblich, A. R., and Tappan, H., 1954, Emendation of the foraminiferal genera *Ammodiscus* Reuss, 1862, and *Involutina* Terquem, 1862: Wash. Acad. Sci., Jour., v. 44, no. 10, p. 306-310, 2 text-fig.

The genus *Ammodiscus* is found to be a junior synonym of the genus *Spirillina* and hence must be suppressed. The authors emend the genus *Ammodiscus* and state that all those planispiral agglutinated forms commonly referred to as *Ammodiscus* will be henceforth regarded as and placed under the genus *Involutina* Terquem, 1862. The type species of the genus is designated as *Involutina silicea* Terquem, 1862. As *Ammodiscus* is now regarded as *Involutina,* it is removed from the family previously called Ammodiscidae and placed in the family Tolypamminidae Cushman, 1929, subfamily Involutininae Cushman, 1940.

58. Loranger, D. M., 1954, Ireton microfossil zones of central and northeastern Alberta. Western Canada Sedimentary Basin; A Symposium: Ralph Leslie Rutherford Memorial Volume, p. 182-203, 2 pl., 3 text-fig.

Thirty-three of the most commonly occurring species of microfossils in the Ireton shale member of the Woodbend formation, of Upper Devonian age in northeastern and central Alberta, are illustrated and briefly described. The microfauna consists primarily of ostracods; however, two previously described Foraminifera (*Endothyra gallowayi* and *Semitextularia thomasi*) are included and their stratigraphic importance discussed.

59. Matthew, G. F., 1895, The *Protolenus* fauna: New York State Acad. Sci. Trans., v. 14, Foraminifera p. 109-111, pl. 1.

From the Cambrian rocks of the St. John series of New Brunswick, a fauna of eight species, of which seven are new, is briefly described and illustrated by line drawings. The new forms are *Orbulina? ovalis, O. intermedia, O.? ingens* [Cushman (1955) states: "Although there are references to '*Orbulina*' in the literature which would indicate its presence early in the fossil series, those from the Cambrian are certainly erroneous, and it is to be suspected that those from formations before the Tertiary are not truly *Orbulina*."], *Globigerina cambrica, G. grandis, G. didyma,* and *G. turrita.* [Later workers believe that true *Globigerina* did not evolve until Cretaceous time; Croneis, *et. al.* (1932, p. 138) report that the fauna described by Matthew is in reality phosphatic concretions.]

60. Miklukho-Maklai, K. V., 1958, The phylogeny and stratigraphic significance of Paleozoic Lagenidae: Akad. Nauk S.S.S.R., Doklady, v. 122, no. 3, p. 481-484, 1 text-fig., [in Russian].

Briefly outlines the phylogenetic development of the Paleozoic Lagenidae from Ordovician through Late Permian time from the Siberian faunal region; their stratigraphic implications are also discussed. One phylogenetic diagram is included.

61. Miller, A. K., and Carmer, A. M., 1933, Devonian Foraminifera from Iowa: Jour. Paleontology, v. 7, no. 4, p. 423-431, pl. 50, fig. 10-11.

From the Devonian Hackberry formation of Iowa, one new genus and two new species are described and illustrated by whole-specimen photomicrographs. The new forms are *Semitextularia thomasi* n. gen., and *Lituotuba dubia.* A complete discussion of previously reported occurrences of Devonian Foraminifera is also given.

62. Miller, H. W., 1956, The index value of Silurian Foraminifera and some new forms from wells in Kansas: Jour. Paleontology, v. 30, no. 6, p. 1350-1359, 1 text-fig.

Two new species of Foraminifera, *Ammodiscus leei* [emended to genus *Involutina;* see Loeblich and Tappan, 1954] and *Arenosiphon rugosa,* from Kansas are described and illustrated by line drawings; two new forms are described from subsurface samples but not named. The index value of Silurian Foraminifera is restricted to correlation of series because of incomplete knowledge of geographic and stratigraphic range. A chart showing the stratigraphic and geographic range of all species of Silurian Foraminifera described from North America is appended.

63. Moreman, W. L., 1930, Arenaceous Foraminifera from Ordovician and Silurian limestones of Oklahoma: Jour. Paleontology, v. 4, no. 1, p. 42-59, pl. 5-7.

From the Ordovician and Silurian limestones of the Arbuckle Mountain region of Oklahoma, a fauna of three new genera and twenty-seven new species is described and illustrated by whole-specimen photomi-

crographs. The microfauna has been derived from hydrochloric acid insoluble residues. The new forms are *Crithionina rara, Bathysiphon curvus, B. deminutionis, B. exiguus, Psammosphaera cava, Sorosphaera tricella, Stegnammina triangularis* n. gen., *S. cylindrica, S. hebesta* (*sic henbesta*), *Raibosammina mica* n. gen., *R. aspera, Lagenammina sphaerica, L. stilla, Thurammina tubulata, T. subsphaerica, T. irregularia, T. triangularis, T. phasela, T. elliptica, T. arcuata, Tholosina convexa, T. elongata, Colonammina verruca* n. gen., *C. conea, Hyperammina minuta, Ammodiscus? furca* [genus emended to *Involutina;* see Loeblich and Tappan, 1954], and *Lituotuba exserta.*

64. Moreman, W. L., 1933, Arenaceous Foraminifera from the Lower Paleozoic rocks of Oklahoma: Jour. Paleontology, v. 7, no. 4, p. 393-397, pl. 47.

From the Ordovician, Silurian, and Devonian rocks of the Arbuckle Mountain region of Oklahoma, a fauna of one new genus and ten new species is described and illustrated by drawings. The new forms are *Rhabdammina trifurcata, Marsipella aggregata, Saccammina biosculata* [now referred to the genus *Saccamminopsis;* see Sollas, 1921], *Lagenammina cucurbita, Webbinella tholus, W. quadripartita, Hyperammina hastula, Saccorhiza flexiliramosa, Glomospira biplana,* and *Kerionammina favus* n. gen.

65. Pokorny, V., 1951, The Middle Devonian Foraminifera of Celechovice, Czechoslavakia: Vestnik, Kralovske Ceske Spolecnosti Nauk, v. 9 (?), p. 1-29, pl. 1, 17 text-fig.

From the Middle Devonian rocks of Czechoslovakia (red marly coral limestones of the Givetian), a fauna of eight species, of which four genera and five species are new, is described and illustrated by line drawings and whole-specimen photomicrographs. The new forms are *Thurammina minuscula, Kettnerammina givetiana* n. gen., *K.? mesodevonica, Moravammina segmentata* n. gen., *Vasicekia moravica* n. gen., and *Paratextularia* n. gen. The genoholotype of *Paratextularia* is *Textularia? proboscidea* Cushman and Stainbrook, 1943. Moravammininae, a new subfamily of the family Hyperamminidae, is erected. Taxonomic changes include the following: *Lagena* sp. Bartenstein, 1937, and *Hyperammina* sp. Bartenstein, 1937 = *Vasicekia moravica;* and *Lituotuba* sp. Bartenstein, 1937 = *Moravammina segmentata.* Special chapters deal with the ecology and the general character of the faunal association and its relation to the assemblages of other regions.

66. Pokorny, V., 1956, Semitextulariidae, a new family of Foraminifera: Univ. Carolina, Geol. v. 2, no. 3, p. 279-286, [in English with Czech and Russian abstract].

A new family of Foraminifera, the Semitextulariidae, is created for the Middle to Upper Devonian genera *Semitextularia* Miller and Carmer, 1933; *Pseudopalmula* Cushman and Stainbrook, 1943; and *Paratextularia* Pokorny, 1951.

67. Poulson, C., 1932, The Lower Cambrian faunas of east Greenland: Meddelelser om Grønland, v. 87, no. 6, p. 25-26, pl. 4, fig. 11, text-fig. 4 a-e.

From the Lower Cambrian Ella formation of eastern Greenland, globular objects believed to be Foraminifera are assigned to an unnamed species of *Lagena.* The forms are illustrated by line drawings of the apertural openings and one photomicrograph of a group of specimens. [Howell and Dunn (1942) described the above forms as *Psammosphaera? greenlandensis.*]

68. Prantl, F., 1947, On the occurrence of the genus *Psammosiphon* Vine, 1882 in the Devonian of Bohemia: Vestnik, Statniho Geologickeho Ustavu Republiky Ceskoslovenske, v. 22, p. 225-234, 2 pl., [in Czech with Russian and English summary].

From the Devonian rocks of central Bohemia, numerous tests of the genus *Psammosiphon* Vine, 1882, previously thought to be a representative of the Annelida, were studied in detail and are now thought to belong to the group of agglutinated Foraminifera. One new species, *Psammosiphon remesi,* is described and illustrated by whole-specimen and thin-section photomicrographs. [Chapman (1901, p. 143) believes that *Psammosiphon amplexus* Vine, 1882 = *Stacheia amplexa* (Vine).]

69. Rauser-Chernoussova, D. M., and Reitlinger, E. A., 1957, Development of Foraminifera during the Paleozoic and their stratigraphical importance: Akad. Nauk S.S.S.R., Izvest. Ser. Geol. no. 11, p. 103-124, 3 text-fig., [in Russian].

A lucidly written concise essay on the phylogeny of Paleozoic Foraminifera, based upon a complete survey of the world literature. Three excellent phylogenetic diagrams are also included.

70. Reitlinger, E. A., 1948, Cambrian Foraminifera of Yakutsk: Byull. Moskov. Obshchestva Ispytatelei Prirody, Otdel. Geol. 23, no. 2, p. 77-81, 1 pl., [in Russian].

From the Lower Cambrian formations (*Protolenus* zone) of the Yakutsk area, in east-central Siberia, U.S.S.R., four new genera referred to the Foraminifera are described and illustrated by thin-section photomicrographs. The new genera and genotypes are *Obruchevella delicata, O. delicata* var. *elongata, Glomovertella firma, Cavifera concinna,* and *Syniella invenusta.* [Oldest authenticated record of Precarboniferous Foraminifera.]

71. Reitlinger, E. A., 1954, Devonian Foraminifera from some sections of the eastern part of the Russian Platform: Paleontol. Sbornik No. 1, p. 52-81, pl. 17-24, [in Russian].

From the Devonian rocks of the eastern part of the Russian Platform, a fauna of thirty-seven species, of which two genera, twenty species, and one variety are new, is described and illustrated by thin-section photomicrographs. The new forms are *Irregularina lobata, I.? horrida, I. obscura, Lagenammina oviodes, L. piriformis, Cribrosphaera simplex* n. gen., *Vicinesphaera solida, V. parva, V. grandis, Parathurammina paracushmani, P. praetuberculata, P. eodagmarae, Caligella gracilis, Ammodiscus medius* [emended to genus *Involutina;* see Loeblich and Tappan, 1954], *Parathikhinella* n. gen., *Tikhinella bulbacea, Eonodosaria tikinensis, Umbella bykovae* var. *grandis, U. nana, Nanicella ovata,* and *N. evoluta.*

72. Ruedemann, R., and Shrock, R. R., 1939, A new Wisconsin Upper Cambrian Foraminifer: Am. Jour. Sci., v. 237, p. 66-71, 3 text-fig.

A new chitinous and filamentous fossil with dendroid structure is described, from the Franconia sandstone (Upper Cambrian) of Wisconsin. The new form most closely resembles the chitinous Foraminifera and is provisionally assigned to the genus *Chitinodendron* with the specific designation of *C. franconianum.* The specimens are illustrated by line drawings.

73. Schlüter, C., 1879, *Coelotrochium decheni,* eine Foraminifere aus dem Mitteldevon; Zeitschrf. f. Geol. Geschellschf., v. 31, p. 668-675, 4 text-fig., [in German].

["In 1879, Schlüter described some peculiar bulbous structures, 4 or 5 mm in diameter, from the Middle Devonian of Gerolstein, in the Eifel region of Germany, and concluded that they were Foraminifera. He recognized, however, that they were not at all similar or closely related to any Foraminifera known at that time, and he proposed a new generic term for his single species, *Coelotrochium decheni.* Dr. Joseph A. Cushman has recently written us that Mrs. Richter, wife of Dr. Rudolf Richter of the Natural History Museum at Frankfurt, has restudied Schlüter's specimens and has ascertained that they are not Foraminifera."; *fide,* Miller and Carmer, 1933, p. 424.]

74. Schubert, R. J., and Liebus, A., 1902, Vorläufige Mittheilung über Foraminiferen aus dem böhmischen Devon: Verh. Geologischen Reichsanstalt, Jahr. 1902, no. 2, p. 66, [in German].

From the Devonian rocks of Bohemia, representatives of the following genera were reported: *Hyperammina, Saccammina, Reophax, Stacheia, Botellina, Technitella, Thuramina* (*sic Thurammina*), *Storthosphaera,* and *Bulimina.* [Prantl (1947, p. 234) believes that the form referred to as *Thurammina* may possibly be a species of *Psammosiphon.*]

75. Schwalb, H., and Collinson, C., 1956, Specific variations among arenaceous Silurian Foraminifera from Illinois (Abstract): Jour. Paleontology, v. 30, no. 4, p. 1011.

Briefly states that there is much more morphological variation in Silurian foraminiferal suites than previously believed; concludes that this wide range of variation is of little taxonomic value.

76. Smith, J., 1881, Notes on a collection of bivalved Entomostraca and other Microzoa from the Upper Silurian strata of the Shropshire district: Geol. Mag., n.s., d. 2, v. 8, p. 70-75.

In an appendix to the above paper on the microfauna of the Silurian of Shropshire, T. Rupert Jones provisionally listed three varieties of *Lagena vulgaris* Williamson from five localities - var. *laevis* Montagu, var. *clavata* D'Orbigny, and var. *sulcata* Walker and Jacob. [Later work (see Cummings, 1952) indicates that the above varieties of *Lagena* should now be referred to *Saccamminopsis fusulinaformis* (M'Coy).]

77. Smith, J., 1915, Upper Silurian Foraminifera of Gothland: Mag. Nat. Hist., v. 15, 8th ser., p. 301-309, pl. 13.

From the Upper Silurian rocks of Gothland, a fauna of twenty-nine species, of which ten are new, is briefly described and illustrated by line drawings. The new forms are *Hyperammina minutissima, H. rectangula, Webbina gothemensis, Lagena cylindrica, L. gottlandica, L. gutta, L. storavedensis, L. visbeyensis, L. acutangula,* and *Nodosaria siluriana.*

78. Sollas, W. J., 1921, On *Saccammina carteri* Brady, and the minute structure of the foraminiferal shell: Geol. Soc. London, Quart. Jour., v. 77, p. 193-212, pl. 7.

To avoid confusing this form with the living arenaceous genus *Saccammina,* a new genus *Saccamminopsis* is proposed. The petrography of the test wall of *Saccamminopsis* is discussed in detail.

79. Stewart, G. A., and Lampe, L., 1947, Foraminifera from the Middle Devonian bone beds of Ohio: Jour. Paleontology, v. 21, no. 6, p. 529-536, pl. 78-79.

From acetic acid insoluble residues of the Middle Devonian bone bed of Ohio, a fauna of two new genera and thirteen new species is described and illustrated by drawings. The new forms are *Psammosphaera delicatula, P. devonica, P. discoidea, P. rotunda, Sorosphaera columbiense, S. bicelloidea, Sorosphaeroidea polygonia* n. gen., *Webbinelloidea hemospherica* n. gen., *W. similis, W. sola, W. trilocularis, Tholosina? circularis,* and *T.? ovoidea.*

80. Stewart, G. A., and Priddy, R. R., 1941, Arenaceous Foraminifera from the Niagaran rocks of Ohio and Indiana: Jour. Paleontology, v. 15, no. 4, p. 366-375, pl. 54.

From the insoluble residues of the Niagaran rocks (Silurian) of southwestern Ohio and southeastern Indiana, a fauna of twenty-one species, of which ten are new, is described and illustrated by drawings. The new forms are *Rhabdammina geniculata, R. minuta, R. triradiata, Marsipella? torta, Psammosphaera subsphaerica, Sorosphaera osgoodensis, Raibosammina*

irregularis, Saccammina aspera [now referred to the genus *Saccamminopsis;* see Sollas, 1921], *Thurammina crescentrica,* and *Trochammina prima.*

81. SUMMERSON, C. H., 1958, Arenaceous Foraminifera from the Middle Devonian limestones of Ohio: Jour. Paleontology, v. 32, no. 3, p. 544-558, pl. 81-82, 7 text-fig.

From insoluble residues of the Middle Devonian Columbus limestone of Ohio, a fauna of thirty-five species, of which two genera and eighteen species are new, is described and illustrated by whole-specimen photomicrographs. The new forms are *Weikkoella sphaerica* n. gen., *W. bindosa, Psammosphaera aspera, P. elongata, Sorosphaeroidea trichora, S. pentachora, Psammosphax hormiscoides, Webbinella disparicella, Webbinelloidea multicarinata, W. nodosa, W. polyhedra, W. rugosa, Fairliella carmani* n. gen., *F. clitellata, F. dicantha, F. discoidea, F. lameyi,* and *Proteonina helena.* The associated fauna is summarized, and implications of the ecology are suggested, namely, a warm, somewhat shallow marine environment.

82. TERQUEM, M., 1880, Observation sur quelques fossiles des époques primaires: Soc. Géol. de France, Bull., sér. 3, v. 8, p. 414-418, pl. 11, [in French].

["Terquem figured and briefly described a few Foraminifera from the Middle Devonian of Gerolstein and Paffrath, both in the Eifel district of western Germany. A longitudinally ribbed, sub-moniliform specimen found between the costae of an *Atrypa reticularis* from near Gerolstein was described as a new species, *Placopsilina costata.* In the sand filling of a *Megalodon* from Paffrath, Terquem found many small casts apparently representing both Foraminifera and ostracodes, but in general indeterminable. Numerous small spheroids more or less covered with small spines were referred to the genus *Orbulina;* a pyriform body was assigned to *Lagenulina* (a subgenus of Lagena); a cristellarian was compared to *Cristellaria vestuta* of the Jurassic; a fusiform body was regarded as a representative of *Fusulina;* and numerous small, globular bodies consisting of two or three chambers were assigned to *Globigerina.* Terquem's descriptions of these forms are short, some of his identifications are obviously wrong, and it is, of course, not possible to tell from his figures how accurate his observations were. Chapman (1918) has stated that he is 'inclined to think that Terquem's prickly Orbulinae may have more than a fancied relationship to the orbicular radiolarians,' but he has refrained from expressing an opinion in regard to the rest of the identifications except to state that Terquem's paper is an "authentic record of Devonian Foraminifera."; *fide,* Miller and Carmer, 1933, pp. 424-425.]

83. THALMANN, H. E., 1950, New names and homonyms in Foraminifera: Contrib. Cushman Found. Foram. Research, v. 1, pt. 3, 4, p. 41-45.

Twenty-four new names replacing homonyms, of which only four are of Paleozoic Foraminifera, are recorded. The new names are *Ammodiscus diminutivis* Dunn, n. name for *A. minutus* Dunn, 1942 [*Ammodiscus* emended to genus *Involutina;* see Loeblich and Tappan, 1954]; *Proteonina? devexa* Dunn, n. name for *P.? ovata* Dunn, 1942; *Psammosphaera compressa* Dunn, n. name for *P. subsphaerica* Dunn, 1942; and *Thurammina elegans* Dunn, n. name for *T. splendens* Dunn, 1942.

84. THALMANN, H. E., 1959, Foraminiferal homonyms: Contrib. Cushman Found. Foram. Research, v. 10, pt. 4, p. 127-129.

Arnoldia Hovasse, 1956, preoccupied by *Arnoldia* Mayer, 1887, Beitr. Geol. Karte d. Schweiz, v. 24, p. 27 (Mollusca), by *Arnoldia* Kieffer, 1895 (Diptera), and by *Arnoldia* Wlassenko, 1931 (Vermes); in a letter dated 1/19/59 Hovasse indicates that *Arnoldia* will be changed to *Birrimarnoldia.*

Lagena tuberosa Bykova, 1956, preoccupied by *Lagena tuberosa* Matthes, 1939, Palaeontogr. v. 90, p. 61, pl. 4, fig. 22, Middle Oligocene, Germany. *Lagena ventricosa* preoccupied by *Lagena ventricosa* Silvestri, 1903, Atti, Accad. R. Sci. Torino, v. 39, p. 10, pl. 4.

85. THOMAS, A. O., 1921, Small fossils from the Lime Creek shales: Geol. Soc. America, Bull., v. 32, p. 13-131.

The author states that he had found in screenings from the Upper Devonian Lime Creek (Hackberry) shales of Iowa an abundant rotaline foraminifer, a few specimens referable to the genera *Lagena* and *Saccammina* and a *Globigerina*-like species. In 1929, he referred the rotaline form to the genus *Endothyra,* and in a later paper described the species in detail (Thomas, 1931) and called it *E. gallowayi.* ["Since in these two later papers he did not mention the forms that he had earlier referred to *Lagena* and *Saccammina,* nor those he had compared with *Globigerina,* it is logical to conclude that he had recognized that they were not Foraminifera. We have had access to the material studied by him, and insofar as we are able to ascertain, the specimens that were referred to *Lagena* are internal molds of spirally marked subspherical bodies at present generally regarded as doubtful oogonia belonging to some genus related to the modern *Chara,* and therefore tentatively referred to the Charophyta. The specimens that were assigned to *Saccammina* are bryozoans, but we have not been able to locate the specimens that were compared with *Globigerina.*"; *fide,* Miller and Carmer, 1933, pp. 426-427.]

86. THOMAS, A. O., 1929, Foraminifera in the Iowa Devonian: Iowa Acad. Sci., Proc., v. 36, p. 279-280.

Briefly states that the fossils found in the shales from the Cerro Gordo member of the Upper Devonian of Floyd County, Iowa, are referrable to the genus *Endothyra.*

87. THOMAS, A. O., 1931, Late Devonian Foraminifera from Iowa: Jour. Paleontology, v. 5, no. 1, p. 40-41, pl. 7.

From the late Devonian Lime Creek beds of Iowa, one new species of Foraminifera, *Endothyra gallowayi*, is described and illustrated by whole-specimen and thin-section photomicrographs. [Later study (Henbest, 1935) indicates that this form belongs to the new genus *Nanicella*.]

88. VINE, G. R., 1882, Notes on the Annelida Tubicola of the Wenlock shales from the washings of George Maw: Geol. Soc. London, Quart. Jour., v. 38, p. 377-393, pl. 15.

After extensive work by Prantl (1947), the genus *Psammosiphon*, originally described by Vine as a worm tube, is now placed under the Foraminifera. Two new species, *Psammosiphon elongatus* and *P. amplexus*, are described in detail, and one line drawing is given.

89. VOLOGDIN, A. G., 1939, Middle Cambrian Archaeocyatha and algae from the south Urals: Problems of Paleontology, v. 5, p. 209-276, 12 pl., 12 text-fig., [in Russian with English summary].

Describes from the Middle Cambrian rocks of the southern Ural Mountains of Russia a supposed alga, which is illustrated by whole-specimen drawings and thin-section photomicrographs. [Later work, see Elias, 1950, indicates that this form is more correctly placed under the adnate Foraminifera.]

90. VOLOGDIN, A. G., 1958, The Lower Cambrian Foraminifera of Tuva: Akad. Nauk S.S.S.R., Doklady, v. 120, no. 2, p. 405-408, 22 text-fig., [in Russian].

From the Lower Cambrian archaeocyathid limestones of Tuva, in the asiatic portion of the U.S.S.R., a fauna of nine genera and fourteen species of Foraminifera of which seven genera and twelve species are new is described and illustrated by thin-section drawings made at high power (plus 200×). Associated with the archaeocyathids and Foraminifera were green and red algae. One new order of Foraminifera, Reitlingerellida, was erected to include the following genera: *Obruchevella* Reitlinger, 1948; *Glomovertella* Reitlinger, 1948; *Cavifera* Reitlinger, 1948; *Syniella* Reitlinger, 1948; *Tuvaellina* Vologdin new genus; *Lukaschevella* Vologdin new genus; *Lebedevaella* Vologdin new genus; and *Reitlingerella* Vologdin new genus. The new species described are as follows: *Tuvaellina prima, T. longiuscula, T. composita, Bostrychosaria bistorta, B. cavitata, Flexurella obvoluta, F. discoidea, Kordeella campylodroma, Lukaschevella spiralis, L. tannuolaica, Lebedevaella involventis,* and *Reitlingerella densa.*

91. WALCOTT, C. D., 1905, Cambrian faunas of China: U. S. Nat. Mus., Proc., v. 29, no. 1415, p. 10; specimen figures in Walcott, C. D., 1913, Carnegie Inst., v. 3, no. 54, pl. 1, fig. 1.

From a Cambrian limestone in China, a single specimen of what has been referred to the Foraminifera *Globigerina? mantoensis* is briefly described and illustrated by one drawing. [Material needs to be restudied to ascertain true foraminiferal relationship.]

92. WOOD, A., 1946, The supposed Cambrian Foraminifera from the Malverns: Quart. Jour. Geol. Soc. London, v. 102, pt. 4, p. 447-460, pl. 26-28, 1 text-fig.

The Foraminifera described by Chapman (1900) from a calcareous band in the White Leaved Oak shales (Upper Cambrian) are shown by the author to have been derived from a loose fragment of Early Jurassic age. As "the earliest-known well-preserved Foraminifera," these have had a great influence on the classification of the group, and the views of certain authors as to the evolutionary sequence of foraminiferal types will have to be completely revised. The genera *Lagena, Nodosaria, Dentalina, Cristellaria, Spirillina,* and *Marginulina,* previously considered to range unchanged from Cambrian to Recent, probably range from Mesozoic only. The isolation of Paleozoic Foraminifera becomes now much more marked, and the incoming of Mesozoic types must have been relatively rapid.

93. WOOD, A., 1948, "*Sphaerocodium*," a misinterpreted fossil from the Wenlock limestone: Proc. Geol. Assoc., v. 58, p. 9-22, pl. 2-5.

From the Silurian Wenlock and Woolhope limestones of England and the Baltic region, one new genus and species, *Wetheredella silurica,* previously thought to be an alga, is described and illustrated by fine thin-section photomicrographs. The new form is of the encrusting type and is unique, in that it is an unchambered, branching, and perforate form.

94. WOOD, A., 1949, The supposed Silurian Foraminifera from Cardiganshire: Proc. Geol. Assoc., v. 60, pt. 3, p. 226-228, pl. 8.

Material from the Silurian rocks of Cardiganshire, described by Blake (1876) and Keeping (1881) as containing Foraminifera, have been re-examined, and the supposed Foraminifera are considered to be inorganic markings.

95. WOOD, A., 1957, The "Devonian Foraminifera" from Tamworth, New South Wales: Nat. Mus. Australia, Mem., no. 22, pt. 5, p. 1-4, pl. 1.

Re-examination of the "Devonian Foraminifera" reported by Chapman (1918) has shown that the supposed Foraminifera are oolite grains that are more or less affected by dolomitization and mechanical distortion.

96. YABE, H., and HANZAWA, S., 1935, Foraminifera? remains from Ordovician limestone of Manchuria: Imperial Acad. Japan, Proc., v. 11, no. 17, p. 55-57, 3 text-fig.

From the Ordovician Ssu-yen formation of

Manchuria, spherical bodies questionably referred to the Foraminifera are described and illustrated by whole-specimen and thin-section photomicrographs. The spherical bodies form prominent relief on the weathered surface of the rock; these closely resemble tests of the arenaceous Foraminifera, such as *Psammosphaera,* because of their thin, apparently arenaceous test and undivided interior. However, petrographic examination of the "test" wall shows that it consists of a film of dolomite crystals instead of other mineral grains such as quartz.

DISTRIBUTION OF ARTICLES ACCORDING TO GEOLOGIC AGE AND CATEGORY

PRECAMBRIAN
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CAMBRIAN
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ORDOVICIAN
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1, 10, 12, 17, 21, 24, 28, 32, 34, 35, 36, 37, 38, 41, 47, 48, 56, 62, 63, 64, 75, 76, 77, 80, 88, 93

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2, 4, 5, 6, 8, 11, 14, 19, 22, 25, 29, 30, 42, 47, 50, 51, 52, 53, 54, 55, 58, 61, 64, 65, 66, 68, 71, 74, 79, 81, 82, 86, 87

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
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221. INTERTIDAL FORAMINIFERA OF THE CALIFORNIA AND OREGON COAST

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ABSTRACT

A total of 51 beach and tidepool samples was taken along the coast of California and Oregon, a distance of approximately 1105 statute miles. Over 120 species representing 57 genera were collected. All three test types (arenaceous, porcellaneous and hyaline) are present. By the use of percentage of population methods it was possible to recognize characteristic living provincial and cosmopolitan faunas within this area. Living present-day benthonic species predominated in the area of study with fossil and planktonic species occurring in only insignificant numbers. The area studied is a coast of upwelling but no deep water Foraminifera were collected. There is an increase from north to south in the number of genera and number of species with a resultant increase in the variety of the faunas. There is no corresponding increase in the number of individuals or total population.

INTRODUCTION

This study was undertaken to determine the characteristic foraminiferal assemblages occurring in the littoral zone of the open coast of California and Oregon. The coastwise extent of these assemblages and, if possible, the factors controlling or influencing their distribution were also to be determined.

The intertidal region as used in this paper is that part of the coast situated between low and high tide levels and consists of beaches and rocky shores. Lagoons and marshes were excluded from this study because they represent special and local ecologic conditions and do not reflect the faunal distribution along an open coast.

The samples were collected by the author over a period of four weeks in the late summer of 1955. This period of four weeks is believed to be short enough to meet biological oceanographic requirements of uniformity of conditions.

The writer is indebted to the Allan Hancock Foundation for the use of laboratory and library facilities. Thanks are also due to Mr. Joseph L. Reid, Jr. of Scripps Institution of Oceanography for aid in locating certain oceanographic data and to Dr. Kenneth O. Emery and Dr. William H. Easton for their helpful criticism of the manuscript. The writer is especially grateful to Dr. Orville L. Bandy for suggesting the study, examining the Foraminifera and for his helpful suggestions and encouragement toward the completion of this project.

Location

The area studied along the coastline of the North Pacific Ocean extends from latitude 32° 32′ N. at the southern end of California to latitude 46° 10′ N. at the northern boundary of Oregon at the Columbia River (text fig. 1). This distance represents 13° 38′ of latitude and an approximate straight line distance along the coast of 1105 statute miles.

The coastal area, in general, is readily accessible by major highways and secondary roads; however, some parts are inaccessible due to the ruggedness of the terrain and in some instances because of fencing of large areas by property owners.

Nature of Intertidal Region

Beaches and rocky shores, the two basic parts of the intertidal region, border on the open ocean along the coast under study.

Beaches were found to be of all types, from pebbly to coarse sand and of steep slope to beaches of fine sand and of very gentle slope.

Rocky shores have high water level platforms or storm terraces as described by Edwards (1941) and here tidepools are found in abundance. Tidepools from which Foraminifera were collected range from 6 inches to 2 or 3 feet in depth and from several square feet to over 100 square feet in area. All the tidepools are accessible to the sea and are flooded during periods of high tide. The water in the tidepools is therefore typically marine except for increases in salinity due to evaporation, or dilution by rainfall and seepage from ground-water. Chemical changes may also occur due to plant and animal life during periods of low tide at night (Emery, 1946).

Previous Work

On the Pacific coast area, much work of a biological nature has been done by E. H. Myers (1935, 1942, 1943). There are also several papers of this nature by Lois Martin (1930-1931, 1932). However, with the exception of Natland (1953), it was not until Crouch (1952) and Bandy (1953a, b) published on foraminiferal ecology off California that much in the way of foraminiferal ecologic studies was undertaken in the Pacific coast area. Prior to this time, it is true, papers were published on Foraminifera in the Pacific coast area, both fossil and Recent; however, most of these papers were, in the final analysis, taxonomic with little or no ecology involved. Walton (1955), McGlasson (1959) and Zalesny (1959) touched on near-shore or intertidal Foraminifera in their studies and Reiter (1959) dealt entirely with Foraminifera from the in-

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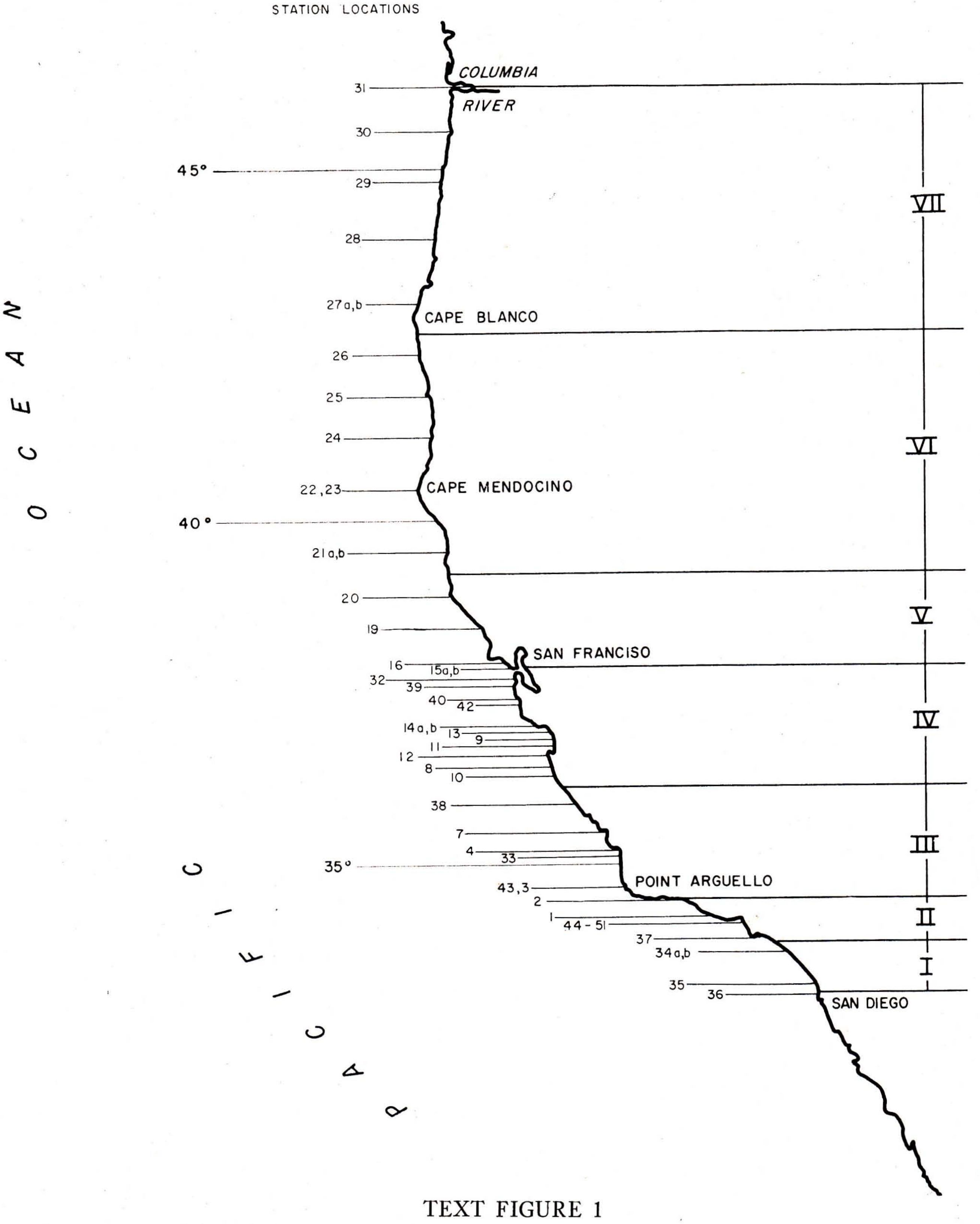


TEXT FIGURE 1
California-Oregon coast showing sample locations and coastal segments

tertidal region. Reiter's study was of a local area and of the faunal variations due to seasonal changes within this area. Watkins (1959) reported on the shelf Foraminifera and touched on the near-shore and intertidal Foraminifera of part of the Orange County coast of southern California.

METHODS

It was attempted, in the collection of beach samples, to space the collecting stations about fifty miles apart. This spacing of samples was believed to be adequate to obtain a representative sampling. This fifty mile spacing, of necessity, had to be adjusted depending on the accessibility and occurrence of beaches. No effort was made to be selective as to the nature of the beach from which samples were collected. Beach samples were collected from beaches composed of fine-grained sand on low slopes to those composed of coarse-grained sand or pebbles on steep slopes.

Tidepool samples were collected where tidepools were present and accessible. An attempt also was made

Table 1

Sample Locations

Station Number	N. Latitude	W. Longitude	Type
36	32°50′42″	117°16′44″	Tidepool
35	33°02′45″	117°17′49″	Beach
34a	33°32′42″	117°47′59″	Tidepool
34b	33°32′47″	117°48′05″	Beach
37	33°42′40″	118°18′09″	Tidepool
44	33°59′35″	118°28′49″	Beach
45	34°00′18″	118°29′28″	Beach
46	34°00′58″	118°30′13″	Beach
47	34°01′37″	118°31′08″	Beach
48	34°01′58″	118°31′45″	Beach
49	34°02′14″	118°33′12″	Beach
50	34°02′13″	118°34′53″	Beach
51	34°02′17″	118°35′45″	Beach
1	34°05′12″	119°03′39″	Beach
2	34°28′15″	120°30′36″	Tidepool
3	34°36′31″	120°38′10″	Tidepool
43	34°36′42″	120°38′07″	Beach
33	35°06′23″	120°38′02″	Beach
4	35°09′10″	120°40′06″	Tidepool
7	35°26′51″	120°54′24″	Tidepool
38	35°53′31″	121°27′38″	Beach
10	36°25′07″	121°54′52″	Beach
8	36°29′00″	121°56′08″	Tidepool
12	36°37′24″	121°56′26″	Tidepool
11	36°36′08″	121°52′41″	Beach
9	36°40′02″	121°47′35″	Beach
13	36°58′20″	121°49′48″	Beach
14b	37°01′19″	122°12′54″	Tidepool
14a	37°01′29″	122°13′03″	Tidepool
42	37°25′46″	122°26′14″	Beach
40	37°30′05″	122°29′35″	Beach
39	37°38′07″	122°29′38″	Beach
32	37°43′54″	122°30′22″	Beach
15b	37°51′33″	122°34′32″	Beach
15a	37°51′33″	122°34′48″	Tidepool
16	37°53′48″	122°38′15″	Beach
19	38°26′59″	123°07′31″	Beach
20	38°56′40″	123°43′53″	Tidepool
21a	39°38′38″	123°47′02″	Tidepool
21b	39°38′38″	123°47′02″	Beach
23	40°24′07″	124°22′53″	Beach
22	40°24′17″	124°23′15″	Tidepool
24	41°13′35″	124°06′34″	Beach
25	41°35′36″	124°13′18″	Beach
26	42°25′14″	124°25′31″	Beach
27a	43°06′50″	124°26′14″	Tidepool
27b	43°06′50″	124°26′14″	Beach
28	44°02′12″	124°07′59″	Beach
29	44°48′40″	124°03′40″	Tidepool
30	45°35′56″	123°57′04″	Beach
31	46°10′54″	123°59′11″	Beach

to maintain a fifty-mile spacing between tidepools; however, this was not always possible. In a few instances both beach and tidepool samples were collected within one or two hundred yards of each other.

The location of all samples by latitude and longitude and the type of samples, whether tidepool or beach, are listed in Table 1, and are plotted on the location map in text figure 1.

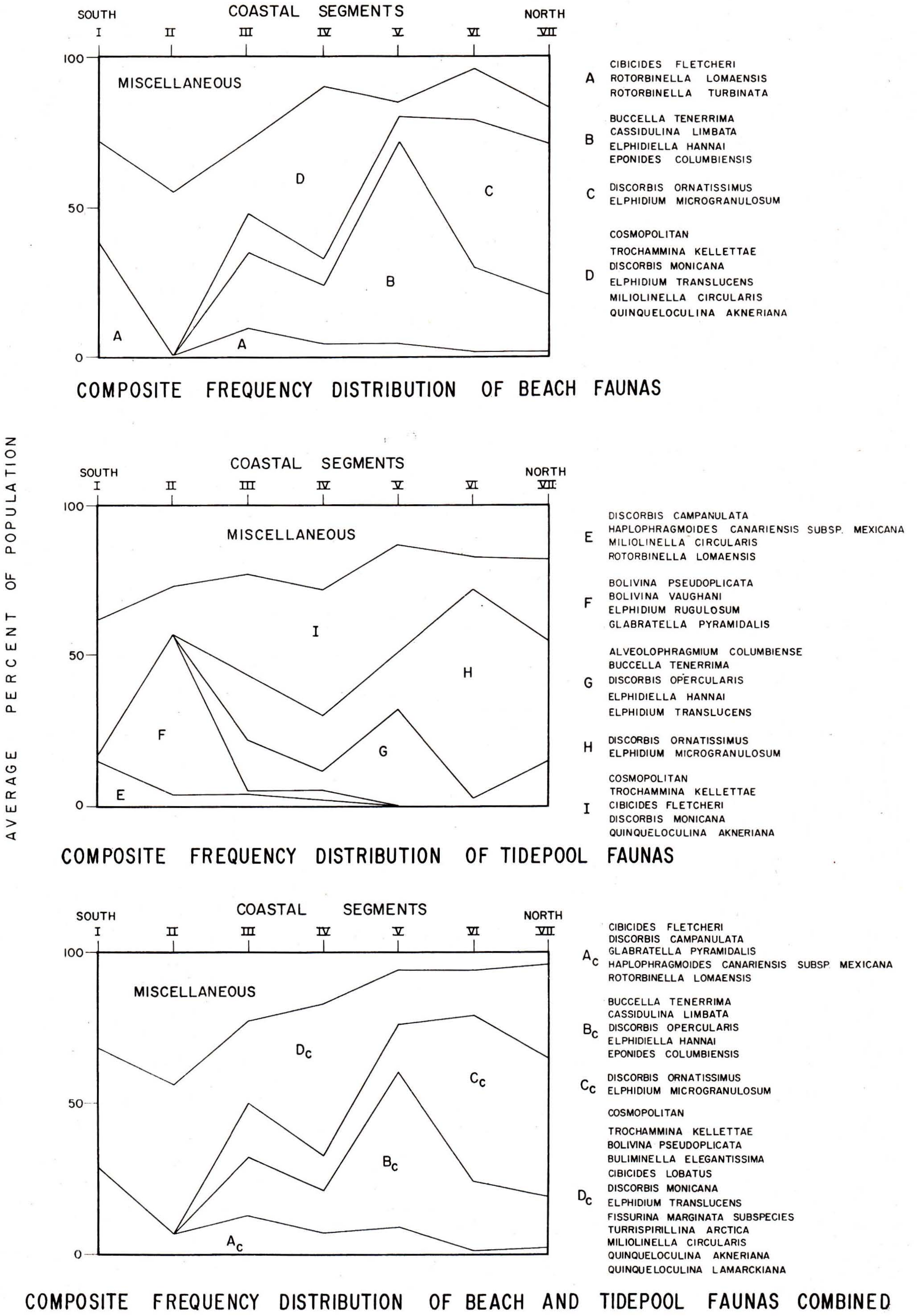
Beach samples were collected by scooping up the top one-fourth inch of sand along the swash mark of the last wave. This process was continued until one quart of sediment had been gathered. The sample was then preserved in isopropyl alcohol and sealed until returned to the laboratory.

Tidepool samples were collected somewhat differently and because of their nature are not therefore as consistently quantitative as the beach samples. When occurring in sufficient quantity a quart of algae from each tidepool was placed in a jar and preserved with isopropyl alcohol. In some tidepools a small amount of sediment was found to have settled in the bottom and when possible this sediment was also collected. At station number 22 at Devil's Gate, just south of Cape Mendocino, a thin but noticeable coating of sediment covered the upper surfaces of the algae. This condition may have been present in other tidepool samples but went unnoticed because of the color and shape of the algae present.

All samples were treated with rose Bengal, a protoplasmic stain, in order to determine which of the Foraminifera were living at the time of collection. The staining method was modified slightly from that developed by Walton (1952). A small amount of rose Bengal solution was added to the collected sample on return to the laboratory and the sample was then allowed to stand until washed. The solution was made of two grams of rose Bengal to one liter of distilled water. The more concentrated solution was used, rather than the one gram solution used by Walton, in order to allow for dilution by the fluid in which the sample was preserved.

The stained samples were washed on a 250 mesh Tyler screen (with mesh openings of 0.061-mm.) to remove all excess rose Bengal stain and fine sediment. After washing, the sand or beach samples were dried and the Foraminifera separated from the sand by the flotation method, using carbon tetrachloride. The algal samples from the tidepools were gently agitated or scrubbed in order to remove the attached foraminiferal tests and care was taken to break up the calcareous algae as little as possible as they are very difficult to segregate from foraminiferal tests by the separation methods employed. In tidepool samples, after the washed algae had been discarded, the residue on the screen was dried and the foraminiferal tests in most cases were then picked individually.

The author found that with the use of rose Bengal as outlined above the identification of living and dead



TEXT FIGURE 2

Composite frequency distribution of characteristic faunas by coastal segments individuals at the time of collection was fairly certain. The protoplasm of the living Foraminifera was stained a bright rose or red color which was apparent within the test and not as a pink or reddish coating on the exterior surface. The stained protoplasm would appear either as a solid mass or sometimes as several smaller masses in separate chambers of the test, probably because the alcohol caused the protoplasm to shrink. The bright rose color was seen easily in those Foraminifera with clear hyaline tests, less easily seen and more pinkish in the forms having heavier, thicker tests, and not readily apparent in the dry tests of the porcellaneous types. However, when a stained and therefore living miliolid was moistened with water, the staining of the protoplasm was seen readily through the test.

The total population was counted in most samples, both tidepool and beach; however, in five beach samples and four tidepool samples, the population was large enough to require the sample to be split into a smaller fraction. The number of individuals counted by this method was in excess of 400 and was representative of the whole sample. In order to record the total population, the entire sample of those split for counting was examined for species of rare occurrence. All population counts have been translated into percentages and the percentage method is used for presentation of results (Table 2).

FORAMINIFERA

General Remarks

Foraminifera of the three test types, arenaceous (agglutinated), porcellaneous and hyaline were collected throughout the traverse and are represented by a total of 57 genera and over 120 species (Table 2). The number of individual Foraminifera in one quart of sand collected from beaches ranged from 3 to over 102,000 (calculated) and in the tidepool samples the number of individuals ranged from 65 to over 122,000 (calculated). In the plotting of the percentage figures, the totals of the beach samples for stations 44 through 51 were averaged, as these represent a series of samples in Santa Monica Bay which are relatively close together and should be averaged if they are to have a proper relation to the more widely spaced stations along the rest of the coastline.

Benthonic forms comprised by far the larger percentage of the total population with the planktonic forms making up only a small percentage (text fig. 3). This relationship holds true for both the beach and tidepool faunas. In actual numbers of individuals there were more planktonic Foraminifera in the tidepool samples than in the beach samples and percentage-wise the planktonic forms were slightly more numerous in the south than in the north; however, in the over-all picture the number of planktonic Foraminifera is almost insignificant. The planktonic Foraminifera were all of the genus *Globigerina* with the exception of several individuals of *Tretomphalus myersi*, of which the benthonic form is generally referred to *Discorbis*.

The occurrences of the three test types of benthonic Foraminifera expressed as percentage of total population are plotted for beach samples and for tidepool samples (text fig. 3).

In the ecological environments of both tidepools and beaches, the hyaline tests predominated in general over the other two types of tests; however, in several areas in the beach zone faunas along the coast, arenaceous Foraminifera predominate due almost entirely to the presence of the one species *Trochammina kellettae*.

The proportion or percentage of population with hyaline tests in the tidepool faunas increases moderately from south to north with a parallel or corresponding decrease in the proportions of porcellaneous and arenaceous species. A similar situation occurs in the beach faunas; however, this change is not very irregular and the increase in the percentage of hyaline forms is at the expense of the arenaceous species because the percentage of porcellaneous individuals is relatively insignificant in the beach assemblages.

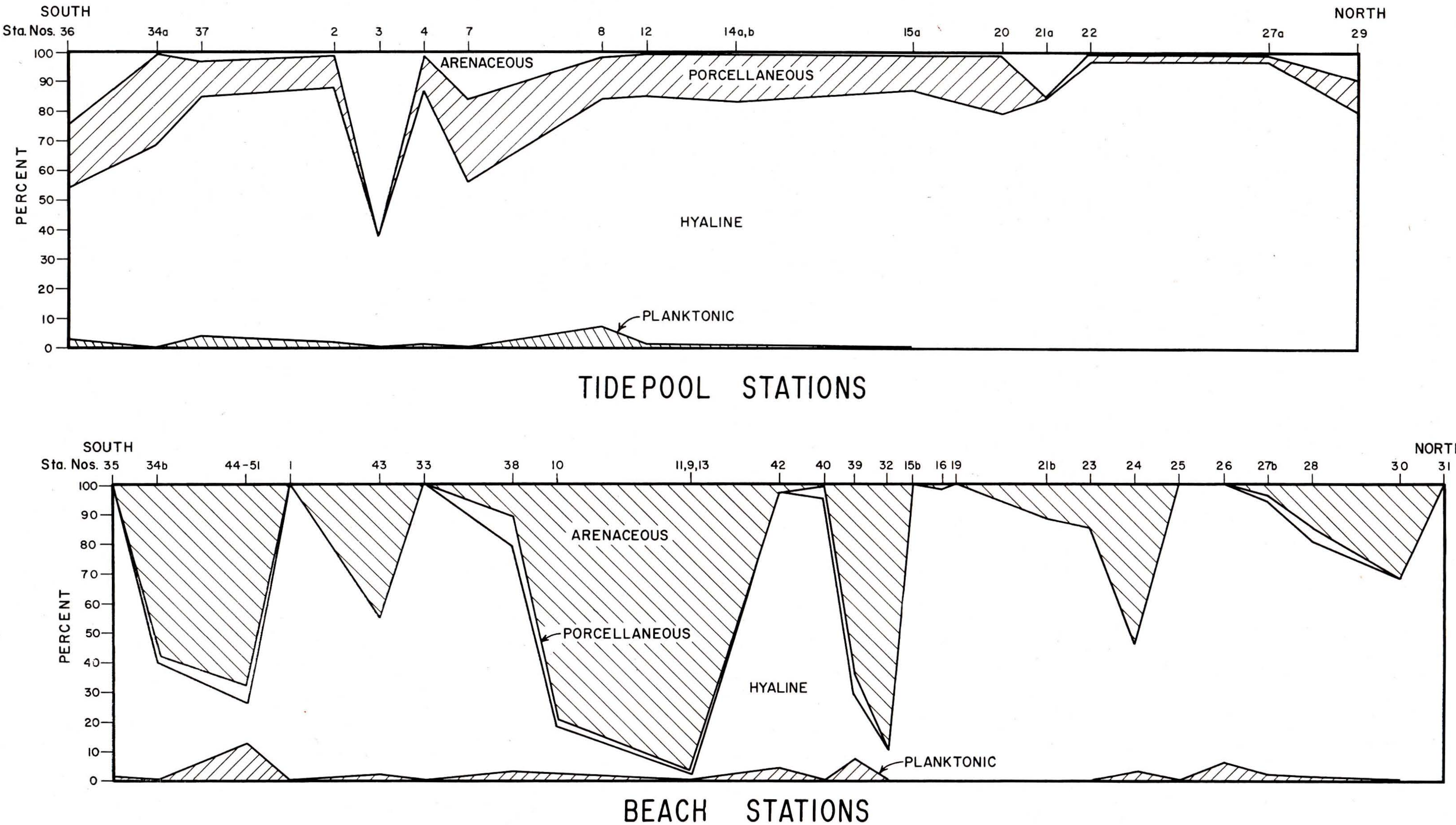
Fossil Foraminifera

Of the more than 120 species collected, 64 were represented by one or more individuals living at the time of collection. Of the remainder, 22 species were fossil and for the most part are not known to be living today. These fossil Foraminifera are listed below:

Anomalina californiensis
Bolivina decurtata
Bulimina subacuminata
Buliminella curta
Cibicides mckannai
Epistominella gyroidinaformis
Epistominella spp. (damaged)
Glomospira sp. (damaged)
Guembelina sp.
Gyroidina reliziana
Pullenia miocenica
Siphogenerina sp. (damaged)
Siphonodosaria sp.
Uvigerina modeloensis
Uvigerina proboscidea
Uvigerinella californica
Uvigerinella californica subsp. *perparva*
Uvigerinella obesa
Valvulineria californica subsp. *obesa*
Valvulineria miocenica
Virgulina bramletti
Virgulina sp. (internal cast)

All these fossil species with the exception of *Bulimina subacuminata* and *Cibicides mckannai* are Miocene species. They occurred mostly from Pismo Beach southward and are attributable to the Miocene strata bordering the coast in this region. A few Miocene forms were collected in the Monterey Bay area which is also a region of Miocene strata.

Cibicides mckannai is common in the Pliocene sediments of southern California which border on the region where it was collected at Laguna Beach and to the south. The one individual of *Bulimina subacuminata* from the Oregon coast is probably from the Pliocene sediments in that area.



PERCENTAGE DISTRIBUTION OF TEST TYPES AND PERCENTAGE OF TOTAL POPULATION OF PLANKTONIC FORAMINIFERA

TEXT-FIGURE 3

Number of Genera and Species

The number of genera and species for each collecting station in the area studied are plotted in order from north to south in text figure 4. There is a rough relationship between the number of genera and number of species since an increase in one results in a similar increase in the other.

Both the tidepool and beach traverses can be divided into two corresponding divisions. This division takes place in the general area of San Francisco and is shown by the fact that north from station 15, in both faunas, there is generally a small number of genera and species. South of San Francisco, or station 15, the number of genera and species is generally higher; this is more apparent in the tidepool section than the beach section. The increase in the number of genera and number of species in the beach section occurs in two areas south of San Francisco (stations 43, 33 and 38, and stations 42 and 40).

Living Foraminifera

As shown in text figure 1, the coastline was divided into coastal segments, I to VII, comprised of groups of collecting stations. From these segments it was possible to compute the average percentage of population for the characteristic Foraminifera for each coastal segment and to arrive at characteristic faunas for beach and tidepool environments of the entire coast. The breaking down of the coastline into coastal segments, the determination of their limits, and the selection of the characteristic species and their faunas was all done by inspection and trial and error methods. Tables 3 and 4 show, in tabular form, the characteristic species and their faunal distribution expressed in percentage of total population for beach faunas and tidepool faunas, respectively. Text figure 2 represents these data graphically.

All the species listed in Tables 3 and 4 were found living with the exception of *Elphidium translucens*, which was assumed to be living in the area because of its widespread occurrence in constant though not large numbers.

Beach Faunas

Three separate faunas (A, B and C) characterize the beach areas from south to north and are partially masked by a group of cosmopolitan species (D) which are always present (Table 3). Intermingled with the three characteristic beach faunas there also occurs a group of miscellaneous species, many in number but which do not occur in significant quantities and are sporadic in occurrence.

Fauna A, which is the characteristic southern fauna, is dominated by three species, *Cibicides fletcheri*, *Rotorbinella lomaensis* and *Rotorbinella turbinata*. This fauna predominates in segment I and persists through the northern areas as a minor or secondary feature through the presence of *Cibicides fletcheri* and to a lesser degree *Rotorbinella lomaensis*.

Table 3

Characteristic Beach Faunas

Fauna	Species	Coastal Segments I	II	III	IV	V	VI	VII
(Provincial)								
A	*Cibicides fletcheri*	24	1	5	4	4	2	2
A	*Rotorbinella lomaensis*	13	0	5	1	1	—	—
A	*Rotorbinella turbinata*	2	—	—	—	—	—	—
B	*Buccella tenerrima*	—	—	8	3	13	3	7
B	*Cassidulina limbata*	—	—	13	5	2	3	1
B	*Elphidiella hannai*	—	—	4	9	48	19	11
B	*Eponides columbiensis*	—	—	—	2	4	3	—
C	*Discorbis ornatissimus*	—	—	x	x	7	15	3
C	*Elphidium microgranulosum*	—	x	13	9	6	34	47
(Cosmopolitan)								
D	*Trochammina kellettae*	29	48	18	54	x	16	11
D	*Discorbis monicana*	1	3	5	2	x	x	x
D	*Elphidium translucens*	3	2	1	1	5	1	1
D	*Miliolinella circularis*	—	1	—	x	—	—	x
D	*Quinqueloculina akneriana*	x	x	x	—	x	—	x

Numbers denote average percentage of population per segment.
x represents less than 1 per cent.

Fauna B, which consists of *Buccella tenerrima*, *Cassidulina limbata*, *Elphidiella hannai* and *Eponides columbiensis*, dominates the central portion of the coastline studied. The areal extent of this fauna extends from Gaviota, immediately south and east of Point Conception, northward to the Columbia River, reaching its dominance in segment V which extends from San Francisco to Point Arena.

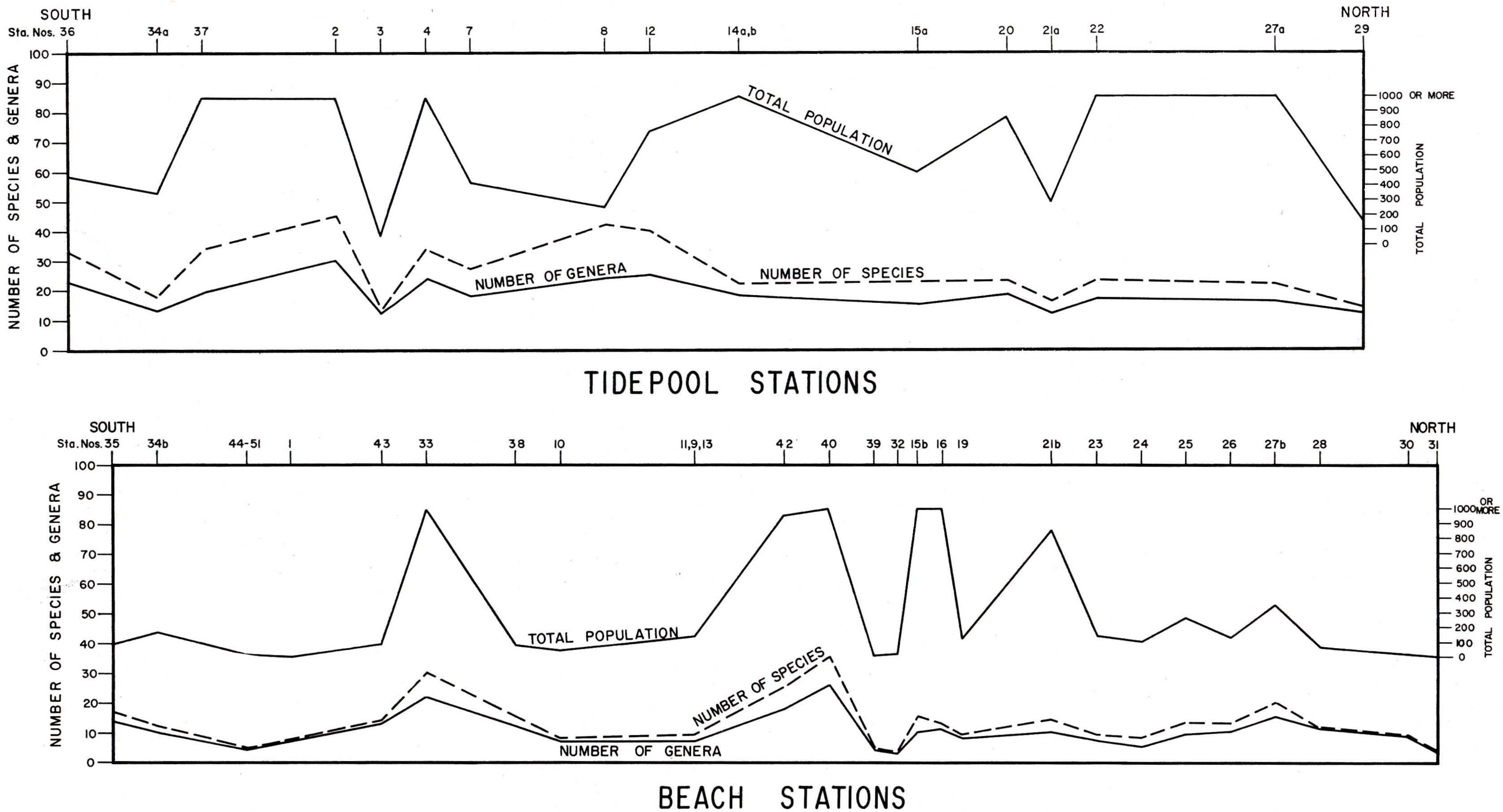
Fauna C, characterized by two species, *Discorbis ornatissimus* and *Elphidium microgranulosum*, dominates segments VI and VII in the northern reaches of the area under consideration, from immediately north of Point Arena to the Columbia River.

A fourth fauna, D, is present throughout the entire area and is therefore classed as a cosmopolitan fauna. This cosmopolitan fauna consists of the small but numerous arenaceous species *Trochammina kellettae* with *Discorbis monicana*, *Elphidium translucens*, and a scattering of the porcellaneous species *Miliolinella circularis* and *Quinqueloculina akneriana*.

Faunas A, B and C overlap on each other from Gaviota north or throughout segments III through VII but each of these characteristic faunas has an area in which it is dominant.

Tidepool Faunas

Four faunas (E, F, G and H) characterize the tidepool areas (Table 4) from south to north and, as in



NUMBER OF GENERA AND NUMBER OF SPECIES

TEXT-FIGURE 4

the beach faunas, the tidepool faunas are partially masked by a group of cosmopolitan species (I).

Table 4

Characteristic Tidepool Faunas

Fauna (Provincial)	Species	Coastal Segments I	II	III	IV	V	VI	VII
E	*Discorbis campanulata*	3	—	—	—	—	—	—
E	*Haplophragmoides canariensis* subsp. *mexicana*	6	—	—	—	—	—	—
E	*Miliolinella circularis*	3	3	x	x	x	x	1
E	*Rotorbinella lomaensis*	3	1	4	x	x	—	—
F	*Bolivina pseudoplicata*	3	6	1	1	x	x	x
F	*Bolivina vaughani*	x	2	x	x	—	—	—
F	*Glabratella pyramidalis*	—	35	x	2	x	—	—
F	*Elphidium rugulosum*	—	10	—	—	—	—	—
G	*Alveolophragmium columbiense*	x	—	3	x	x	x	x
G	*Buccella tenerrima*	—	—	4	2	3	x	2
G	*Discorbis opercularis*	x	—	2	4	20	2	7
G	*Elphidiella hannai*	—	—	7	x	5	1	6
G	*Elphidium translucens*	—	—	x	x	4	x	—
H	*Discorbis ornatissimus*	—	—	x	x	4	12	x
H	*Elphidium microgranulosum*	—	—	22	18	15	57	40
(Cosmopolitan)								
I	*Trochammina kellettae*	6	2	16	x	x	7	—
I	*Cibicides fletcheri*	7	x	5	9	5	x	2
I	*Discorbis monicana*	30	11	9	27	18	4	22
I	*Quinqueloculina akneriana*	1	3	2	3	10	x	3
I	*Quinqueloculina lamarckiana*	x	x	1	3	3	x	—

Numbers denote average percentage of population per segment.

x represents less than 1 per cent.

Segment I, the southernmost segment, has a small but characteristic tidepool fauna, fauna E, composed of *Discorbis campanulata*, *Rotorbinella lomaensis*, *Haplophragmoides canariensis* subsp. *mexicana* and *Miliolinella circularis*. *Miliolinella circularis* does appear weakly throughout the entire area to the Columbia River at the north but because of its strong appearance in the south it is not included in the cosmopolitan species as it has been in the beach faunas.

Fauna F dominates segment II, from just north of Laguna Beach to the area east of Gaviota. Fauna F is strongly represented by *Glabratella pyramidalis* and is accompanied by *Bolivina pseudoplicata*, *Bolivina vaughani* and *Elphidium rugulosum*. With the exception of *Elphidium rugulosum*, the other members of this fauna extend beyond the boundaries of segment II, to both the south and north, with *Bolivina pseudoplicata* extending northward into segment VII.

Fauna G centers about segment V, the area from San Francisco to Point Arena, and is composed of *Alveolophragmium columbiense*, *Buccella tenerrima*, *Discorbis opercularis*, *Elphidiella hannai* and *Elphidium translucens*.

Fauna H, represented by *Discorbis ornatissimus* and *Elphidium microgranulosum*, dominates the northern area composed of segments VI and VII extending from just north of Point Arena to the Columbia River. This fauna is notable for its high percentage of *Elphidium microgranulosum*.

A cosmopolitan fauna occurs in the tidepools, as in the beaches, and consists of several species occurring in fairly persistent numbers throughout all segments. These species are *Trochammina kellettae*, *Cibicides fletcheri*, *Discorbis monicana*, *Quinqueloculina akneriana* and *Quinqueloculina lamarckiana*. *Quinqueloculina akneriana* is noticeably more numerous in segment V; however, because of its persistent appearance in the other segments it is placed here in the cosmopolitan category.

Segments III and IV, the area from Gaviota to San Francisco, appears to be a region of overlapping tidepool faunas with no one fauna dominating.

Beach and Tidepool Faunas Combined

Totaling the beach and tidepool faunas by combining the statistics of Tables 3 and 4 makes it possible to show the true characteristics and areal extent of the intertidal faunas as a whole (Table 5). These combined faunas are designated as A_c, B_c, C_c and D_c. By this method it is possible to distinguish three provincial faunas and one cosmopolitan fauna.

The southern portion of the coastline studied, from Gaviota to San Diego, which forms segments I and II is characterized by fauna A_c which is a *Cibicides fletcheri*, *Rotorbinella lomaensis* fauna and includes *Discorbis campanulata*, *Glabratella pyramidalis* and *Haplophragmoides canariensis* subsp. *mexicana*.

Segments III, IV and V are characterized by fauna B_c consisting of *Buccella tenerrima*, *Cassidulina limbata*, *Discorbis opercularis*, *Elphidiella hannai* and *Eponides columbiensis*. This is the area from Gaviota to just north of Point Arena.

The northern part of the region studied, segments VI and VII, from Point Arena to the Columbia River, is dominated by two characteristic species, *Discorbis ornatissimus* and *Elphidium microgranulosum*. This fauna is designated C_c.

A number of species have a continuous though not large occurrence and are placed in a cosmopolitan fauna, D_c. There are two important exceptions to this, the most important and noticeable being the abundant occurrences of the arenaceous species *Trochammina kellettae*. The second important species in

Table 5

Characteristic Beach and Tidepool Faunas Combined

Fauna (Provincial)	Species	I	II	III	IV	V	VI	VII
A_c	*Cibicides fletcheri*	16	1	8	6	8	1	2
	Discorbis campanulata	2	1	—	—	—	—	—
	Glabratella pyramidalis	—	4	x	x	—	—	—
	Haplophragmoides canariensis subsp. *mexicana*	3	—	—	—	—	—	—
	Rotorbinella lomaensis	8	x	5	1	1	—	—
B_c	*Buccella tenerrima*	—	—	6	3	9	2	5
	Cassidulina limbata	—	—	6	3	1	3	x
	Discorbis opercularis	x	—	1	1	8	x	3
	Elphidiella hannai	—	—	6	6	31	14	9
	Eponides columbiensis	—	—	x	1	2	4	x
C_c	*Discorbis ornatissimus*	—	—	x	x	6	14	2
	Elphidium microgranulosum	2	x	18	12	10	41	44
(Cosmopolitan)								
D_c	*Trochammina kellettae*	17	43	17	36	x	13	16
	Bolivina pseudoplicata	2	x	x	x	x	x	x
	Buliminella elegantissima	x	x	x	x	—	x	3
	Cibicides lobatus	x	x	x	1	1	x	x
	Discorbis monicana	15	3	8	11	7	1	9
	Elphidium translucens	1	1	x	x	5	1	1
	Fissurina marginata subsp.	x	x	x	x	x	x	x
	Turrispirillina arctica	2	x	x	x	x	x	x
	Miliolinella circularis	2	2	x	x	x	x	x
	Quinqueloculina akneriana	x	x	1	1	4	x	2
	Quinqueloculina lamarckiana	x	x	1	1	1	x	—

Numbers denote average percentage of population per segment.
x represents less than 1 per cent.

this cosmopolitan group is the hyaline *Discorbis monicana.* The remaining hyaline species are *Bolivina pseudoplicata, Buliminella elegantissima, Cibicides lobatus, Elphidium translucens, Fissurina marginata* subspecies and *Turrispirillina arctica.* Three porcellaneous species have a cosmopolitan occurrence. They are *Miliolinella circularis, Quinqueloculina akneriana* and *Quinqueloculina lamarckiana.*

Live/Dead Relationships

The live/dead ratios and the percentage of living and percentage of dead as shown in Table 2 were plotted as to beach or tidepool type and in sequence from north to south. These plotted data are not reproduced here because of their cumbersome nature. The live/dead ratios and the figures for the percentages of living and dead show no trends from one locality to another along the coast. These results are as anticipated and show that the samples were collected laterally along both ecological and sedimentary environments, rather than from one environment into another as would be the case if samples were collected from an offshore traverse with a continual deepening of the water and changing ecological and sedimentary conditions.

Distorted Foraminifera

Distorted Foraminifera were found in insignificant numbers and were confined entirely to the Miliolidae. These distorted forms occurred in large numbers at only two stations, 34_a and 7. As these two stations are tidepool stations, their salinities may have been subject to change by either evaporation or dilution by ground water. A change from normal salinities can produce abnormal foraminiferal forms (Arnal, 1955).

The species *Discorbis monicana* was observed in many shapes but these varying shapes were not abnormalities but the result of a growth pattern which conformed to the shape of the algae on which the individual was growing.

OCEANOGRAPHIC CONDITIONS

The temperatures and salinities of the coastal area of California and Oregon are influenced in a general way by the offshore California Current and by upwelling.

The California Current is a massive movement of water about 350 miles wide and in general no more than 1000 feet deep (Sverdrup, Johnson and Fleming, 1942). This current moves in a southeastward direction along the coast as far south as central Baja California (Manar, 1952).

The coast along California and Oregon appears to be a coast of upwelling with the entire region being affected to a greater or lesser degree by this phenomenon. Intense upwelling occurs off the Cape Mendocino-Cape Blanco area and off the area about Point Arguello but its effects are more pronounced in the region of the outer shelf than nearshore.

It should be emphasized here that the California Current and upwelling have only a general effect on the physical properties of the marine water of the coastal area containing the tidepool and beach regions of this paper. Temperatures and salinities vary greatly along beaches and in tidepools, more than they do slightly offshore, with temperatures spanning great diurnal ranges, often exceeding the average seasonal range at points only 100 yards offshore (Emery, personal communication).

Data from nearshore locations such as piers, tide stations and lightships (Robinson, 1957; U. S. Department of Commerce, 1952), give a general picture of nearshore temperatures and salinities but it is believed that the temperatures and salinities of the beaches and tidepools exceed both the maximum and minimum ranges of these data.

The nearshore temperatures from the Columbia River to Point Arguello are generally the same with an annual maximum temperature of from about 14° C. to about 16° C. The annual minimum temperature is from about 9° C. to about 10° C. The annual temperature range in this same area is from about 5° C. to 7° C. There is a lowering of both maximum and minimum temperatures of from about 2° C. to about 4° C., respectively, in the areas off Cape Mendocino and Point Arguello. From Point Arguello to San Diego the annual nearshore temperatures increase southward reaching a maximum of about 23.5° C. and a minimum of about 12° C. off San Diego. The annual nearshore temperature range increases southward, from Point Arguello to San Diego, from about 7° C. to about 12° C. respectively.

The nearshore salinities are generally lower north of San Francisco, being from 31°/oo to 32.8°/oo. South of San Francisco the nearshore salinities are higher and are about 33.5°/oo.

Maximum and minimum temperatures of tidepools exceed nearshore temperatures as evidenced by tidepool temperatures taken by Emery (1946) at La Jolla, near San Diego, and by Klugh (1924) at "New Brunswick" on the Atlantic Coast. These data are for periods of low tide when the tidepools were isolated from ocean water and are as follows:

Tidepool Temperatures

Emery — La Jolla

Time of Year	Minimum °C.	Maximum °C.	Ocean °C.
Nov. & Dec.	7.0	24.0	—
Apr. & May	13.3	28.0	13.8 - 17.5
Aug.	—	34.5	—

Klugh — "New Brunswick"

Time of Year	Minimum °C.	Maximum °C.	Ocean °C.
Summer	15.0	28.5	14.0 - 15.5

The data of both investigators show a large diurnal temperature range occurring in tidepools adjacent to the ocean during periods of low tide when the tidepools were isolated from ocean water.

Reiter (1959) measured the water temperatures of beaches in Santa Monica Bay, California. His temperature readings were made once a week and at about the same time of day for each station so the diurnal range is not known; but a study of his data indicates that temperatures from September through April are about 4° C. or 5° C. above the expected nearshore temperatures.

The water temperatures of beaches and tidepools are affected by solar heating, back radiation, heat transfer by wind, evaporation, direct rainfall, runoff from the land by streams and rivers, and leakage of groundwater from the land into tidepools or through beaches.

Solar heating is believed to have a greater effect in the south than in the north because of the reduced cloud cover and the same probably holds true for back radiation which is most effective at night with a clear sky. Heat transfer is most pronounced when the air is cooler than the water and this effectively reduces the water temperature.

Salinities are affected by evaporation and by dilution directly by rainfall, runoff from the land by streams and rivers, and by leakage of groundwater into tidepools or through beaches. The lower salinities of nearshore water north of San Francisco are probably due to the increased cloud cover reducing the effects of evaporation combined with increased rainfall and increased fresh water runoff from the land. The salinities of the tidepools and beaches must be affected to a greater extent by dilution and evaporation than would be the water of the nearshore area.

An additional condition prevails in relatively shallow water beyond the surf zone which subjects Foraminifera living there on the bottom to large diurnal temperature ranges. It has been found by Arthur (1955) that there is a rising and falling of the thermocline near shore with the result that benthonic forms living from 3 meters to 8 meters deep are subject to sudden or abrupt changes in temperature during a single summer day which are as great as the seasonal changes within the area (as a result of this rise and fall of the thermocline).

DISCUSSION AND CONCLUSIONS

The data presented have shown that the predominating types of Foraminifera found within the intertidal region were the benthonic forms with the almost total exclusion of the planktonic. The planktonic Foraminifera were all of the genus *Globigerina* and it is interesting to note that, of these few planktonic individuals collected, approximately one-third were living at the time of capture. Because of their scattered occurrence and few numbers, these various species of *Globigerina* have no significance. It is believed that these species of *Globigerina* were probably stray individuals or the offspring of stray individuals carried inshore by local currents.

The benthonic Foraminifera were not only present in the intertidal region but numerous examples were found and large percentages often were alive.

The intertidal region is not believed to be the natural habitat of the benthonic Foraminifera collected in either of the ecological areas, beach or tidepool. The benthonic Foraminifera are, however, believed to be nearshore inhabitants carried into the intertidal region by local currents and wave action and the live specimens collected were those individuals which had not died or were able to continue to live in this region. If, as Dietz and Menard (1951) held, the maximum depth of effective wave action, which they term the base of vigorous abrasion, is 5 fathoms or 30 feet, then most of the Foraminifera found in the intertidal region have been transported into this region from depths bordering on 30 feet or less. Because wave action brings sand ashore as evidenced by cyclical changes of beach width and height, and as currents can move sediment, as pointed out by Dietz and Menard, it is concluded that Foraminifera having the same size as sand grains can be moved ashore the same as sand grains.

There is a possibility that tidepool environments may be such that individuals carried into a tidepool may continue to live and even to reproduce there. Evidence of this may be shown by the generally larger numbers of individuals collected from tidepools in comparison with beach collections; however, such a comparison may be invalid because the material collected in each of the two environments, algae versus sand, was different.

Benthonic Foraminifera, because they are captives of their environment, are adapted to the variable conditions of the environment in which they live. The benthonic forms found within the intertidal region are species that are able to withstand the wide range of conditions present in the nearshore area, of which the most marked is the relatively large and sometimes rapid change of temperature.

Foraminifera living in tidepools which are isolated from the ocean during periods of low tide at night are faced with a rigorous chemical change in the water of the tidepool. There is an increase of CO_2 content and a lowering of the pH of the water (Emery, 1946). This condition results in the water becoming unsaturated at night in respect to $CaCO_3$ and an accompanying solution of $CaCO_3$ from the rock forming the tidepool or other substances within the tidepool. There are no data available as to the effect this chemical change or condition has on foraminiferal populations in tidepools if they are able to become established in such an environment.

As shown in Tables 3, 4, and 5, cosmopolitan species form a major part of the faunas found along the coast. One reason for this is that these cosmopolitan species are for some reason better able to withstand the wide range of conditions present in the nearshore area and are therefore more wide ranging because the physical changes within the environment do not restrict them.

The foraminiferal faunas which are more provincial in nature may be restricted by current conditions, salinities, temperature conditions, a combination of these factors, or possibly by some other factors. Beach faunas B and C, tidepool faunas G and H, and the combined beach and tidepool faunas B_c and C_c do not extend south of Point Conception. The probable higher temperatures and salinities of the intertidal region of segments I and II, indicated by higher nearshore temperatures and salinities, combined with the change in currents in the Point Conception area, may play a controlling influence in restricting the above faunas to the area of the coast north of Point Conception. Beach fauna C, tidepool fauna H, and the combined beach and tidepool fauna C_c form a large percentage of the population in segments VI and VII. There is no readily apparent reason for this; however, their abundant occurrence may be due to lower salinities resulting from increased rainfall and fresh water runoff from the land. Segments III, IV, and V appear to be a transition zone between segments I and II on the south and segments VI and VII on the north. This region is dominated by beach fauna B, tidepool fauna G and combined beach and tidepool fauna B_c.

An indication of temperature control over the distribution of Foraminifera is given by the areal distribution of *Cassidulina limbata.* This species reaches its maximum abundance in segment III in the area immediately north of Point Arguello; no individuals were noted south of Point Conception. The species did not occur in the intertidal region to the south where warmer waters are encountered but it does occur in abundance at depths offshore to the south where lower temperatures are encountered. Natland (1933) reported *Cassidulina limbata* in abundance off southern California at a depth range between 125-900 feet; Bandy (1953a) found *Cassidulina limbata* in abundance off San Diego at a depth range of 200-800 feet and McGlasson (1959) found the species in abundance below 240 feet off Catalina Island.

Another interesting species was the small, cosmopolitan, arenaceous species *Trochammina kellettae.* This minute form was found ranging in greatest diameter from 0.12 mm. to 0.21 mm. This species, as described by Cushman and McCulloch (1939), has a diameter from 0.25 mm. to 0.40 mm. The small form collected in this study may possibly be a planktonic larval form or a dwarf form which is easily carried ashore by wave action. *Trochammina kellettae* occurred in most of the station samples collected, both beach and tidepool. Generally, where it occurred as a predominant species, the station was a beach rather than a tidepool station and the total population was relatively small. The species is common along the entire coast of this study and occurs in more or less constant numbers. Its variation in percentage of total population is mostly due to the varying total number of individuals of other species collected at the same time. As already mentioned, this an extremely small species and was difficult to recover during the processing of the samples. When the beach-sand samples were concentrated with carbon tetrachloride, it had a tendency to stick in the filter paper and had to be picked off individually. It is believed that the main reason this species is absent or occurs in reduced numbers in the tidepool samples is that their small size enabled the individuals to cling to, or be hidden in, the algae collected and therefore, not be recovered during the processing of the sample. There was no continuous trend in size in the individuals of *Trochammina kellettae* from north to south, though the southernmost sample contained more of the larger members of this species and also the largest individual of all those collected.

Generally speaking, fossil Foraminifera within the area studied presented little if any problem in their recognition or occurrence. Most fossil species were easily recognized by their preservation as the specimens mostly were calcareous or siliceous casts. As to their occurrence, they are readily related to the Pliocene and Miocene sediments occurring in the same area of collection. Three abundant species in the northern half of the area do, however, present a problem in these respects. These living species, *Elphidiella hannai, Buccella tenerrima,* and *Discorbis ornatissimus,* occur in abundance in the Recent samples and, as they also occur in significant numbers in the upper Pliocene and Pleistocene formations along the coast in this area, there is the distinct possibility that fossil representatives of these species may be confused with present day specimens found in the beach sands. The author believes that there were few if any pre-Recent individuals of the above species present because those collected were generally of fresh appearance and showed little evidence of weathering or erosion; however, since only a very few were found to be alive when collected, it is possible that many are fossil individuals.

As has been noted, there is a slight increase from north to south in both the number of genera and number of species. This is in general related to a southward increase in temperatures and salinities. This phenomenon indicates an increase in variety of the faunas in warmer and more saline waters, but there is no corresponding increase in the number of individuals or total population.

As the coast under study is a coast of upwelling, it is interesting to note that no deep water forms were collected. Therefore there is no evidence to substantiate an often-voiced idea that upwelling makes it possible for normally deep-living Foraminifera to live in shallow waters (Harrington, 1955). Surface temperatures are not reduced enough by upwelling to equal those found at 3000 to 5000 foot depths; the velocities of upwelling are too low to carry Foraminifera upward and upwelling itself is a relatively shallow overturning of the water (Sverdrup, Johnson, and Fleming, 1942).

The ratios of living to dead Foraminifera (L/D ratio) showed no trends. This is explained by the fact that in this study the sampling was done laterally through ecological and sedimentary environments which were in general uniform.

This study shows the occurrence of two main groups of benthonic species, the cosmopolitan and the provincial. It was possible to group the benthonic provincial species into characteristic regional faunas with areas in which they were dominant.

In the future it would be interesting to see a similar study made with much closer sampling in the intertidal area combined with samples from deeper water beyond the breaker zone.

FAUNAL REFERENCE LIST

The original references to the species found in this study are arranged alphabetically below. The references also include illustrations of the species and all are in the Catalogue of Foraminifera by Ellis and Messina. *Variety* has been retained when it is part of the original reference.

Alveolophragmium columbiense (Cushman) = *Haplophragmoides columbiense* Cushman, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 2, p. 39, pl. 6, figs. 2a, b.

Alveolophragmium columbiense (Cushman) var. *evolutum* (Cushman and McCulloch) = *Haplophragmoides columbiense* Cushman var. *evolutum* Cushman and McCulloch, 1939, Allan Hancock Pacific Expeditions, vol. 6, no. 1, p. 73, pl. 5, figs. 11, 12; pl. 6, figs. 1, 2.

Angulogerina albatrossi Cushman var. *hirsuta* Todd, 1948, Allan Hancock Pacific Expeditions, vol. 6, no. 5, p. 278, pl. 35, fig. 4.

Angulogerina hughesi (Galloway and Wissler) = *Uvigerina hughesi* Galloway and Wissler, 1927, Jour. Paleontology, vol. 1, p. 76, pl. 12, fig. 5.

Angulogerina hughesi (Galloway and Wissler) var. *picta* Todd, 1948, Allan Hancock Pacific Expeditions, vol. 6, no. 5, p. 290, pl. 36, fig. 3.

Anomalina californiensis Cushman and Hobson, 1935, Cushman Lab. Foram. Research, Contr., vol. 11, pt. 3, p. 64, pl. 9, fig. 8a-c.

Astrononion stellatum Cushman and Edwards, 1940, Cushman Lab. Foram. Research, Contr., vol. 13, p. 32, pl. 3, figs. 9, 10, 11.

Bolivina acuminata Natland, 1946, in Cushman and Gray, Cushman Lab. Foram. Research, Spec. Publ. no. 19, p. 34, pl. 5, fig. 46.

Bolivina advena Cushman, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 2, p. 29, pl. 5, figs. 1a, b.

Bolivina brevior Cushman, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 2, p. 31, pl. 5, figs. 8a, b.

Bolivina decurtata Cushman, 1926, Cushman Lab. Foram. Research, Contr., vol. 2, pt. 2, p. 44, pl. 6, figs. 7a, b.

Bolivina imbricata Cushman, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 2, p. 31, pl. 5, figs. 7a, b.

Bolivina marginata Cushman, 1918, Bull. 676, U. S. Geol. Survey, p. 48, pl. 10, fig. 1.

Bolivina pseudoplicata Heron-Allen and Earland, 1930, Roy. Micr. Soc. London, Jour., ser. 3, vol. 50, pt. 1, p. 81, pl. 3, figs. 36-40.

Bolivina seminuda Cushman var. *humilis* Cushman and McCulloch, 1942, Allan Hancock Pacific Expeditions, vol. 6, no. 4, p. 211, pl. 26, figs. 1-6.

Bolivina striatula Cushman, 1922, Publ. 311, Carnegie Instit. Washington, p. 27, pl. 3, fig. 10.

Bolivina vaughani Natland, 1938, Scripps, Inst. Oceanogr., Bull., Tech. Ser., vol. 4, no. 5, p. 146, pl. 5, fig. 11.

Buccella frigida (Cushman) = *Pulvinulina frigida* Cushman, 1922, Contr. Canadian Biology, no. 9, p. 144.

Buccella tenerrima (Bandy) = *Rotalia tenerrima* Bandy, 1950, Jour. Paleontology, vol. 24, no. 3, p. 278, pl. 42, figs. 3a-c.

Bulimina denudata Cushman and Parker, 1938, Cushman Lab. Foram. Research, Contr., vol. 14, p. 57, pl. 10, figs. 1-2.

Bulimina subacuminata Cushman and R. E. Stewart, 1930, San Diego Soc. Nat. Hist., Trans., vol. 6, p. 65, pl. 5, figs. 2-3.

Buliminella curta Cushman, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 2, p. 33, pl. 5, fig. 13.

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Calcituba polymorpha Roboz, 1884, K. Akad. Wiss. Wien, Math.-Naturw. Cl., Bd. 88, Abth. 1, Heft 2, p. 421, figs. 1-16.

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Cassidulina minuta Cushman, 1933, Cushman Lab. Foram. Research, Contr., vol. 9, pt. 4, p. 92, pl. 10, fig. 3.

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Cassidulina tortuosa Cushman and Hughes, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, p. 14, pl. 2, fig. 4.

Cassidulina translucens Cushman and Hughes, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, p. 15, pl. 2, fig. 5.

Cibicides fletcheri Galloway and Wissler, 1927, Jour. Paleontology, vol. 1, p. 64, pl. 10, figs. 8-9.

Cibicides lobatus (Montagu) = *Truncatulina lobata* Montagu) d'Orbigny, 1839, in Barker-Webb and Berthelot, Hist. Nat. Îles Canaries, "Foraminifères," vol. 2, pt. 2, p. 134, pl. 2, figs. 22-24 (= *Serpula lobata* Montagu, 1803, Test. Brit., pp. 515, 516).

Cibicides mckannai Galloway and Wissler, 1927, Jour. Paleontology, vol. 1, p. 65, pl. 10, figs. 5-6.

Cibicides refulgens Montfort, 1808, Conch. Syst., vol. 1, p. 123, text-figs.

Cornuspira involvens (Reuss) = *Operculina involvens* Reuss, 1850, Denkschr. Akad. Wiss. Wien, vol. 1, p. 370, pl. 46, fig. 20.

Discorbis campanulata (Galloway and Wissler) = *Globorotalia campanulata* Galloway and Wissler, 1927, Jour. Paleontology, vol. 1, p. 58, pl. 9, fig. 14.

Discorbis monicana Zalesny, 1959, Micropaleontology, vol. 5, no. 1, p. 124, pl. 1, fig. 4a-c.

Discorbis opercularis (d'Orbigny) = *Rosalina opercularis* d'Orbigny, 1839, in Ramón de la Sagra, Histoire physique et naturelle de l'Île de Cuba, Foraminifères, p. 93. (plates published separately) ibid., vol. 8, pl. 3, figs. 24-25, pl. 4, fig. 1.

Discorbis ornatissimus Cushman, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 2, p. 42, pl. 6, figs. 11, 12.

Discorbis terquemi van Bellen, 1946 = *Rotalina involuta* Terquem, 1882, Mém. Soc. géol. France, sér. 3, vol. 2, p. 76, pl. 15, fig. 10.

Discorbis cf. *D. translucens* Earland, 1934, Foraminifera; Part III. In; "Discovery" Repts., vol. 10 (1935), p. 181, pl. 8, figs. 20-22. This species is closely similar to *Discorbis translucens* Earland in size and proportion. Test hyaline; rotaloid; finely perforate dorsally giving a frosted appearance, coarsely perforate ventrally with a radial alignment of the perforations resulting in a radial beaded appearance; chambers arranged in about three whorls with six chambers in the last whorl; dorsal sutures oblique and curved, ventral sutures radial; ventral side deeply umbilicate with umbilical flaps as is the case with the genotype *Discorbis vesicularis* Lamarck.

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Elphidium concinnum Nicol, 1944, Jour. Paleontology, vol. 18, p. 179, pl. 29, figs. 5, 9.

Elphidium fax Nicol subsp. *fax* Nicol, 1944, Jour. Paleontology, vol. 18, p. 177.

Elphidium hughesi Cushman and Grant, var. *foraminosum* Cushman, 1939, A monograph of the foraminiferal family Nonionidae, U. S. G. S. Prof. Paper 191, p. 49, pl. 13, fig. 8.

Elphidium microgranulosum (Thalmann) = *Themeon granulosus* Galloway and Wissler, 1927, Jour. Paleontology, vol. 1, p. 83, p. 193, pl. 12, figs. 15, 16.

Elphidium rugulosum Cushman and Wickenden, 1929, U. S. Nat. Mus., Proc., vol. 75, art. 9 (no. 2780), p. 7, pl. 3, fig. 8.

Elphidium translucens Natland, 1938, Scripps Inst. Oceanography, Bull., Tech. Ser., vol. 4, p. 144, pl. 5, figs. 3-4.

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Eponides columbiensis (Cushman) = *Pulvinulina columbiensis* Cushman, 1925, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 2, p. 43, pl. 7, fig. 1.

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Fissurina lucida (Williamson) = *Entosolenia marginata* (Montagu) var. *lucida* Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 17, pl. 2, fig. 17.

Fissurina marginata Seguenza, 1862, Dei terreni Terziarii del distretto di Messina; Parte II, p. 66, pl. 2, figs. 27-28.

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Gaudryina atlantica (Bailey) = *Textularia atlantica* Bailey, 1851, Smithsonian Inst., Contr. Knowledge, vol. 2, art. 3, p. 12, figs. 38-43.

Gaudryina atlantica (Bailey) var. *pacifica* Cushman and McCulloch, 1939, Allan Hancock Pacific Expeditions, vol. 6, no. 1, p. 94, pl. 9, figs. 1-2.

Gaudryina subglabrata Cushman and McCulloch, 1939, Allan Hancock Pacific Expeditions, vol. 6, no. 1, p. 92, pl. 8, figs. 5-7.

Glabratella lauriei (Heron-Allen and Earland) = *Discorbina lauriei* Heron-Allen and Earland, 1924, Linnean Soc. London, Jour., Zoology, vol. 35, p. 633, pl. 36, figs. 50-52; pl. 37, figs. 53-55.

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Globigerina subcretacea Lomnicki, 1901, Naturf. Ver. Brünn, Verh., Bd. 39 (1900), Abh., p. 17.

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Lagena amphora Reuss, 1863, K. Akad. Wiss. Wien, Math.-Naturw. Cl., Sitzber., Bd. 46, Abth. 1 (1862), p. 330, pl. 4, fig. 57.

Lagena apiopleura Loeblich and Tappan, 1953, Smithsonian Inst., Misc. Coll., vol. 121, no. 7 (publ. 4105), p. 59, pl. 10, figs. 14-15.

Lagena catenulata (Williamson) = *Entosolenia squamosa* (Montagu) var. α, *catenulata* Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 19, pl. 2, fig. 20.

Lagena pliocenica Cushman and Gray, var. *timmsana* Cushman and Gray, 1946, Cushman Lab. Foram. Research, Contr., vol. 22, p. 68, pl. 12, figs. 15-17.

Lagena scalariformis (Williamson) = *Entosolenia squamosa* (Montagu) var. 6, *scalariformis* Williamson, 1848, Ann. Mag. Nat. Hist., 1848, ser. 2, vol. 1, p. 20, pl. 2, figs. 21-22.

Lagena striatopunctata Parker and Jones, var. *cista* Cushman and McCulloch, 1950, Allan Hancock Pacific Expeditions, vol. 6, no. 6, p. 352, pl. 47, figs. 14, 15.

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Miliolinella circularis (Bornemann) = *Triloculina circularis* Bornemann, 1855, Deutsch. Geol. Ges., Zeitschr., vol. 7, no. 2, p. 349, pl. 19, fig. 10.

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Nonionella costifera (Cushman) = *Nonionina costifera* Cushman, 1926, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 4, p. 90, pl. 13, figs. 2a-c.

Nonionella miocenica Cushman var. *stella* Cushman and Moyer, 1930, Cushman Lab. Foram. Research, Contr., vol. 6, p. 56, pl. 7, fig. 17.

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Quinqueloculina jugosa Cushman, 1944, Cushman Lab. Foram. Research, Spec. Publ. no. 12, p. 13, pl. 2, fig. 15.

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222. ON THE "GENUS" *CATAPSYDRAX*, AND THE *GLOBIGERINA QUADRILOBATA* GENS

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ABSTRACT

The "genus" **Catapsydrax** is a polyphyletic one, inasmuch as globigerines of the "clustered" type all seem to go through various developmental stages during geologic time. These stages begin with **Globigerina**, then change into **"Globigerinoides,"** and each species ends with tests which, when adult, develop **"Catapsydrax"** chambers. This was shown for **Globigerina daubjergensis**, **G. venezuelana** (where the **Globigerinoides**-stage is absent), and also for **G. quadrilobata-triloba-sacculifera.** Typical **"Catapsydrax"** chambers also are found frequently in **G. (Globigerinoides) conglobata.** Polyphyletic genera, however, do not form biologic units and for this reason should be withdrawn as soon as possible. **Catapsydrax** chambers seem to be developed at the end of each generic appearance as a means of forming cysts for sporulation, somewhat in the same way as occurs in benthonic Foraminifera which form mud cysts. **Catapsydrax** chambers also are found in **G. minuta.** Thus, specimens with **Catapsydrax** chambers are found during the entire Tertiary and are very common in the Recent.

THE "GENUS" *CATAPSYDRAX*

Bolli, Loeblich and Tappan (1957) established the new genus, *Catapsydrax,* with *Globigerina dissimilis* Cushman and Bermudez, 1937, as type species. This genus was considered to be the center of a whole subfamily of Foraminifera, the Catapsydracinae, into which Banner and Blow (1959, p. 6) put the "genera" *Tinophodella* Loeblich and Tappan, 1957, *Catapsydrax* Bolli, Loeblich and Tappan, 1957, *Globigerinita* Brönnimann, 1952, *Globigerinoita* Brönnimann, 1952, *Globigerinatheka* Brönnimann, 1952, and *Globigerinatella* Cushman and Stainforth, 1945.

All of these "genera" are described as having, in the later stages of development, a chamber of different aspect, having a varying number of "accessorial apertures," which closes the umbilical part of the test. In their discussion of these "genera," Banner and Blow (1959, p. 25) state that "Even within the genus *Catapsydrax,* it is highly probable that polyphyletism will become apparent when the interrelationships of its species become better known."

From a biologic standpoint it is obvious that a genus which is stated to be polyphyletic is not a genus at all and the author (Hofker, 1959) has already pointed out the artificial status of such genera. Moreover, Parker (1958) pointed out that in several species of Recent *Globigerina* closing chambers "similar to that seen in *Globigerinita*" are found, and that "as previously mentioned this feature occurs occasionally in many species, it is suggested that it may have some connection with the reproductive process." *"Catapsydrax" dissimilis* always is found occurring with specimens much resembling *Globigerina venezuelana;* in older layers, *G. venezuelana* is found without *"Catapsydrax"*[1]; this would mean that in its later stages of specific development it also developed the power to form a bulla over the umbilicus thus producing the form which is know as *"dissimilis."*

The author (Hofker, 1960) was able to show that in the species *Globigerina daubjergensis* Brönnimann, 1953, this specific stage of development in which *"Catapsydrax"* chambers became common was reached at the end of the Danian. It was shown that this species, during its development, goes through *"Globigerina"* and *"Globigerinoides"* into *"Catapsydrax"* which strongly suggests that, where a single biologic unit shows such a development, the "genera" *Globigerinoides* and *Catapsydrax* are artificial genera. At least twice a species of *Globigerina* developed into *"Catapsydrax,"* in the Dano-Paleocene and again in the Eocene-Oligocene.

Lead by the hint given by Parker, the author studied samples from the deep sea south of Sumatra in which *Globigerina conglobata* Brady, 1879, was abundant. Banner and Blow (1960, pp. 6, 7) studied the types and figured a lectotype. Their description and figure fully agree with the specimens found off Sumatra; moreover they are conspecific with many specimens the author studied from several stations of the Ingolf Expedition in the North Atlantic and from the Caribbean.

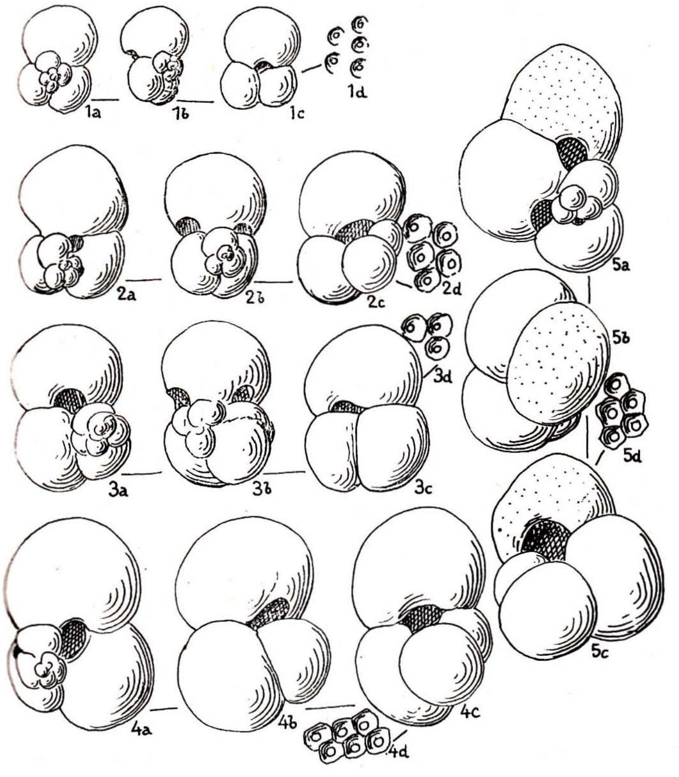
In the Sumatra samples, specimens with bulla chambers closing the umbilical cavity are very common. Banner and Blow (1959, p. 6) define this bulla for *"Catapsydrax"* as follows: "Primary chamber wall and bulla similar in structure; accessory apertures few and unrestricted."[2] The figures given here show that this definition fully agrees with the structure found in most of the specimens of *Globigerina conglobata.* In several samples this bulla is the normal feature; some specimens show the remnants of a bulla which has been broken away. The wall of the bulla shows the typical pores with the index typical of *G. conglobata* and there are usually two small "accessory apertures" which are sutural and occur opposite each other. This would suggest that, were *"Catapsydrax"* a valid genus

1 Beckmann (1953, p. 393) stated that in the allied **G. mexicana** small dorsal openings also occur in Lower Oligocene specimens, and that many of these forms show **Catapsydrax** chambers.

2 In reality, the porous wall of the bullae in all species studied, also in **Globigerina dissimilis**, is much thinner and lacks pustules or other ornamentation.

(which the author believes it is not), *Globigerina conglobata* would have to be included in that genus along with all other "clustered" globigerines.

It has been suggested by many authors studying Recent planktonic species that *Globigerina triloba* Reuss, 1850, *G. quadrilobata* d'Orbigny, 1846, and *G. sacculifera* Brady, 1877, should be included in a single species. Study of the pore diameters, which may, according to what has been found in the development series of *G. daubjergensis,* form a constant feature in each development series of globigerines, revealed that specimens of typical *G. quadrilobata* from the Miocene of the Vienna Basin (type locality), typical *G. triloba* and typical *G. sacculifera* show coarse pores slightly increasing in diameter with time. Thus, we may assume that since this character is found to be of major importance in species of *Globigerina* that these three species are conspecific.



TEXT FIGURES 1-5

Fig. 1. *"Globigerina* cf. *trilocularis* d'Orbigny" of Bolli (1957, pl. 22, figs. 8, 9). Oligocene of Trinidad and Ecuador (Ecuador, unit 45, 42, 33, 32). a, dorsal side without dorsal openings; b, from side; c, ventral side; d, pores opening into pits in the surface. a-c, × 27; d, × 160.

Fig. 2. *"Globigerinoides quadrilobatus* (d'Orbigny)" of Banner and Blow (1960, pl. 4, fig. 3). Upper Miocene of Vienna Basin, Austria, Nussdorf, Kahlenberg Strasse 126. a, dorsal side with dorsal openings; b, side view; c, ventral side; d, pores in honeycomb structure. a-c, × 27; d, × 160.

Fig. 3. *"Globigerinoides triloba immatura* Le Roy" of Bolli (1957, pl. 25, figs. 3, 4). Lengua formation, Upper Miocene, Trinidad. a, dorsal side with dorsal opening at last-formed chamber; b, from side; c, ventral side; d, pores in honeycomb structure. a-c, × 27; d, × 160.

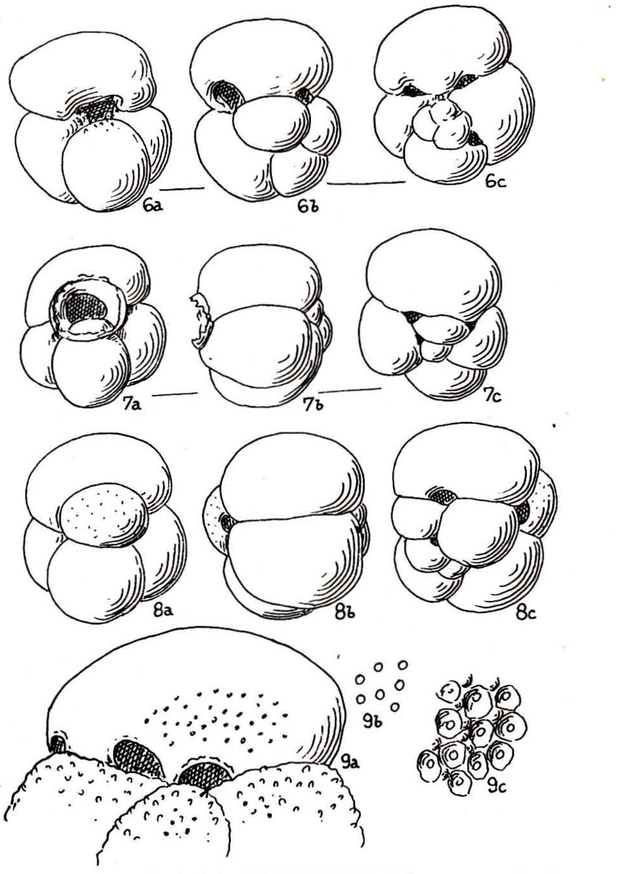
Fig. 4. *"Globigerina triloba* Reuss." Recent, south of Sumatra, sample "Van Gogh," 2° 17′ S., 99° 56′ E., depth 613 fathoms. a, dorsal side; b, side view; c, ventral side; d, pores in honeycomb structure. a-c, × 27; d, × 160.

Fig. 5. *"Globigerina triloba* Reuss var. *sacculifera* Brady." Same sample as Fig. 4. a, dorsal side; b, ventral side showing that the thin-walled last-formed abnormal chamber is a "bulla"; c, side opposite to *a;* d, pores in honeycomb structure. a-c, × 27; d, × 160. (The bulla chamber is dotted in the figure to accentuate it.)

Banner and Blow (1960, pp. 17-19) described the lectotype of Miocene *G. quadrilobata* and (1960, pp. 21-24) that of *G. sacculifera.* A large collection of *G. triloba* from Recent localities (Caribbean, North Atlantic, tropical Pacific) revealed to the author that many specimens differ in no way from *G. quadrilobata* as defined by Banner and Blow. Many specimens have four chambers in the last-formed whorl, others only three, with many intergrades between. In Miocene material, from various localities in the Vienna Basin, of which there is a large amount, the author did not find a single specimen which would suggest even the existence of a form of the *sacculifera* type. Such forms appear for the first time in the Upper Miocene of Trinidad.

In Recent collections, invariably when *quadrilobata-triloba* is found there are also specimens of the *sacculifera* type in abundance. In *G. daubjergensis, G. dissimilis* and *G. conglobata,* the bulla always has a much thinner wall than the previous chambers; thus, this is typical for a bulla. In all the specimens studied of typical *G. sacculifera,* the somewhat protruding last-formed typical chamber also has a thinner wall which is pierced by pores having the index typical for *triloba* and, in addition, has two more or less large "accessory apertures." When the test is observed in such a way that this last-formed "sacculiferous" chamber is turned toward the observer, it becomes clear that this chamber is a real "bulla" and that it covers the umbilical cavity. Thus, it falls within the definition of the bulla as given by Banner and Blow. We find, therefore, that *G. quadriloba* as it occurs in the Miocene developed gradually into a form know as *G. triloba,* which is an end stage in which *"Catapsydrax"* chambers develop just as was found in *G. daubjergensis;* these forms give rise to the "species" *G. sacculifera.* It is very probable that the *quadrilobata-triloba-sacculifera* gens began in the Oligocene with a form without dorsal sutural openings (see *G. daubjergensis*). Such a trend may also be found for the *G. conglobata* gens. In the Upper Oligocene and Miocene of Ecuador, the author has found all intermediate stages of the *quadrilobata* gens, as well as the stage without dorsal pores in the Upper Oligocene. In this gens also, the pore diameters form a continuous series and, therefore, give important evidence.

Forms with *"Catapsydrax"* chambers, thus, are found at the end of a specific development in *G. daubjergensis, G. venezuelana, G. quadrilobata* and, very



TEXT FIGURES 6-9

"Globigerinoides" conglobatus Brady, 1879

Fig. 6. (See Banner and Blow, 1960, pl. 4, fig. 4). Same sample as figs. 4, 5. a, ventral side; b, side view; c, dorsal side. × 27.

Fig. 7. Recent, sample "Van Gogh" 10° S., 123° 19′ E., 453 fathoms. This specimen has a bulla chamber which is broken away but of which the remains are clearly visible. a, ventral side; b, side view; c, dorsal side. × 27.

Fig. 8. Same sample as fig. 7. Individual with bulla chamber (*Catapsydrax* chamber). a, ventral side; b, side view; c, dorsal side. This bulla has only two openings and is shown dotted in the figure. × 27.

Fig. 9. Same sample as figs. 4-6. Individual with bulla chamber with more than two openings. a, only the bulla chamber and some adjacent normal chambers are shown; b, pores of the bulla chamber; since its wall is thin, they do not open into pits; c, pores with pustules between, with a kind of honeycomb structure, of a normal chamber wall. a, × 57; b, c, × 160.

probably, *G. conglobata.* All known occurrences of *"Catapsydrax"* should be rechecked in this way. These occurrences clearly show that *"Catapsydrax"* is not a genus in any biologic sense. The same can be said about all the other "genera" in the "Catapsydracinae." This subfamily has no biologic meaning and should be withdrawn, along with its "genera."

It is very probable that the development of the species, *G. daubjergensis,* as found by the author in the uppermost Cretaceous, the Danian and the lower Paleocene, going from a *Globigerina* stage without dorsal openings, through a *Globigerinoides* stage with dorsal openings, and ending in a *"Catapsydrax"* stage with the formation of true bullae, is repeated in many other globigerines with a "clustered" arrangement of chambers and without a real, open umbilicus. We do not know why these globigerines formed dorsal openings, nor why, at the end of their specific development, they formed bullae. This may be due to a different method of propagation at the end of the life of the species; it may also be the result of the increase in diameter . As the author (1959, p. 5, figs. 7, 8) has stated already, a true bulla is formed also in many specimens of *Globigerina rubra* d'Orbigny, often along with a secondary closing of the dorsal openings. This strongly points to a method for forming a closed cyst at the time of sporulation. Benthonic species form such cysts at this time by the use of mud (Hofker, 1930a, *Streblus flevensis, Miliola circularis;* Arnold, 1955, miliolids). Planktonic forms must seek other ways of forming such cysts; bullae and closing plates are such ways.

The statement that typical *"Catapsydrax"* bullae are found in many globigerines of the "clustered" type points to a polyphyletic status of the "species" *Catapsydrax.* The author (Hofker, 1951, p. 47) has already stated that such genera as *Rectobolivina* and *Loxostoma* form end stages of development trends in the *Bolivina* group and that they are, therefore, polyphyletic and do not form real biologic entities. This should be restated here for *"Catapsydrax."*

THE GLOBIGERINA *QUADRILOBATA* GENS

In the *Globigerina daubjergensis* gens we have found that there is a continuous increase in diameter during its evolution, the first stages do not show dorsal openings and have the characteristics of *Globigerina,* later stages show gradually appearing dorsal openings and have the characteristics of *Globigerinoides,* and the latest and largest specimens develop *"Catapsydrax"* chambers. During this whole development, however, two typical characteristics remain constant: the clustered arrangement of the chambers and the structure of wall which is entirely covered with very finely placed pores with small pustules between.

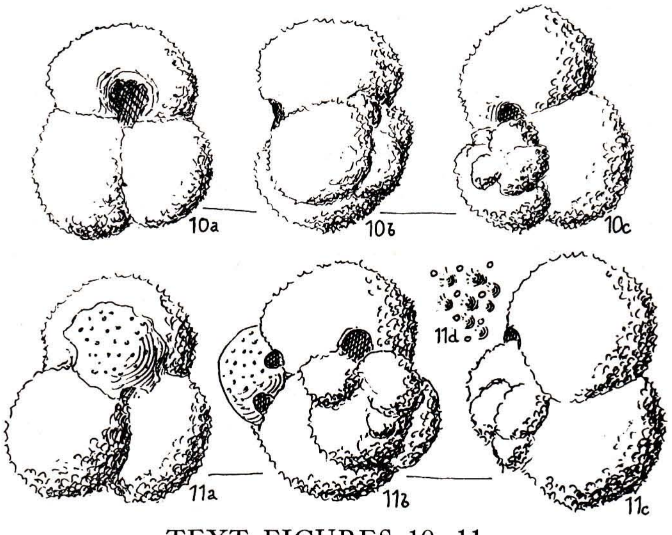
A very similar development was traced in the *quadrilobata* gens. The earliest specimens are characterized by three or four chambers in the last-formed whorl, all chambers visible from the dorsal side, the last-formed chambers rapidly increasing in size so that the larger diameter of the test is 1½-2 times the smaller one, the chambers much inflated so that the periphery is strongly lobulate. All stages show the very typical wall structure which gradually develops a honeycomb structure during the later Oligocene up to the Recent accompanied by a slight increase in the size of the pores, ranging from 2-3 in the Oligocene, 3-5 in the Miocene, up to 5-6 in the Pliocene and Recent. In the Oligocene this structure is not so definite as in the later stages since at that time the meshes did not fuse and each pore opened into a distinctly rounded pit. A similar development was found in the *G. triloculinoides* and *G. pseudobulloides* groups. Thus, in all four groups, there are very distinct pores which always open into pits or honeycomb structures at the surface of the test wall. The following pore diameters were found:

Ecuador, unit 21
2-4μ, pits; Oligocene (*trilocularis*)
Ecuador, unit 28, 30, 31
2-4μ, pits; Oligocene-Miocene (*trilocularis*)
Ecuador, unit 42, 54, 55
3-4μ, honeycomb; Miocene (*quadrilobata*)
Trinidad Miocene
4-5μ, honeycomb; Miocene (*quadrilobata*)
Austria, Nussdorf
3-5μ, honeycomb; Miocene (*quadrilobata*)
Recent, Caribbean
5-6μ, honeycomb; Recent (*triloba*)
Recent, Pacific
5-7μ, honeycomb; Recent (*sacculifera*)

When we take these general characteristics as a base, we find that the specimens in the Oligocene do not have dorsal openings and, therefore, belong to the *Globigerina* type. Such specimens have been described and figured by Bolli (1957, pl. 22, figs. 8, 9) as *"Globigerina* cf. *trilocularis* d'Orbigny." In these samples we do not find larger specimens with dorsal openings but it is obvious that in geologically younger samples we may find young specimens (of more highly developed types) which do not differ from these early forms. Bolli placed the Oligocene-Miocene boundary in Trinidad exactly at the point where the first individuals with dorsal openings (*Globigerinoides* type) appear. The earliest specimens only show two openings in the last-formed chamber (Lower Miocene). In the Upper Miocene (Tortonian) of Nussdorf, Vienna Basin, as well as in the Middle and Upper Miocene of Trinidad (Cipero marl) and of Ecuador, we find still larger specimens which have dorsal openings in earlier chambers also. Such specimens have been figured by Bolli (1957, pl. 25, fig. 4) as *"Globigerinoides triloba immatura* Le Roy" and *"G. triloba triloba* (Reuss)." However, these same forms were referred by Banner and Blow (1960) to *G. quadrilobatus*. The Pliocene and Recent forms are all designated by authors as *Globigerina triloba* as well as immature specimens of *G. sacculifera*. In the later Miocene, Bolli also found, in Trinidad, specimens which may already be primitive forms of the *sacculifera* type (Bolli, 1957, pl. 25, fig. 5) but the specimens at hand appear to have a much finer wall structure. In the Recent seas *sacculifera* is very common along with normal *triloba; sacculifera* is the *"Catapsydrax"* of *triloba*.

The gradual development of this gens strongly points to the artificiality of at least several of the "species" mentioned. Since we find the same sequence of forms as is found in the case of *G. daubjergensis* we may take it for granted that all these forms belong to one biologic unit, the *G. quadrilobata* gens. Priority calls for the name *quadrilobata* for this gens, which runs through the species:

trilocularis	Oligocene
quadrilobata	Miocene
triloba	Miocene-Pliocene-Recent
sacculifera	Pliocene-Recent (Miocene?)



TEXT FIGURES 10, 11

Globigerina minuta Natland, 1938

Fig. 10. Sample "Van Gogh," 2° 40′ S., 100° 24′ E., depth 715 fathoms. Normal individual. a, ventral side; b, side view; c, dorsal side. × 57.

Fig. 11. Same sample as fig. 10. Specimen with *"Catapsydrax"* chamber covering the umbilical cavity. a, ventral side with the "bulla"; b, ventral side showing the bulla with two of its three openings; c, side view; d, surface of the test wall with relatively fine pores with sharp pustules between. a-c, × 57; d, × 160.

Just as in *G. daubjergensis* we find, along with the increase of diameter, the development from *Globigerina* characters through *Globigerinoides* characters into *Catapsydrax* characters, thus, once more pointing to the invalidity of the "genera" *"Globigerinoides"* and *"Catapsydrax."*

The accessorial chambers which always cover the umbilical hollow were called by Beckmann (1953, pl. 25, designation of figures) "umbilicalkämmerchen" (umbilical chambers) which appears to be a much better designation than that used by Bolli, *et al.* and by Banner and Blow, bullae, a less significant designation.

CONCLUDING REMARKS

In the Pacific a small *"Globigerinoides,"* which seems to be identical with *Globigerina minuta* Natland, is common. In this species, bullae covering the ventral umbilical cavity, provided with two or three "accessorial" openings, are frequent (see figs. 10, 11).

So it appears that most of the globigerines, when they have reached the "*Globigerinoides*" stage, also can develop "*Catapsydrax*" chambers, bullae or "umbilical chamberlets." Typical bullae have now been reported in:

Globigerina daubjergensis Brönnimann
G. venezuelana Hedberg
G. quadrilobata d'Orbigny
G. rubra d'Orbigny
G. minuta Natland
G. glutinata Egger

All these species belong to the "clustered" type of *Globigerina*. In the more trochoid forms, such as *G. bulloides* d'Orbigny or *G. hexagona* Natland, such additional chambers covering the umbilical cavity were not found nor have they been reported in any planispiral forms such as *G. aequilateralis* Brady.

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Hofker, J., 1930a, Generationswechsel von *Rotalia beccarii* var. *flevensis*, nov. var.: Zeitschr. Zellforschung und mikrosk. Anatomie, vol. 10, pt. 4, pp. 756-768.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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223. *HAPLOPHRAGMOIDES SANDIEGOENSIS*, NOM. NOV.

TAKAYASU UCHIO
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The writer was recently informed by Dr. A. E. Cockbain of the University of British Columbia that *Haplophragmoides quadratus* Uchio, 1960 (Cushman Found. Foram. Research, Spec. Publ. no. 5, p. 52, pl. 1, fig. 17; pl. 5, fig. 14), described from the San Diego, California, area is preoccupied by *Haplophragmoides quadratus* Earland, 1934 (Discovery Reports, vol. 10, p. 88, pl. 3, figs. 7, 8), described from the Falklands Sector of the Antarctic. The new name *Haplophragmoides sandiegoensis* is proposed for the San Diego form.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XII, PART 2, APRIL, 1961

AN INDEX TO THE GENERA AND SPECIES OF THE FORAMINIFERA, 1890 - 1950. GEORGE VANDERBILT FOUNDATION: STANFORD UNIVERSITY, STANFORD, CALIFORNIA

393 Pages. 1960. $10.00 + Postage

This newly published volume supplies students of the foraminifera with an invaluable tool. Similar in style to the annual indices to the genera and species of foraminifera published by Thalmann for many years, it covers all newly proposed generic and specific names appearing between 1890 and 1950.

In 1955, Charles Davies Sherborn's *"An index to the genera and species of the Foraminifera"* covering the genera and species described through 1889, long out of print and difficult for foraminiferal workers to obtain, was reprinted by the Smithsonian Institution. The lack of complete coverage of foraminiferal literature after 1890 by a comprehensive index remained a serious lack to workers in this field. Students of foraminifera now owe a debt of gratitude to Hans E. Thalmann for continuing the earlier work of Sherborn and completing an index of genera and species for the 60 year period 1890 through 1950, and to the George Vanderbilt Foundation at Stanford University for undertaking the publication of this important volume. Thalmann's index is published in an attractive, well printed, double columned quarto volume. The following data are given for generic names: reference, type species, family assignment and geologic age; for species: the reference, geologic age and area from which described are given. The generic and specific names are printed in bold face type for easier visibility. Some references for years prior to 1890 are also given when these were not included in the Sherborn index.

A complete coverage of the well scattered foraminiferal literature through 1950 is now available in two volumes, the Sherborn index through 1889, and the Thalmann index through 1950. The new volume may be obtained from the George Vanderbilt Foundation at Stanford University.

ALFRED R. LOEBLICH, JR.
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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XII, PART 2, APRIL, 1961

RECENT LITERATURE ON THE FORAMINIFERA

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

BANDY, ORVILLE L. General correlation of foraminiferal structure with environment.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. XXII, Proc. Internat. Pal. Union, Copenhagen, 1960, p. 7-19, text figs. 1-9 (charts).—An important paper in which trends of morphologic categories (such as size, shape, coiling, internal structures, nature of wall, and ornamentation) in several groups (arenaceous, porcelaneous, chilostomellid, rotaloid, asterigerinid, buliminid, uvigerinid, cassidulinid-virgulinid, and bolivinid) are shown in their relation to modern environments (bay, shelf, bathyal zone).

Foraminiferal ecology of the Gulf of California (abstract).—Geol. Soc. America Bull., v. 71, No. 12, pt. 2, Dec. 1960, p. 2047-2048.—Species characteristic of 8 environmental and depth zones are listed.

BANDY, ORVILLE L., and ARNAL, ROBERT E. Concepts of foraminiferal paleoecology.—Am. Assoc. Petroleum Geologists Bull., v. 44, No. 12, December 1960, p. 1921-1932, text figs. 1-14 (graphs, maps).—Number of genera, species, and specimens increases away from shore and with deeper water up to a maximum on the outer shelf and upper and middle bathyal zones. Planktonic specimens are deposited most abundantly on outer shelf and in upper bathyal zones. Diversity of porcellaneous species indicates shoal-water and near-shore environments. Arenaceous Foraminifera with simple interiors (such as **Ammobaculites**) are characteristic of estuarine and other shoal-water environments while those with complex interiors (such as **Cyclammina**) are typically found at bathyal depths. Fossil species that are similar and related to Recent species, as well as those that are similar but not related, may be used in interpreting paleoecology in the same way that fossil specimens of Recent species are used. Seven biofacies from estuarine to abyssal, are worked out for the middle Tertiary of the San Joaquin basin, and paleobathymetric maps constructed to show its evolution.

BERGGREN, WILLIAM A. Paleocene biostratigraphy and planktonic Foraminifera of Nigeria (West Africa).—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. VI, Proc. sec. 6, Copenhagen, 1960, p. 41-55, pl. 1, text fig. 1 (map), tables 1, 2.—In this preliminary report on incomplete studies of rich assemblages from 5 boreholes, Upper Cretaceous, Paleocene (lower, middle, and upper), and Eocene (lower and middle) are recognized on the basis of planktonic species. About 45 are listed and 10 are illustrated.

BERMUDEZ, PEDRO J. Foraminiferos planctonicos del Golfo de Venezuela.—Mem. Soc. Ciencias Nat. La Salle, v. 20, No. 55, Jan.-April 1960, p. 58-76, pl. 1. —Twenty-two species and 2 varieties (1 new) of planktonics are described and illustrated. Some of the benthonics are listed.

BIELECKA, WANDA. Micropalaeontological stratigraphy of Upper Jurassic sediments of Poland.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. VI, Proc. sec. 6, Copenhagen, 1960, p. 98-105, text fig. 1 (map), 1 range chart.—Range is shown between Oxfordian and Bononian for 71 short-ranged Foraminifera and 7 long-ranged ones.

BOGDANOVICH, A. K. O Meandrovom Raspolozhenii Kamer u Nekotorykh Nubekuljarij i Sistematicheskom Znachenii Ehtogo Priznaka.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 5-8, pl. 1, text fig. 1.—Illustrations of **Nubecularia.**

O Novom Predstovitele Miliolid s Probodennoj Stenkoj. —Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 17-20, pl. 1.—**Foraminella** gen. nov. (genotype **F. obscura** sp. nov.), a coiled globular miliolid with final tubular portion.

BONET, F. Afloramientos del Eoceno en el Norte de la Peninsula de Yucatan.—Bol. Asoc. Mex. Geol. Petr., v. 11, Nos. 1, 2, Jan., Feb. 1959, p. 1-12, pls. 1, 2. —Based on **Coskinolina floridana.**

BUCHANAN, J. B., and HEDLEY, R. H. A contribution to the biology of **Astrorhiza limicola** (Foraminifera).—Jour. Marine Biol. Assoc. U. K., v. 39, 1960, p. 549-560, text figs. 1-5.—The animal inhabits stable areas of fine to medium clean sand and is non-selective in its test construction. It is a slowly mobile predator, obtaining its food by means of its adhesive pseudopodia which are extended over the sand and through the interstitial spaces. No evidence of an inner chitinous lining of the test was found.

BULATOVA, Z. I. O Dvukh Tipakh Kompleksa Foraminifer s **Gaudryina filiformis** Berthelin v Zapadnoj Sibiri.—Sibirskii nauchno-issl. instit. geol., geofiz. mineral., Trudy, vyp. 2, 1959, p. 37-40, text fig. 1 (map).

BUTLER, E. ANN. Miocene-upper Oligocene Foraminifera of Louisiana.—Louisiana Geol. Survey Paleont. Studies, v. 1, pt. 1, April 1959, 35 p., illust.—First in a series, this compilation of species used in local petroleum exploration includes figures and descriptions (with the addition of some revised descriptions) of 20 species. Illustrated list of terminology is included.

BUTTERLIN, JACQUES. Presencia de **Pellatispirella** Hanzawa 1937 en Mexico.—Bol. Asoc. Mex. Geol. Petr., v. 12, Nos. 3, 4, March, April 1960, p. 85-89, pl. 1.

BUTTERLIN, JACQUES, and BONET, FEDERICO. Microfauna del Eoceno Inferior de la Peninsula de Yucatan.—Univ. Nac. Autonoma Mexico, Instit. Geol., Paleontologia Mexicana No. 7, 1960, p. 1-18, pls. 1-3, text fig. 1 (map), tables 1-7.—Four species, in **Coskinolina, Borelis, Operculina,** and **Discocyclina.**

CHENOUARD, L., DE KLASZ, I., and MEIJER, M. Deux nouvelles espèces du genre **Siphogenerinoides** (Foraminifère) du Crétacé Supérieur de l'Afrique Occidentale.—Revue de Micropaléontologie, v. 3, No. 2, Sept. 1960, p. 71-76, pl. 1, maps.

CICHA, IVAN. Bericht über das Vorkommen des Marinen Untermiozäns bei l'Ubietova, westlich von Banska Bystrica (German summary of Czeck text).—Vestnik Ustred. Ustavu Geol., roc. 35, cislo 5, 1960, p. 361-363, pls. 1, 2.—Photographs of 2 Aquitanian assemblages.

CICHA, IVAN, and ZAPLETALOVA, IRENA. Stratigraphische Verbreitung der planktonischen Foraminiferen im Miozän der karpatischen Becken.—Vestnik Ustred. Ustavu Geol., roc. 35, cislo 5, 1960, p.

351-355, 1 range chart.—Ranges between Aquitanian and Tortonian are shown for 27 planktonic species.

CITA, M. B., and SILVA, ISABELLA PREMOLI. Pelagic Foraminifera from the type Langhian.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. XXII, Proc. Internat. Pal. Union, Copenhagen, 1960, p. 39-50, text figs. 1-4 (maps, columnar sections, range chart, correlation table).—Three tentative planktonic zones (one new, the other two of worldwide distribution) are recognized at the type section, plus a lowermost Miocene zone below and a middle Miocene zone above. Occurrence of 27 planktonic species is shown in 25 samples taken across this interval, and correlation with the Trinidad planktonic zones is indicated.

DIDKOVSKY, V. Y. On the phylogenetic development of certain representatives of the family Peneroplidae (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1958, No. 3, p. 324-329, text figs. 1-4.—**Peneroplis** is a divergent branch of **Spirolina. Dendritina** is eliminated as a young stage of **Spirolina. Neopeneroplis** new genus, originated in middle Sarmatian from **Spirolina.**

On the foraminifer fauna of the Azov Sea (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1958, No. 10, p. 1135-1138.—Migration, between 1950 and 1957, of Black Sea species into Azov Sea is affected by regulation of the Don River system.

A new representative of the family Peneroplidae **Neopeneroplis sarmaticus** gen. et sp. n., from the middle Sarmatian deposits of the Ukraine and Moldavia (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1958, No. 11, p. 1251-1254, 1 pl.—Also a new species of **Spirolina.**

Vikopnih Peneroplidi Pivdenno-Zakhidnoji Chastini Radjans'kogo Sojuzu.—Akad. Nauk URSR, Kiev, Instyt. geol. nauk, Trudy, ser. strat. paleont., vyp. 28, 1959, p. 1-70, pls. 1-23, text figs. 1-8.—In **Spirolina,** 22 species (18 new) and 9 varieties (all new); in **Neopeneroplis,** 1 species; in **Peneroplis,** 5 species (4 new).

A new species of foraminifer, **Miliolina podolica** sp. n., from the upper Tortonian deposits of Podolia (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1959, No. 3, p. 306-308, text figs. 1-3.

On the microfauna of the Konka horizon deposits of the Ukrainian SSR (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1959, No. 4, p. 412-415, map, table.—Stenohaline species with Mediterranean aspect indicate link with open sea through northern Caucasus and central Asia.

New **Bolivina** species in the middle Sarmatian deposits of Moldavia (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1959, No. 5, p. 525-530, text figs. 1-5.—Five new species.

A new representative foraminifer fauna, **Trochammina winogradovi** sp. n. in the Black Sea (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1959, No. 8, p. 903-907, text figs. 1, 2 (drawings, map).—Occurs on silty bottom between 5 and 40 meters.

DROOGER, C. W. Some early rotaliid Foraminifera. I, II, and III.—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, v. 63, No. 3, 1960, p. 287-334, pls. 1-5, text figs. 1-3 (map, diagram, phylogenetic diagram).—Based solely on Paleocene well material from French Guyana, 6 species (in 5 genera) are described and illustrated. Two genera are new: **Storrsella** (type species **Cibicides haastersi** van den Bold) and **Smoutina** (type species **S. cruysi** n. sp.). Test structures are discussed as to their significance in classification. A diagram indicates possible phylogenetic relationships between genera of the Rotaliidea. A key for determination of genera is included, based on morphologic differences.

Microfauna and age of the Basses Plaines formation of French Guyana. I and II.—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, v. 63, No. 4, 1960, p. 449-468, pls. 1-4, range chart.—A small fauna, chiefly rotaliid, indicates Paleocene age and shallow marine deposition under back-reef conditions.

EAMES, F. E., BANNER, F. T., BLOW, W. H., and CLARKE, W. J. The American Oligocene.—Nature, v. 187, No. 4738, Aug. 20, 1960, p. 679-680.—In East Africa are planktonic assemblages, representative of stages between upper Eocene and Aquitanian, that are conspicuously absent in America between Jacksonian and Vicksburgian.

ETERNOD OLVERA, YVETTE. Foraminiferos del Cretacico Superior do la Cuenca de Tampico-Tuxpan, Mexico.—Bol. Asoc. Mex. Geol. Petr., v. 11, Nos. 3, 4, March, April 1959, p. 61-134, pls. 1-9, 1 map.—Fifty-one species and subspecies (7 species and 1 subspecies new) are described and illustrated.

FOMINA, E. V. K Voprosu o Priurochennosti Verkhne- i Nizhnetul'skikh Kompleksov Foraminifer k Razlichnym Karbonatnym Fathijam Tul'skogo Gorizonta Podmoskovnogo Bassejna.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 72-82, pls. 1, 2.—Six species (3 new) and one new variety from the Mississippian.

FURSSENKO, A. V. On criteria in the systematics of Foraminifera (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 11-22.—Of the four kinds of criteria: morphologic, geochronologic, geographic, and ecologic, morphologic criteria seem most significant.

GLAESSNER, M. F., McGOWRAN, B., and WADE, M. Discovery of a Kangaroo-Bone in the Miocene of Victoria.—Australian Jour. Sci., v. 22, No. 12, June 1960, p. 484-485, text figs. 1, 2.—Age determined by Foraminifera.

GOLEV, B. T. Preparirovanie i Okrashivanie Rakovin Nummulitov.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 132-135.—On preparation and staining of nummulite shells.

GOLIK, A. On the geology of the Ziklag area, Israel.—Bull. Research Council Israel, sec. G, Geo-Sci., v. 9G, No. 2-3, Aug. 1960, p. 129-134, map, cross sections.—Nine lithologic units, from Maestrichtian to Miocene, with ages determined by smaller Foraminifera.

GREITZER, Y. On the geology of the Lachish area, Israel.—Bull. Research Council Israel, sec. G, Geo-Sci., v. 9G, No. 2-3, Aug. 1960, p. 109-116, map, cross sections, Foraminifera range chart.—Ten lithologic units, from middle Eocene to Miocene, with ages determined by smaller Foraminifera.

GRIGELIS, A. A. **Epistominoides primaevus** sp. nov.—Pervaja Nakhodka Roda **Epistominoides** v Nizhnem Oksforde Litvy.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 67-71, text fig. 1.—From the lower Oxfordian of Lithuania.

On the phylogenetic line of the family Epistominidae in the Jurassic deposits of Lithuania (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 98-104, text figs. 1-5.—**Epistominita sudaviensis** gen. et sp. nov.

an intermediate form between **Epistomina** and **Epistominoides,** and **Rectoepistominoides scientis** gen. et sp. nov., the final evolutionary stage in this phylogenetic line.

GROZDILOVA, L. P., and LEBEDEVA, N. S. Foraminifery Kamennougol'nykh Otlozhenij Zapadnogo Sklona Urala i Timona.—Russia Vses. neft. nauchno-issl. geol.-razved. instit., Trudy, vyp. 150, 1960, p. 1-264, pls. 1-33, text figs. 1-47.—An illustrated atlas in which 151 species (10 new) and 23 varieties (3 new) are included in 54 genera and 13 families. Characteristic assemblages are listed for 32 zones between Gschelian and Tournaisian.

GRUBIC, ALEKSANDAR. Le genre **Loftusia** Brady (French summary of Serbian text).—Bull. Serv. Geol. Geophys. Serbie, tome XVI, 1958, p. 41-55.—Yugoslavian localities are on the western periphery of the Middle East center of development of the genus in the Maestrichtian. Four of the 11 species attributed to this genus belong elsewhere.

HAUSMANN, HELLMUT E. Über die Möglichkeit, geringe Bodenbewegungen aus Paläontologischen Daten zu folgern.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. VI, Proc. sec. 6, Copenhagen, 1960, p. 56-63, text figs. 1-4 (map, graphs, columnar sections).—Interpretation of post-middle Oligocene crustal movements is based on the finding of frequency maxima of **Bolivina beyrichi** at different depths in 5 bore-holes in a 25-km. traverse across middle Oligocene Septaria clay.

HEDLEY, R. H. The iron-containing shell of **Gromia oviformis** (Rhizopoda).—Quart. Jour. Micr. Sci., v. 101, pt. 3, Sept. 1960, p. 279-293, text figs. 1-6, tables 1-3.—The large amount and nature of union of iron in the shell suggests the iron results from more than a reaction between the iron in normal sea-water and the shell material, and is probably incorporated there by some activity of the living animal.

HILTERMANN, HEINRICH, and KOCH, WILHELM. Oberkreide-Biostratigraphie Mittels Foraminiferen.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. VI, Proc. sec. 6, Copenhagen, 1960, p. 69-76, pls. 1-4.—Restricted ranges in 22 stratigraphic units from upper Albian to Danian are plotted for 67 species.

HOFKER, J. Les Foraminifères du Crétacé supérieur dans le Bassin de Mons. I.—Les Foraminifères de la Craie Phosphatée de Ciply. II.—Les Foraminifères du Tuffeau de Saint-Symphorien.—Ann. Soc. Géol. Belgique, tome 83, Bull. No. 6, March 1960, p. 165-195, text figs. 1-18; 1-34.—These two faunas are recorded and illustrated. The former indicates middle part of upper Maestrichtian; the latter, the Cretaceous-Tertiary boundary.

Le problème du Dano-Paléocène et le passage Crétacé-Tertiaire.—Revue de Micropaleontologie, v. 3, No. 2, Sept. 1960, p. 119-130, pls. 1-3, text fig. 1 (diagram), 1 table.—Three species of **Globigerina** from Cretaceous-Tertiary transition beds in Denmark show evolving characters as follows, from older to younger: (a) increasing size and development toward **Globigerinoides**- and **Catapsydrax**-structures in **Globigerina daubjergensis;** (b) wall changing from smooth to honeycomb in **G. pseudobulloides;** and (c) decreasing number of chambers per final whorl and wall becoming more coarsely honeycomb in **G. triloculinoides.**

IRELAND, H. A. Emendations to upper Pennsylvanian arenaceous Foraminifera from Kansas.—Jour. Paleontology, v. 34, No. 6, Nov. 1960, p. 1217, 1218.—A genus and a species (homonyms) are renamed, and corrections and additions of locality data are made to the 1956 paper.

IVANOVA, L. V. On the vertical distribution of Foraminifera in the Polanica series on the Chechva River and the Dolina district in the Subcarpathians (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1958, No. 3, p. 304-306.—A planktonic subzone in upper Oligocene.

JAHN, THEODORE L., and RINALDI, ROBERT A. Protoplasmic movement in the foraminiferan, **Allogromia laticollaris;** and a theory of its mechanism. —Biol. Bull., v. 117, No. 1, August 1959, p. 100-118, text figs. 1-5.—Unlike certain other members of the Sarcodina, where the pseudopodia possess a central core and a hyaline layer outside the streaming granules, in **Allogromia** the pseudopodia consist of a hyaline gel material to which the granules are attached. A new theory of protoplasmic flow (filament streaming, with the two portions of filament separated by shearing forces acting longitudinally and oppositely within the pseudopodium) is proposed to explain simultaneous flow outward along half the circumference and inward along the other half, as if each pseudopodium were a semi-cylindrical filament turned back upon itself at the tip. Two-way streaming continues even in freshly-cut segments of pseudopodia. Taxonomic significance of differences between the two major types of protoplasmic streaming (pressure flow and filament streaming) is discussed.

KAPTARENKO-CHERNOUSSOVA, O. K. On the taxonomy of the Jurassic Lagenidae (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1958, No. 10, p. 1110-1113.—Instability of generic and specific features is a result of the stage of emergence and development of the family.

On the interpretation of new species and on the geological duration of the Meso-Cainozoic Foraminifers (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1960, No. 7, p. 944-949, pls. 1-3.—A plea for study of phylogenetic series to aid creation of a natural taxonomy and reduce the number of new species. Examples of variability and polymorphism are illustrated.

KIPRIJANOVA, F. V. Nekotorye Peschanye Foraminifery iz Melovykh i Paleogenovykh Otlozhenij Zaural'ja.—Akad. Nauk SSSR, vyp. 51, Sbornik po Voprosam Stratig., No. 5, 1960, p. 73-82, pls. 1, 2.—Eight new species from Paleocene and Upper Cretaceous, all arenaceous.

KRASHENINNIKOV, V. A. Mikrostruktura Stenki U Miothenovykh Diskorbid i Rotaliid.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 41-49, pls. 1, 2.—Six new species of **Discorbis** are described and illustrated from the upper Tortonian of Podolia.

Foraminifers in rhythms of Miocene deposits in the south-west of the Russian platform (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 78-84.—A few families and genera are listed as to their prevalence under different ecologic conditions, such as rate of accumulation of sediments, associated organisms, depth of water, and nature of water mass.

KRIVOBORSKIJ, V. V. Stereoskopicheskoe Mikrofotografirovanie Foraminifer.—Russia Vses. neft. nauchno-issl. geol. instit. Trudy, vyp. 153, Mikrofauna, SSSR, Sbornik 11, 1960, p. 327-339, pls. 1, 2, text figs. 1-4.

KULCHITSKY, Y. O., ZHILOVSKY, N. I., DABAGYAN, N. V., MAXIMOV, A. V., and KHLOPONIN, K. L. Stratigraphy of the Palaeocene and Eocene of the Eastern Carpathians (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev, 1958, No. 3, p. 310-314, 2 correl. tables.—Foraminifera facies as basis for subdivision.

LIPINA, O. A. Tournaisian Foraminifera of the Russian Platform and the Ural (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 48-55, phylogeny diagram.—The family Tournayellidae represents the evolutionary transition between the 2-chambered Devonian Ammodiscidae and the multilocular Carboniferous Endothyridae.

MAJZON, LASZLO. Paleogene Foraminifera horizons of Hungary (English summary of Hungarian text).—Földtani Közlöny, Bull. Hungarian Geol. Soc., k. 90, f. 3, July-Sept. 1960, p. 355-362, pl. 18, text fig. 1 (map and profile), 1 table.—Two new species of **Heterostegina** from the upper Rupelian. Zonation from Londonian to Chattian consists of 14 Foraminifera zones.

MALAKHOVA, N. P. Stratigrafija Nizhnekamennougol'nykh Otlozhenij Severnogo i Srednego Urala po Faune Foraminifer.—Akad. Nauk SSSR, Ural. filial, Sverdlovsk, Trudy Gorno-Geol. Instit., vyp. 52, 1960, p. 1-110, text figs. 1-8, tables 1-9.

MANGIN, JEAN-PHILIPPE. Données nouvelles sur le Nummulitique pyrénéen.—Bull. Soc. Géol. France, ser. 7, tome 1, No. 1, November 1959, p. 16-30, text figs. 1, 2 (sections, paleogeographic maps).—Diagnostic Foraminifera listed from beds between Maestrichtian and Oligocene.

MASELLA, LUCILLA. Le **Schackoina** (Foraminifera, Globigerinacea) del Cretaceo di Patti (Messina).—Riv. Mineraria Siciliana, Anno 11, No. 61, Jan.-Feb. 1960, p. 16-30, pls. 1-10, text figs. 1-41.—**Schackoina cenomana** and its 7 subspecies (3 new from Patti).

MAYNC, WOLF. Biocaractères et analyse morphométrique des espèces Jurassiques du genre **Pseudocyclammina** (Foraminifère). II. **Pseudocyclammina jaccardi** (Schrodt).—Revue de Micropaleontologie, v. 3, No. 2, Sept. 1960, p. 103-118, pls. 1, 2, text figs. 1-8 (columnar sections, outline drawings, graphs), correlation table.—Delimitation of the species by biometric means reveals other naturally-included species.

MIKLUKHO-MAKLAJ, A. D. Novye Fuzulinidy Verkhnego Paleozoja SSSR in Materialy k "Osnovam Paleontologii."—Akad. Nauk SSSR, Paleont. instit., vyp. 3, 1959, p. 3-6, pl. 1, figs. 1-5.—Two species and 3 subspecies, all new.

The correlation of Upper Paleozoic deposits of Middle Asia, Caucasus and the Far East of the USSR on the basis of a study of Foraminifera (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 69-77, correl. table.—Faunal subdivision of Upper Carboniferous and Permian is based chiefly on fusulinids. A single Russian-Chinese biogeographical region existed in the Carboniferous while two regions—Siberian and Caucasian—existed in the Permian.

MOROZOVA, V. G. The paleocenoses of Danian-Montian Foraminifera and their stratigraphic and paleogeographic importance (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 85-97, text figs. 1, 2 (diagram, graph).—Nine paleocenoses within Danian, Montian, and Thanetian beds are analyzed as to their depth, temperature, and bottom conditions, the interpretation being based on Recent zonations of Norton and Natland and on Grimsdale's and van Morkhoven's study of planktonic-benthonic ratio.

MOULLADE, M. Sur quelques Foraminifères du Crétacé Inférieur des Baronnies (Drôme).—Revue de Micropaleontologie, v. 3, No. 2, Sept. 1960, p. 131-142, pls. 1, 2, text figs. 1, 2 (columnar section, range chart).—Eight species (3 new) and 2 new subspecies described and illustrated.

MURATA, SHIGEO. Foraminifera from Sakasegawa group in the north coastal district of the Amakusa-shimoshima, Kumamoto Pref., Kyushu.—Bull. Kyushu Inst. Tech., No. 6, March 1960, p. 35-42, table 1, text fig. 1 (columnar section).—Species listed and 4 faunules recognized and placed in lower Oligocene to upper Eocene.

Foraminifera from the Nakado formation, Sakito-Matsushima coal-field, Nagasaki Pref., Kyushu.—Bull. Kyushu Inst. Tech., No. 6, March 1960, p. 43-48, table 1, text fig. 1 (columnar section).—Species listed indicate an age a little older than Aquitanian.

NEMKOV, G. I. Dimorfizm u Nummulitov.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 50-66, tables 1, 2.

NEMKOV, G. I., and BARKHATOVA, N. N. Nummulity, Assiliny i Operkuliny Kryma i ikh Znachenie Dlja Zonal'nogo Raschlenenija Ehothenovykh Otlozhenij.—Izvest. Vyssh. Ucheb. Zaved., Geol. Razved., No. 5, 1960, p. 29-43, pls. 1-4, text fig. 1 (range and abundance chart).—Illustrations and diagnoses for 25 nummulites (none new) having restricted ranges within the Eocene; 17 in **Nummulites**, 3 in **Assilina**, and 5 in **Operculina**.

OBREGÓN DE LA PARRA, JORGE. Consideraciones sobre el Daniano en la Cuenca Sedimentaria de Tampico-Misantla.—Bol. Asoc. Mex. Geol. Petr., v. 11, Nos. 1, 2, Jan., Feb. 1959, p. 13-20, pls. 1, 2 (map, chart), 2 photographs.—A **Globigerina** zone at the base of the Paleocene.

POKORNY, VLADIMIR. K Voprosy ob Ehkologii Soobshchestv Flishevykh "Peschanykh" Foraminifer.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 10-16.

DE PORTA, J., and SOLÉ DE PORTA, N. El cuaternario marino de la isla de Tierrabomba (Bolivar).—Univ. Indust. Santander (Colombia), Bol. Geol., No. 4, 1960, p. 19-44, text figs. 1-11 (map, graphs, pie diagrams, columnar sections), distribution table.—Quantitative analysis of Foraminifera from several Pleistocene levels.

RAUSER-CHERNOUSOVA, D. M. The criterion of the geographical area in the systematics of Foraminifera (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 23-31, table 1, 1 map.—Complete diagnosis of a species must be based on knowledge of its areal distribution. If such knowledge is not available, the species is conventional or a morpho-species. Recognition of geographical and chronological subspecies will simplify the systematics of Foraminifera.

REITLINGER, E. A. Importance of Foraminifera for the stratigraphy of Lower Carboniferous sediments (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 56-64, correl. table.—The boundary between

the European and North America zoogeographic provinces of the Lower Carboniferous is in Asiatic Russia and is marked by impoverished assemblages and the presence of some forms close to North American forms. Lower Carboniferous zones of the two provinces are tentatively correlated.

ROUVILLOIS, A. Le Thanétien du Bassin de Paris (Étude hydrogéologique et micropaléontologique).—Mém. Mus. Nat. Hist. Nat., Paris, n. ser., ser. C, tome VIII, 1960, p. 1-151, pls. 1-8, charts 1-17 (tables, graphs, maps, distrib. chart).—In a systematic part (p. 56-77, pls. 1-4) are described 43 species (9 new) and 2 varieties (1 new). **Sigmomorphinoides** n. subgen. (genotype **Sigmomorphina parisiensis** n. sp.) is erected for specimens having 2 apertures on the final chamber.

RUGGIERI, GIULIANO. Segnalazione de **Globoquadrina altispira** nei trubi di Buonfornello (Palermo).—Riv. Mineraria Siciliana, Anno 11, No. 61, Jan.-Feb. 1960, p. 11-15, text figs. 1-5.—**Globoquadrina altispira globosa** in lower Pliocene.

SADA, KIMIYOSHI. On the Upper Permian fusulinid fauna in the Atetsu Limestone Plateau, Okayama Prefecture (in Japanese with English summary).—Jour. Geol. Soc. Japan, v. 66, No. 777, June 1960, p. 410-425, maps, columnar sections.

SAITO, TSUNEMASA. Tertiary stratigraphy of the Kakegawa District, central Japan and its planktonic Foraminifera (in Japanese with English abstract).—Contr. Instit. Geol. and Paleont., Tohoku Univ., No. 51, Sept. 1960, p. 1-45, text figs. 1-7 (outcrop diagrams), pls. 1-6 (maps, columnar sections), charts 1-7 (maps, distrib. table, range chart, correl. table, facies diagram), tables 1, 2.—Oligocene and Miocene planktonic assemblages are analysed quantitatively. Stratigraphy is based on world-wide planktonic zones.

SEIBOLD, EUGEN, and SEIBOLD, ILSE. Über Funde von Globigerinen an der Dogger/Malm-Grenze Süddeutschlands.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. VI, Proc. sec. 6, Copenhagen, 1960, p. 64-68, text fig. 1.—Former reported occurrences of **Globigerina** in the Jurassic are confirmed by new findings (15 specimens illustrated and described in detail, 0.17-0.27 mm in diameter).

SEIGLIE, GEORGE A. Notas sobre algunas especies de Heterohelicidae del Cretacico Superior de Cuba.—Bol. Asoc. Mex. Geol. Petr., v. 11, Nos. 1, 2, Jan., Feb. 1959, p. 51-62, pls. 1-4, 4 text figs. (maps, outline drawings).—Six species (4 new) are described and illustrated. **Pseudotextularia** is emended.

SEROVA, M. JA. Ob Ontogeneze i Filogeneticheskom Razvitii Roda **Hauerina**.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 22-30, text figs. 1, 2.—Gradational series illustrating differences in size and shape of test and in complexity of aperture within as well as between several species of **Hauerina.**

Miliolidy Paleogenovykh Otlozhenij Aralo-Turgajskoj Nizmennosti.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 83-131, pls. 1-6, text figs. 1, 2, 1 range chart.—Descriptions and illustrations of 29 species (17 new) and 2 new subspecies and 7 varieties (4 new) from Paleocene to lower Oligocene of Aral-Turgai lowland.

SOSNINA, M. I. On the methods of studying Lagenidae (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 32-47, pls. 1, 2, text figs. 1-15.—The Permian genus **Pachyphloia** was studied by consecutive polished sections, cut in 3 mutually perpendicular planes. Reconstruction of internal structure and external form reveal that diverse sections of **Pachyphloia** have been misinterpreted as numerous other genera, 4 of which are synonyms of **Pachyphloia.**

Microfaunistic zones in the Carboniferous and Permian deposits of the Sikhote-Alin (in Russian with English abstract).—Internat. Geol. Congress, 21st Sess., Rept. Soviet Geologists, Problem 6, Pre-Quaternary Micropaleontology, Moscow, 1960, p. 65-68, correl. table.—In the sequence of 10 zones, the 5 Carboniferous zones are correlatable with zones in Europe and eastern Asia, while the 5 Permian zones indicate progressively greater isolation of the marine basins and formation of the Pacific province.

SOURDILLON, O. Étude micropaléontologique du Tertiaire du forage de Frouas (Landes).—Revue de Micropaleontologie, v. 3, No. 2, Sept. 1960, p. 81-94, pls. 1, 2, text figs. 1-3 (map, range and abundance charts).—Quantitative analysis of well samples with upper(?) Eocene, Oligocene, and Pliocene(?)-Miocene recognized on the basis of planktonic Foraminifera. Photographs of many of the significant species are included.

STAINFORTH, R. M. The American Oligocene.—Nature, v. 187, No. 4738, Aug. 20, 1960, p. 678-679.—Comments on physical and paleontologic evidence for its existence in the Eastern Venezuela Basin.

SUBBOTINA, N. N. Mikrofauna Oligothenovykh i Miothenovykh Otlozhenij R. Vorotyshche (Predkarpat'e).—Russia Vses. neft nauchno-issl. geol. instit. Trudy, vyp. 153, Mikrofauna SSSR, Sbornik 11, 1960, p. 157-263, pls. 1-10, tables 1-4.—About 50 species and varieties (32 species and 2 varieties new) described and illustrated from Oligocene and Miocene formations of the Carpathian foothills.

SUBBOTINA, N. N., PISCHVANOVA, L. S., and IVANOVA, L. V. Stratigrafija Oligothenovykh i Miothenovykh Otlozhenij Predkarpat'ja po Foraminiferam.—Russia Vses. neft. nauchno-issl. geol. instit. Trudy, vyp. 153, Mikrofauna SSSR, Sbornik 11, 1960, p. 5-155, pls. 1-14, tables 1-7.—Seventy-nine species and varieties (26 species and 1 variety new) described, illustrated, and recorded in beds of Oligocene and Miocene age in the Carpathian foothills.

SULEJMANOV, I. S. O Mikrostrukture Stenki Rakovin Nekotorykh Vidov Tekstulariid v Svazi s ikh Paleoekologiej.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 37-40, text-fig. 1.—Illustrations of two new **Textularia** of upper Campanian age.

TAKAYANAGI, YOKICHI. Cretaceous Foraminifera from Hokkaido, Japan.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), v. 32, No. 1, Nov. 1960, p. 1-154, pls. 1-11, text figs. 1-22 (maps, columnar sections, graphs, outline drawings), tables 1-12.—From study of samples from many sections, two assemblages are recognized, divisible into 10 units of the Japanese time scale ranging from Aptian to Campanian. The lower assemblage, characterized by arenaceous species, lived under fluctuating environments of rapid deposition in a sinking area while the upper assemblage, characterized by calcareous species, lived under stable conditions in a neritic environment. Systematic illustrated catalog includes 158 species (40 new) and 8 subspecies (3 new). **Asanospira** n. gen. (type species **Lenticulina(?) teshioensis** Asano) in the Lituolidae and **Pseudopatellinella** n. gen. (type species **P. cretacea** n. sp.) in the Rotaliidae.

TOCORJESCU, MARIA. Considérations micropaléontologiques sur la limite Crétacé-Éocène (French summary of Rumanian text).—Acad. Repub. Pop. Romîne, sec. Geol. Geogr., tom. 5, No. 2, 1960, p. 277-297,

tables 1-4.—Six subzones are recognizable in the Flysch of the eastern Carpathians. Danian, containing "agglutinants" and lacking both globotruncanids and globigerinids, is regarded as the end of the Cretaceous.

TOLLMANN, ALEXANDER. Die Foraminiferenfauna des Oberconiac aus der Gosau des Ausseer Weissenbachtales in Steiermark.—Jahrb. Austria Geol. Bundesanstalt, Jahrg. 1960, Band 103, Sept. 1960, p. 133-203, pls. 6-21, text figs. 1, 2, (maps).—Records and illustrates 101 species and subspecies, 2 species new and 1 given a new name.

VENGLINSKI, I. V. O Stroenii Stenki Rakoviny Nekotorykh Agglutinirovannykh Foraminifer.—Akad. Nauk SSSR, Voprosy Mikropaleontologii, vyp. 3, 1960, p. 31-34, pls. 1, 2.—Illustrations of some Miocene agglutinated species.

VILLA, FLORIANO. Contributo allo studio stratigrafico della serie permotriassica del Monte Marzola (Trento). Parte II. Studio micropaleontologico.—Riv. Ital. Pal. Stratig., v. 65, No. 2, 1959, p. 117-130, pls. 2, 3.

VILLA, F., and PIZZOCHERO, M. L. Osservazioni stratigrafiche e micropaleontologiche preliminari sulle serie Oligo-Mioceniche della Val del Lemme e del Torrente Orba.—Boll. Soc. Geol. Ital., v. 77, fasc. 3, 1958, p. 1-6.—Foraminifera listed.

VINOGRADOV, C. La limite Crétacé-Paléogène dans le bassin de la Prahova (French summary of Rumanian text).—Acad. Repub. Pop. Romîne, sec. Geol. Geogr., tom. 5, No. 2, 1960, p. 299-324, pls. 1-6, tables 1, 2, text fig. 1 (sections).—The Maestrichtian-Danian boundary is regarded as the Cretaceous-Paleogene boundary. Planktonics are illustrated from both sides of the boundary.

VOLOSHINA, A. M. Two microfaunal complexes from the upper Tortonian of the southwestern border of the Russian platform (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj RSR, Kiev 1958, No. 3, p. 307-309.—Lists of species from the two different facies.

VAN VOORTHUYSEN, J. H. Die Foraminiferen des Dollart-Ems-Estuarium, **in** Das Ems-Estuarium (Nordsee), ein Sedimentologisches Symposium.—Verh. Kon. Nederl. Geol. Mijnb. Genootschap, Geol. Ser., deel 19, Oct. 1960, p. 237-269, pls. 1-11 (maps, graphs, drawings of Foraminifera).—Quantitative study of Foraminifera (the 5 major species) from about 350 samples across 9 bottom profiles within the estuary. About 75 species and varieties are recorded and many illustrated, including one new, **Goesella waddensis.**

WALLER, HARRY O. Foraminiferal biofacies off the South China coast.—Jour. Paleontology, v. 34, No. 6, Nov. 1960, p. 1164-1182, text figs. 1-15 (maps, graphs), tables 1, 2.—Quantitative analysis of about 147 bottom samples from Asiatic Shelf, southwest of Taiwan to Gulf of Tonkin, shows 4 depth dominant faunas between 54 and 660 feet with boundaries at 150, 275, and 400 feet. There are 116 species reported, of which 46 are restricted as to depth. Foraminiferal number, species number, and percentage of planktonics increase with depth. Pronounced sudden decrease in planktonics is attributable to debouching river water.

WOLOSCHYNA, A. M. Novyj Tortonskij Vid **Ehrenbergina podolica.**—Akad. Nauk SSSR, Paleont. Zhurnal, 1960, No. 3, p. 137-138, text fig. 1.—**Ehrenbergina podolica** sp. nov. from lower Tortonian of Podolia.

ZERNETSKY, B. F. First finds of large **Nummulites distans** Desh. in the Eocene deposits of the northern Black Sea area (in Ukrainian with English summary).—Dopovidi Akad. Nauk Ukrainskoj, RSR, Kiev, 1959, No. 4, p. 420-423, map, 3 text figs.

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