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238. THE GENUS *BIREOPHAX*, A SYNONYM OF *THOMASINELLA*

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ABSTRACT

Evidence is given to show that **Bireophax** is a junior synonym of **Thomasinella.** The latter genus is a bifurcating, arenaceous form in contrast to the uniserial genus, **Reophax.** The five described species of **Thomasinella** are probably synonymous.

C. H. Squyres of the Oasis Oil Company of Libya has kindly drawn the author's attention to the fact that *Bireophax* Bolli, 1960, appears to be synonymous with *Thomasinella* Schlumberger, 1893. Mr. Squyres indicated further that *Bireophax guaricoensis* described from Venezuela is probably a synonym of *Thomasinella aegyptia* described by Omara in 1956. A specimen of *Thomasinella aegyptia* subsequently received confirmed that the two species are, in fact, synonymous.

The genus *Thomasinella* is omitted from most textbooks, and can not be found in Cushman's (1948) *Foraminifera,* in Glaessner's (1945) *Principles of Micropalaeontology* or in Pokorný's (1958) *Grundzüge der zoologischen Mikropaläeontologie.* Galloway (1933), in his *Manual of Foraminifera,* lists *Thomasinella* as a *nomen nudum,* which it was, in fact, as first published by Schlumberger (1889). No species was at that time described under the generic name *Thomasinella,* nor was any other species designated as type species. Only in 1893 did Schlumberger (*in* Thomas, 1893) describe the two species *Thomasinella punica* and *T. rugosa,* but again he did not designate a type species for the genus.

Dr. A. R Loeblich, Jr., has supplied the writer with additional information on the status of the genus *Thomasinella.* This information was prepared for publication in the forthcoming volume on Foraminifera in the *Treatise of Invertebrate Paleontology.* The writer is most grateful to Dr. Loeblich for giving him the opportunity to make use of it in this note. According to this information, *Thomasinella* became a valid genus with the description of the species *Thomasinella punica* and *T. rugosa,* even though neither of the two was designated as type species. In the same year, however, *Thomasinella punica* was subsequently designated as type species by Schlumberger (*in* Peron, 1893) on the explanation to plate 14.

Omara, in 1956, emended the original generic definition of *Thomasinella* by including unbranched uniserial, linear or slightly curved arenaceous Foraminifera, distinguished by simple terminal apertures. He attempted to demonstrate the ontogenetic relationship from uniserial to bifurcating forms on his text figure 1. From the illustrations given by Omara and from direct observations on Venezuelan material, it appears, however, that the unbranched uniserial forms belong, in fact, to *Reophax* and can clearly be separated from the bifurcating *Thomasinella.*

Because of the fragile, multiple branching most collected specimens of *Thomasinella* are broken and the initial stages are, therefore, comparatively scarce. Not one of Omara's twenty figures of bifurcating forms shows the initial chambers, whereas of the seven uniserial forms figured only one shows the initial portion missing. Of the several hundred specimens examined in Venezuela, the author encountered only a few that contained the initial chambers; most of them were figured in Bolli (1960, pl. 1, figs. 1, 2, 4, 5, 9).

The uniserial *Reophax* specimens that apparently are often associated with *Thomasinella* can be further separated from the latter by their chamber shape. The chambers in the *Reophax* specimens are as a rule more globular and higher in relation to their width than is the case in comparable *Thomasinella* chambers. Especially, the final chambers of the uniserial forms (*see* Omara 1956, text fig. 1, figs. 1-4; pl. 101, fig. 3) are elevated, while in the branching forms, the chambers just before the onset of bifurcation (*see* Omara 1956, text fig. 1, figs. 7-10; pl. 101, figs. 1, 6) become reduced in height compared with their width and, in addition, are arched. The author, therefore, never had any difficulty in distinguishing these two genera in the Venezuelan material studied. In Omara's text figure 1, the line between *Reophax* (figs. 1-4) and *Thomasinella* (figs. 5-10) also can be clearly drawn. Another criterion that assists in the distinction of *Reophax* and *Thomasinella* can be a difference in the composition of mineral grains forming the wall. Compared with the *Thomasinella* specimens from Guarico, Venezuela, the associated *Reophax* specimens are often made up of larger mineral grains with glauconite fairly dominant and with the cement either non-calcareous or only slightly calcareous.

On this evidence, it is proposed that *Thomasinella* should be restricted to include only the bifurcating arenaceous forms as defined by Schlumberger and later by the author under the synonym *Bireophax.*

To the author's knowledge the following five species of *Thomasinella* have been described so far: *T. punica* Schlumberger, *T. rugosa* Schlumberger, *T. aegyptia* Omara, *T. fragmentaria* Omara and *T. guaricoensis* (Bolli). By direct comparison *Thomasinella aegyptia* and *T. guaricoensis* are obviously synonymous. It appears that great variation exists in each described species. It is, therefore, the author's contention and also Dr. Loeblich's (personal communication) that a careful comparative study of the five species will probably show that they are, in fact, inseparable. This assumption is supported by the apparently short and probably identical stratigraphic occurrence of all five species.

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239. THE STATUS AND TYPE SPECIES OF *CALCARINA*, *TINOPORUS* AND *EPONIDES* (FORAMINIFERIDA)

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ABSTRACT

Calcarina d'Orbigny, 1826, is recognized as a valid genus, with **Nautilus spengleri** Gmelin, 1788, as type species. **Tinoporus** Montfort, 1808, is regarded as unrecognizable, as the original specimens of the type species, **T. baculatus**, are not preserved, the type locality is ambiguous and the original figure and description could equally well represent the type species of at least three well-defined genera occurring in the localities mentioned. **Eponides** is recognized as valid, and a neotype designated for its type species, **Nautilus repandus** Fichtel and Moll, 1798.

Some authors have questioned the validity of the genus *Calcarina* d'Orbigny, 1826, largely because of question as to the type species and how and by whom it was first legally designated. *Tinoporus* has variously been regarded as equivalent to or as replacing any one of three or more other generic names, as its type species is also doubtful. *Eponides* has been recognized by some authors, but regarded as a *nomen dubium* by others, with new names unnecessarily proposed for the same group of species.

The status of all three genera is fully discussed below and the usage being followed by the writers in preparation of the *Treatise on Invertebrate Paleontology* is explained.

Genus **Calcarina** d'Orbigny, 1826

Calcarina D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 276.

The type species of *Calcarina* has been variously stated to be *Nautilus spengleri* Gmelin, 1788, or *Calcarina calcar* d'Orbigny, 1826, and the genus has been recognized by some authors and has been considered a junior synonym of *Tinoporus* Montfort, 1808, by others.

D'Orbigny originally included in *Calcarina* the following species: 1. *calcar* (new species, included in the Modèles, but neither described nor figured, hence a *nomen nudum*, and in spite of the tautonymous name cannot be the type species), 2. *gaimardii* (new species, not described or figured, hence a *nomen nudum*), 3. *defrancii* (illustrated on pl. 13, figs. 5-7'), 4. *spengleri* (Gmelin, 1788, p. 3371, sp. 10) (a valid previously described species, with references given in the synonymy listed by d'Orbigny), 5. *gaudichaudii* (new species, not described or figured, hence a *nomen nudum*) and 6. *quoyi* (new species, not described or figured, hence a *nomen nudum*).

Parker and Jones (1863) discussed the species given by d'Orbigny in the 1826 Annales des Sciences Naturelles article and (on p. 431) listed species adopted by d'Orbigny from earlier authors. They state under the discussion of *Calcarina spengleri* (Gmelin) that "among the synonyms of this species, D'Orbigny has *"Tinoporus baculatus,* Montf."; this, however, according to Montfort's figure, has more of *Orbitolina* than of *Calcarina* in it; and Dr. Carpenter proposes to use the term *"Tinoporus"* instead of *"Orbitolina"* (Introd. Foram. p. 224)." Parker and Jones (1863, p. 439) state of *Calcarina defrancii* d'Orbigny (the only species illustrated by d'Orbigny), "This is a variety of *C. Spengleri."*

Parker and Jones (1859, p. 482) gave a *"Tabular List of the* Foraminifera *enumerated by* Linné *and* Gmelin," with two columns, one giving "Linnaean names" and the other "typical species and subspecies." In each case the second column cited species they recognized as the type species: *Cristellaria calcar, Nodosaria raphanus, Polystomella crispa, Rotalia beccarii, Peneroplis planatus, Quinqueloculina seminulum,* etc. Under Linnaean names they list *"Nautilus Spengleri* Gm." and opposite it in the column citing types they list *"Rotalia (Calcarina) Spengleri."*

In the later publication by Parker, Jones and Brady (1865, p. 36) in discussing d'Orbigny's models they list the following species of *Calcarina,* in columns as below.

Type	Corrected name	Pl.	Fig.	D'Orbigny's name	Models	
					Livr.	No.
Calcarina Spengleri, *Linn.*	Calcarina Spengleri, *Linn.*	III	87	Calcarina Calcar	2	34
	——— armata, *D'O.*	III	88	Rotalia armata	3	70
	——— bisaculeata, *D'O.*	III	89	——— bisaculeata	1	15
	——— laevigata, *D'O.*	III	90	Siderolina laevigata	4	89

Under a discussion of one of these species, *Rotalia bisaculeata,* Parker, Jones and Brady (1865, p. 21) comment, "This is rather a subvariety of the Rotaline genus *Calcarina,* of which Model no. 34 may be taken as type." Galloway (1933, p. 312) regarded the "genotype (by absolute tautonomy, and designated by Parker, Jones and Brady, 1865)" to be *Calcarina calcar,* considering the last given quotation of Parker, Jones and Brady to be a type citation. This was followed by Finlay (1939, p. 525). Cushman (1948, p. 302) also quoted the above sentence of Parker, Jones and Brady and stated, "This is very ambiguous and may have two interpretations, and the species as already noted may be a *Rotalia.*" He added that "The reference of Parker and Jones (sic), as to the type, is very obscure when their whole sentence is considered, and *Nautilus spengleri* is here considered as the genotype."

Of the six species originally included, four were *nomina nuda* in the original publication, *defranceii* was illustrated but not described (according to the Rules of Nomenclature this was a valid "indication" prior to 1930), and *spengleri* was a valid and previously described species. Even if validated later, *Calcarina calcar* could not become the type species of *Calcarina,* for as noted by Smout (1955, p. 206), it was a *nomen nudum* in the original publication, and other valid species were then included. The question of tautonomy has no bearing in this case. When the genus was described, only *Nautilus spengleri* and *Calcarina defranceii* were valid species and therefore available for original or subsequent designation as type species. Both the tabular references by Parker and Jones (1859, p. 482) and Parker, Jones and Brady (1865, p. 36) refer to *Calcarina spengleri* as "type," and their erroneous inclusion of other forms as synonyms can have no bearing on its status (Parker and Jones, 1860, p. 341, also included *Siderolites calcitrapoides* Lamarck as a synonym of *Calcarina spengleri* and Smout (1955, p. 206) considered *Calcarina* a synonym of *Siderolites*).

Thus the type species of *Calcarina* is *Nautilus spengleri* Gmelin, 1788, fixed by subsequent designation by Parker and Jones (1859, p. 482).

Genus **Tinoporus** Montfort, 1808

Tinoporus MONTFORT, 1808, Conch. Systém., v. 1, p. 146.

Tinoporus Montfort was monotypic, hence the type species is *T. baculatus.* The validity of the genus rests on the status of the type species. Generic and specific limits were then more broadly understood, and all later workers have agreed that Montfort's figure and description were composites. D'Orbigny (1826, p. 276) described *Calcarina* and under the generic heading included "*Siderolite,* Lam., Blainv.; *Tinopore* ? et *Cortale* ? Montf.," indicating that he questioned whether Montfort's *Tinoporus* (or part of it) might be equivalent to *Calcarina,* but did consider *Siderolites* as synonymous. In the synonymy listed for *Calcarina spengleri,* d'Orbigny listed *Tinoporus baculatus* Montfort, and *Siderolites calcitrapoides* both as synonyms of *Nautilus spengleri.*

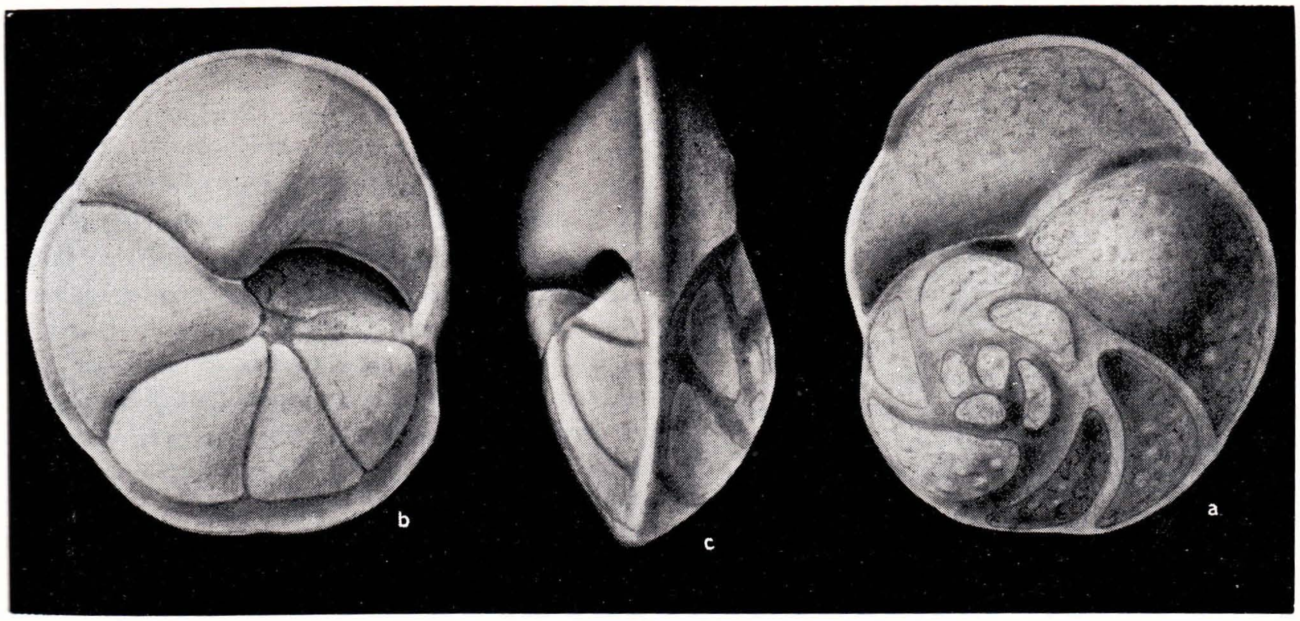
Parker and Jones (1860, p. 341) discussed Montfort's description of *Tinoporus* as follows "Modified from the figure of *Calcarina Spengleri,* var. α, F. & M.; or, rather this is apparently a curious hybrid picture, consisting of a three-spined *Orbitolina,* according to its surface-ornament and its vertical section, but outlined after a three-spined *Calcarina Spengleri* (such as fig. *e.* pl. 15, in Fichtel and Moll's 'Test. microsc.'). The indication of an aperture (the broken newest chamber in *Calcarina*) is also after Fichtel and Moll's figure. The sectional aspects in Montfort's woodcut appear to have been taken, the *vertical* (Orbitoline) from nature, the *horizontal* (Calcarine) from Fichtel and Moll's fig. *k.* with the sectional feature of the spine (also Calcarine) added from some other source. Some stellate variety of *Orbitolina sphaerulata* may perhaps claim the name of *O. baculata,* Montf.; but Montfort's indefiniteness may well lead us to drop the name altogether."

Sacco (1893, p. 206) stated that *Tinoporus baculatus* was a "variety" *of Calcarina* (*Siderolites*) *spengleri* (L.), as indicated by the irregular spines, large and regularly arranged chambers (although these characters were exaggerated and idealized in Montfort's illustration), an externally visible aperture, and the occurrence of the species in the Adriatic Sea. This interpretation was followed by Galloway (1933) and by Finlay (1939). Because *Nautilus spengleri* is the type species of *Calcarina,* this would apparently place *Calcarina* as a synonym of *Tinoporus.*

The Pacific species referred to *Tinoporus baculatus* by Carpenter (1862), Brady (1884), etc., were stated by Sacco to be distinct from *T. bacculatus* of Montfort, and Sacco placed the Pacific species (under the specific name *sphaerulata* Parker and Jones) in a new genus, *Baculogypsina,* even though Parker and Jones had themselves earlier regarded *T. baculatus* Montfort as equivalent to *Orbitolina sphaerulata.* Hofker (1927, p. 12) also regarded *O. sphaerulata* as a synonym of *Tinoporus baculatus,* but Galloway (1933, p. 312) followed Sacco's interpretation stating that *Tinoporu* of Carpenter, Brady, Chapman, Cushman (up t 1919) and others is *Baculogypsina,* and recognized *Tinoporus,* considering the type species to be a synonym of *Nautilus spengleri.*

Cushman (1948, p. 302) followed Parker and Jones (1860) and stated that Montfort included two genera in *Tinoporus,* "both in the composite figure and the description, and as such is entirely invalid." Küpper (1954, p. 28) stated "Since it is difficult to recognize Montfort's type on account of inadequate description and poor illustration the use of this genus is not recommended. Although *Tinoporus* has priority over *Calcarina,* it is advisable to maintain the name *Calcarina* because of its clear definition and better illustration." Smout (1955, p. 205, 206) regarded both *Calcarina* and *Tinoporus* as synonyms of *Siderolites.*

The figures given by Montfort have thus been variously interpreted to represent either that form now regarded as *Calcarina spengleri* (as it was considered by Sacco, Galloway and Finlay) or that now considered to be *Baculogypsina sphaerulata* (as was done by Parker and Jones, Carpenter, Brady, etc.). The "Adriatic occurrence" is not a valid reasoning by Sacco, as Montfort gave the Adriatic occurrence last, stating (1808, p. 148) "L'individu qui a servi de sujet à notre description venoit de la mer des Indes orientales; on le trouva dans le sable dont étoit remplie une coquille du genre casque: on rencontre encore les tinopores parmi d'autres coquilles microscopiques, sur les plages du golfe arabique, ainsi que dans quelques éponges de la mer Adriatique." Thus the "individual" used by Montfort was from the East Indies and not the Adriatic, and Montfort stated only that the species occurred also in the Gulf of Arabia and Adriatic Sea. This leaves considerable doubt as to whether Montfort's specimen was actually the same as *Nautilus spengleri* (= *Calcarina*), *Orbitolina sphaerulata* (= *Baculogypsina*) or possibly *Baculogypsina floresiana* (= *Schlumbergerella*), each species the type of its respective genus. In the interest of stability of nomenclature, *Tinoporus* is therefore here suppressed as unrecognizable on the basis of the type species, which might be conspecific with the type species of any of the three other genera cited. *Calcarina* (type, *Nautilus spengleri*), *Baculogypsina* (type, *Orbitolina sphaerulata*) and *Schlumbergerella* (type, *Baculogypsina floresiana*) are all recognized as valid.



TEXT FIGURES a - c
Eponides repandus (Fichtel and Moll). Recent, Bay of Naples, Italy. a) spiral, b) umbilical and c) edge views of neotype, here designated, × 50.

Genus **Eponides** Montfort, 1808

Eponides MONTFORT, 1808, Conch. Systém., v. 1, p. 126, type species: *Nautilus repandus* Fichtel & Moll, 1798, fixed by original designation.

Pulvinulus LAMARCK, 1816, Tab. Encycl. Method., pt. 23, v. 3, p. 14, type species: *Nautilus repandus* Fichtel & Moll, 1798, fixed by subsequent designation by Galloway (1933, p. 281).

Placentula LAMARCK, 1822, Hist. Anim. s. Vert., v. 7, p. 620, type species: *P. pulvinata* Lamarck, 1822, = *Nautilus repandus* Fichtel & Moll, 1798, fixed by subsequent designation by Children (1823, p. 157).

Pulvinulina PARKER & JONES *in* CARPENTER, 1862, Introd. Study Foram., p. 200, 210, type species: *Nautilus repandus* Fichtel & Moll, 1798, fixed by original designation.

Eponidopsis REISS, 1960, Israel Geol. Survey, Bull. 29, p. 16, type species: *Eponides lornensis* Finlay, 1939, fixed by original designation.

A number of articles in recent years have discussed the status of *Eponides.* Originally described over a century and a half ago, the generic name was not in common use for about two-thirds of that time. The type species of *Eponides* (*Nautilus repandus*) was later given as the type for a later genus *Pulvinulina* Parker and Jones *in* Carpenter (1862, p. 200, 210), and the specimen figured by Jones, Parker and Brady (1866, pl. 2, figs. 22-24) from the English Pliocene was not like that of Montfort (but is congeneric with *Sestronophora* Loeblich and Tappan, 1957). Similarly, the form illustrated by Brady (1884, pl. 104, fig. 18) is not conspecific (or congeneric) with either of the earlier mentioned forms, but has been regarded as *Alabamina* by Hofker (1950, p. 15) and as probably

Poroeponides by Barker (1960, expl. pl. 104). The junior objective synonym *Pulvinulina* was in general use by the English school for half a century. These early British workers were extremely conservative as to both generic and specific limits even including as varieties of a single species, forms now generally recognized as genotype species of five or more genera, but these erroneous later assignments can have no bearing on the validity of the type species (*repandus*) or that of the genus *Eponides*.

Cushman (1927a, p. 76; 1927b, p. 170) recognized *Eponides* for *Pulvinulina* of later authors and for *Pulvinulus* of Lamarck because the latter two were isogenotypic synonyms. Cushman reillustrated Fichtel and Moll's figures and stated (1946, p. 6) that, "From the appearance of the type figure given by Fichtel and Moll, it is evidently incorrectly drawn . . . . If the type specimen is still in existence, a study of it should be made to determine the true characters of the species. It is from Recent material from the Mediterranean." As to the preservation of the types, Cushman stated (1946, p. 3), "I had hoped that the original types might have been preserved in the Museum at Vienna where I found many of the earlier types in 1932, but they were not available at that time."

Redmond (1949, p. 20) again copied the original figures and translated the original description for *Nautilus repandus* and *Eponides*. Because figures and descriptions given by the two original publications agreed closely, he regarded *Eponides* as probably unrecognizable, as these did not agree with *Eponides repandus* as understood by later workers. Hofker (1950, p. 16) gave a redefinition of the genus, which agrees with the general usage of the present time, but added, "The genotype may be *Eponides repandus* from the coast of Chile or *Eponides frigidus* from the North Atlantic." Fichtel and Moll stated that they had a single specimen, and Montfort's figure and description were both apparently modified from those of Fichtel and Moll. The species was stated by Montfort to be rare in algae in the Mediterranean, but there is no indication that he actually had access to specimen(s). *Eponides frigidus* is a cold water species, and belongs to *Buccella* Andersen, and neither specimens from the coast of Chile nor the North Atlantic can be considered as typical since Montfort stated only that the genus occurs in the Mediterranean Sea, as was also noted by Cushman (1946). Recently Hofker (1960, fig. 146) illustrated a characteristic example as *Eponides repandus* from the Recent of the Bay of Naples at about 100 meters in depth.

Reiss (1960, p. 2) reviewed the above-mentioned discussions of Redmond, Hofker, and others, rejected *Eponides* as a *nomen dubium* and proposed a new generic name *Eponidopsis* for the group of species that has been commonly referred to *Eponides*, without commenting on the other available generic names, *Pulvinulus* Lamarck, 1816, *Placentula* Lamarck, 1822, and *Pulvinulina* Parker and Jones, 1862. All of these clearly have priority over *Eponidopsis*, for the argument could well be proposed that these later workers were not concerned with the same species as that of Fichtel and Moll and the Zoological Rules allow for such cases of misidentified genotype species.

It seems both unnecessary and unwise to suppress a name in common use for 35 years merely to resurrect an unused synonym or to propose additional taxa, when the type species can be recognized, as it was by Hofker (1960), in the type area of the Mediterranean, and the later included non-congeneric forms were from other strata or regions. The present instance seems to be one in which selection of a neotype would further stability of nomenclature. Inasmuch as Fichtel and Moll's types were not found by Cushman in 1932 and have not been reported as in existence for the past 164 years, in spite of the numerous articles questioning the status of this and other genera, they must be presumed lost. The proposed neotype of *Nautilus repandus* (= *Eponides*) is deposited in the U. S. National Museum, Washington, D. C. and here illustrated (*see* text figs. a-c). It is from the Bay of Naples and is similar to the specimen illustrated and described by Fichtel and Moll, allowing for the generalized original figures. No areal pores occur in the apertural face as they do in the *Pulvinulina repanda* of Brady (= *Poroeponides*) from the Atlantic. The umbilical side is somewhat roughened in appearance due to the thick wall and granules of secondary calcite. Both the descriptions given by Fichtel and Moll and by Montfort state the original specimen to be ½ line (approximately 1 mm.) in diameter, as is the present specimen. The test proportions, convexity and apertural characters also agree. The greater number of chambers shown in Fichtel and Moll's illustration of the side view is due to the sharp angle of the apertural face, which suggests at low magnification that a septum might occur at that position. Reference to the marginal lobulation of Fichtel and Moll's figure suggests strongly that additional "sutures" were erroneously drawn in by the artist. The illustration given by Montfort is apparently redrawn from the edge view of Fichtel and Moll.

Recognition of this specimen as a neotype validates a commonly used generic name, which has been cited in all major texts and treatises on the Foraminifera for nearly a third of a century (Colom, 1946, p. 251; Glaessner, 1945, p. 146; Cushman, 1948, p. 291; Bermúdez, 1952, p. 48; Sigal *in* Piveteau, 1952, p. 226; Le Calvez *in* Grassé, 1953, p. 246, 247; Pokorný, 1954, p. 217 and 1958, p. 319; Matthes, 1956, p. 81; Rauzer-Chernousova and Fursenko, 1959, p. 269, etc., to cite a few in a half dozen languages) and has served as the basis for both family (Hofker, 1951, p. 321) and subfamily (Subbotina *in* Rauzer-Chernousova and Fursenko, 1959, p. 269) names. Thus, the resurrection of previously suppressed objective synonyms or adoption of still additional new names will not be required.

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240. NOMENCLATURAL PROBLEMS INVOLVING FORAMINIFERA

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Two articles by Cole (1961) and Cole and Applin (1961) in these Contributions, both dealing with nomenclature and taxonomy of larger Foraminifera, provoke the important question: Is it useful that every specialist have his own concept of specific and generic units? There certainly is no possibility of prescribing uniform concepts but there is no necessity either that they should become a set of labels for the author's convenience. If everyone had his own set of labels, which moreover changed repeatedly, in the end each person would be able to read only his own papers. This article certainly is not meant as a special criticism of Cole's work; it merely offers the opportunity of putting the question and I can well imagine that others read my papers with similar questions.

Some points may be raised:

Many authors have emphasized the fact that the usually adopted subgeneric classification of *Lepidocyclina* is far from ideal because of the frequently observed intergradation in populations. As a consequence, it is certainly not advisable to give too much weight to these subgenera. Nevertheless, they have been used for a long time, especially because of their stratigraphic value, and there has been general agreement about the way these subgenera are to be used. Apart from whether the lumping together is correct, with which I do not necessarily disagree, the question may be raised as to whether it is practical to give to the subgenus *Eulepidina* a completely new, wider meaning (Cole, 1961, p. 143). For example, a figure of a European *L. tournoueri* is said to show "typical eulepidine kind of embryonic chambers" (p. 145, pl. 16, fig. 1), although the author of the subgenera, H. Douvillé, considered *L. tournoueri* to be the typical representative of the European *Nephrolepidina*. Cole's figure is a good illustration of Douvillé's *Nephrolepidina* type but certainly not of the *Eulepidina* type of this French author. Nobody, unless they carefully read Cole's paper, will appreciate, or even notice, the different concepts of *Eulepidina* now in existence. If, moreover, the intergradation of (sub)generic features in one population condemns to death their separate existence in nomenclature, it is to be feared that the four still existing subgenera of *Lepidocyclina* recognized by Cole (p. 143) will soon become united, following the example of the camerinids (p. 144).

This latter group furnishes another example of very private ideas. One must admire Cole for his valiant defense of the name *Camerina* against the decision of the International Commission of Zoological Nomenclature but it is not sensible since it causes confusion to those who do not know Cole's papers thoroughly. Moreover, it sets a bad example by neglecting the discipline without which nomenclature would become a tremendous mess.

Cole (1961, p. 142) lays much weight, in generic distinctions, on interbreeding populations, whatever that term may mean in paleontology, but it is strange to note that this concept cannot be applied for species limits. His classification of the Miogypsinidae (1957) recognizes but few species, of very wide concept, but still their limits cut across what to me could be samples of single populations. An example is illustrated (1961, pl. 7) on this plate where a number of miogypsinids from a single level of one boring are figured. Regarding the nepionic features, I see no criteria for the distinguishing of representatives of two separate populations. The individuals used for figures 7 and 11, apart from being photographed from different sides, are to me hardly different. Nevertheless, they are placed in two different species. Moreover, the topotypes of one of these species, *Miogypsina antillea,* do not resemble Cole's specimens at all. In my opinion, there is no reason to recognize more than one species, probably *M. tani,* for these figured individuals.

Although our species concepts differ, I understand, though sometimes with difficulty, Cole's papers on the Miogypsinidae but I believe that it will be difficult for others less interested in this group to do so.

If we wish to base our species on what are thought to be remnants of populations, which is the method certainly closest to the neontological species concept, we must accept their variation in all cases and not only when it falls within the limits of our imaginary species. We cannot give the species a typological basis, because we refuse to apply statistical methods. Cole's (1957, p. 318) reasons for not using such methods do not appear to me to be sufficiently good when he says that they are too troublesome for the industrial paleontologist, cause "undue confusion," and give a terminology that is more confusing and seemingly expresses species relationships in a less natural manner. These statements are seriously doubted but this, of course, is a matter of opinion and is not advanced as necessarily the correct one.

Once more, it should be emphasized that these remarks are not intended as a special criticism of Cole's papers, since for that a personal letter would be more convenient. It is necessary that we should all consider, at least once in a while, the basis of systematics and the resulting nomenclature. In so doing, we must question ourselves to see whether or not a proposed change, however correct we may think it is, will lead to greater confusion. This is certainly the case if we frequently change our ideas and publish them without considering whether or not the changes are really worthwhile.

Another example of causing nomenclatural confusion, of a different type, is clearly criticized in the same issue of the Cushman Contributions in the article by Ruth Todd (1961) on lectotypes and neotypes. In my opinion, she correctly condemns the practice of reviving forgotten specific names to replace widely used ones simply because there is a Law of Priority. Such a practice is indeed jut another way of adding to the confusion.

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241. PERMIAN FOSSILS OF THE KETTLE FALLS AREA, STEVENS COUNTY, WASHINGTON

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ABSTRACT

The Mission Argillite at Kettle Falls, Washington, is composed of metavolcanic rocks, argillite, graywacke, chert-pebble conglomerate, siltstone, and limestone bioherms. The siltstone contains numerous brachiopods (**Muirwoodia** sp., **Anidanthus minor**, **Rhyncopora** sp., **Chonetes** sp., **Orthotetes** sp.), gastropods (**Pleurotomaria euglyphea**, **Euphemites urii**), pelecypods (**Pleurophorus? tropidophorus**), scaphopods (**Dentalium** sp.), crinoid stems and plant fragments. The bioherms, which are found within the siltstone unit, contain fusulines of three species (**Parafusulina antimonioensis**, and two new species, **Pseudofusulinella stevensi** and **Schwagerina missionensis**) previously unknown in Washington. Specimens of these species are described in detail. On the basis of the kinds and distribution of the fossils, especially the fusulines, it is concluded that the deposition of the siltstone unit of the Mission Argillite began in late Leonardian time and continued into early Guadalupian time.

INTRODUCTION

The purpose of this paper is 1) to establish, on the basis of a study of a variety of fossils, the age of the rocks of the Kettle Falls area and 2) to describe in detail three species of fusulines hitherto unreported from Washington.

Kettle Falls is located on U. S. Highway 395 (State Highway 3) about 90 miles north of Spokane, northeastern Washington. It is in the valley of the Colville River about two miles northeast of its confluence with the Columbia River.

Preliminary geologic mapping in the Kettle Falls area (text fig. 1) was done by the senior author while conducting a Washington State University geology field methods course in 1957. Additional work was done in 1959 and 1960 while making a study of the limestone resources of eastern Washington for the State Division of Mines and Geology. During the course of the mapping, abundant and well preserved fusulines, brachiopods, bryozoa, gastropods, pelecypods, and tetracorals were collected from the Permian rocks. The fusulines and brachiopods, especially the fusulines, received most of our attention in this report. McLaughlin and Simons (1951) have described a single mid-Permian fusuline species, *P. dunbari* Needham, from the locality MS, text figure 1. A few of the pelecypods and gastropods have been described by Dixon (1958) and are referred to later in this paper. The tetracorals will be described in a later publication.

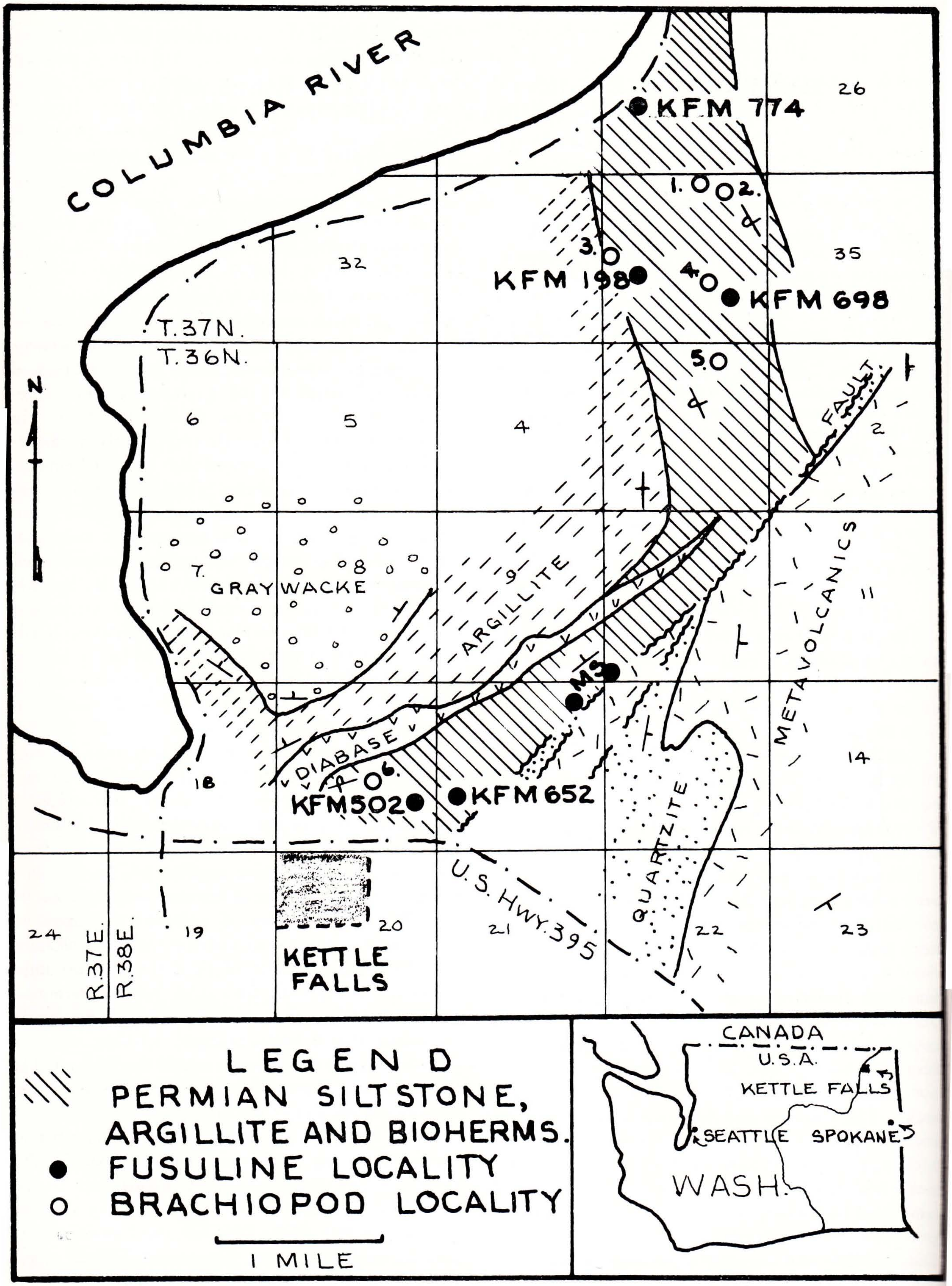
GEOLOGY

The geology of the Kettle Falls area is described by Weaver (1920) in his report on the geology of Stevens County. He includes all of the sedimentary rocks of the area illustrated in text figure 1 under the formation name Mission Argillite. He describes (1920, p. 73) the Mission Argillite as follows:

> "The formation comprises banded and massive argillites, calcareous argillites, quartz-mica schists, and narrow intercalated bands of quartzite and limestone. Argillites and quartz-mica schists predominate as constituents of the formation. In places the argillites are only very slightly metamorphosed and are in composition not far removed from indurated clay-shales. They grade into as well as alternate with black, slaty, carbonaceous argillites. In some places they become very calcareous and approach in composition argillaceous limestones. Bands of pure white limestone varying in thickness from two to over one hundred feet occur interbedded with the argillites. In places these limestone bands are so persistent that they can be traced for several miles and have been mapped as undifferentiated limestones but are to be regarded as constituent parts of the Mission argillite formation."

There are five distinctive rock units that compose the Mission Argillite in the area illustrated by text figure 1. Two units—quartzite and metavolcanics (andesites, tuffs, agglomerate)—comprise the southeastern part of the map area and are separated from three other units—siltstone, argillite, and graywacke—in the northwestern part of the map area by a northeast trending fault zone of unknown displacement. The quartzite appears to underlie the metavolcanics, and the relation of both of these units to the units northwest of the fault zone is as yet undetermined. The conformable siltstone, argillite, and graywacke are folded into a north plunging syncline, the east limb of which is overturned towards the west. A dike (Tertiary?) of diabase has been intruded along and close to the contact of the argillite and siltstone.

Of the five units, the most important is the siltstone because all of the fossils were collected from the siltstone or from the limestone bioherms within that unit. The siltstone unit is estimated to be approximately 4000 feet thick. It is composed principally of gray to dark gray, very fine-grained (.01-.25 mm.) siltstone, argillite, calcisiltite and calcilutite. Widespread very fine-grained disseminated pyrite causes the unit to weather to a distinctive brown color in contrast to the gray-weathering argillite unit to the west.



TEXT FIGURE 1

Geologic map of Kettle Falls area, showing fossil localities.

Scattered within the siltstone unit are at least forty pods, lenses and irregular masses of limestone, which we consider to be bioherms. Their contacts with the enclosing rock are usually covered by alluvium, although the covered interval is often only a few feet wide indicating that the change from limestone to siltstone is an abrupt one. However, toward the ends of some of the limestone masses there is interfingering of limestone and siltstone-argillite. These bioherms range in size from masses 50 feet long and a few feet wide to 1,500 feet long and 100 feet wide. Toward the north end of the siltstone belt the larger masses of limestone are approximately 800 feet long and 600 feet to 700 feet wide. The majority of them stand out in relief above the siltstone, with one side very steep to overhanging and as high as 75 feet. The rock is massive and structureless except for a weak parallel jointing in some outcrops. It is light gray to gray on fresh and weathered surfaces, fine to medium grained, and approximately equigranular. Thin sections show the rock to be composed of fragments of fossils cemented by clear calcite.

Fossils have been found both in the brown-weathering siltstone and in the limestone bioherms. Brachiopods, pelecypods, gastropods, scaphopods, crinoid stems and plant twigs have been collected from the siltstone. Fusulines, tetracorals, bryozoa, gastropods, and crinoid stems were collected from the bioherms.

FOSSIL COLLECTIONS AND IDENTIFICATIONS

Fusuline collections were made from five localities illustrated in text figure 1. Three fusuline species were identified; two are new species, the other species was previously unknown[1] in Washington. The three species and their localities are:

Pseudofusulinella stevensi n. sp. .... KFM 698
Schwagerina missionensis n. sp. .... KFM 698
Parafusulina antimonioensis Dunbar
KFM 774, 198, 652, 502

McLaughlin and Simons (1951) described a fusuline, that they identified as *Parafusulina dunbari* Needham, from localities MS of text figure 1.

Collections of brachiopods were made by the senior author at localities 1, 2, 3, 4, and 5 (text fig. 1); and a collection of gastropods, pelecypods, scaphopods, and brachiopods from locality 6 was made and described by Dixon (1958). The identification of these nonfusuline fossils is discussed below under the heading STRATIGRAPHIC CORRELATION. All fossil collections are filed in the Department of Geology, Washington State University.

STRATIGRAPHIC CORRELATION

The value of the fusulines for stratigraphic correlation is widely recognized. The structural complexity and rapid evolution of these large Foraminifera make them excellent zone fossils. In a recent paper, Bissell (1961) lists the significant species of Foraminifera that appear to have stratigraphic value in the Cordilleran area, including those species characteristic of the subdivisions of the Permian. According to the report (Adams *et al.,* 1939) of the committee, organized by the American Association of Petroleum Geologists to select a standard section of the American Permian and to recommend a scheme of major subdivisions, the four subdivisions (series) of the Permian are as follows, in descending order: Ochoan, Guadalupian, Leonardian, and Wolfcampian.

Rocks ranging in age from upper Wolfcampian to lower Guadalupian have been reported to contain fusulines of the genus *Pseudofusulinella* Thompson. Thompson and Wheeler (1946, p. 23) report that the lower part (Wolfcampian) of the McCloud Limestone of California contains *Neofusulinella occidentalis* Thompson and Wheeler and the upper part (Leonardian) contains *Neofusulinella montis* Thompson and Wheeler. Later, Thompson (1951, p. 117, 118) referred both of these species to the genus *Pseudofusulinella. Pseudofusulinella occidentalis* (Thompson and Wheeler) Thompson was recognized by Henbest (communication to Dunbar, *in* Dunbar *et al.,* 1960, p. 1781) in collections of fusulines from the Coyote Butte Formation of central Oregon. On the basis of his study of these collections, Henbest concluded that the Coyote Butte Formation is no younger than Leonardian. Cooper (1957), following a study of the brachiopod fauna of the Coyote Butte Formation, concluded that (in the United States) correlation is with the fauna of the basal Word (lower Guadalupian). This correlation is based principally on the presence of certain brachiopods (e.g., *Muirwoodia*) that are not found in North America in rocks older than lower Guadalupian. Thompson and Verville (1950, p. 68) consider fusulinid forms found about 150 feet below the top of the Kamloops section of the Cache Creek Group (British Columbia) to be congeneric with *Pseudofusulinella occidentalis.* They regard this part of the Cache Creek Group to be of Leonardian or lower Guadalupian age. Thompson (1951, p. 118) writes that, "*Pseudofusulinella* is very widespread in Lower and Middle Permian rocks of Utah, Nevada, Idaho, California, and British Columbia."

Rocks ranging in age from early Wolfcampian to late Leonardian are known (Dunbar, *et al.,* 1960) to contain members of the genus *Schwagerina* Möller. The new species, *S. missionensis,* found in the Kettle Falls area, bears a closer resemblance to *S. guembeli* Dunbar and Skinner than to any other species. *S. guembeli* is listed on a Permian correlation chart (Dunbar *et al.,* 1960) as an important zone fossil for

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[1] W. R. Danner (1957, A stratigraphic reconnaissance in the northwestern Cascade Mountains and San Juan Island of Washington State: Ph.D. Thesis, Univ. of Washington) mentions finding the fusulinid **Pseudofusulinella occidentalis** in limestone of the Black Mountain Formation at the northern end of Black Mountain, northern Whatcom County. He concludes that the formation is Early Permian.

the lower Leonardian Series. Bissel (1961) lists species of Foraminifera that appear to have stratigraphic index value in the Cordilleran area. He lists *S. guembeli* as an index fossil of the "Medial Leonardian."

Rocks considered to be of lower Guadalupian age have been reported to contain *Parafusulina antimonioensis* Dunbar. *P. antimonioensis* was first identified by Dunbar (1953) in collections from the Middle Permian, northwestern Sonora, Mexico. L. G. Henbest, in a personal communication to Dunbar (Dunbar *et al.*, 1960, p. 1781) reports the presence of *P. antimonioensis* in abundance in collections of fusulines from interbedded sediments 1,200 feet above the base of the Dekkas Andesite of the Klamath Mountains, northern California. Henbest concludes that a Word age (lower Guadalupian) is indicated.

In the Kettle Falls area the fusulines *Pseudofusulinella stevensi* and *Schwagerina missionensis* were found in only one bioherm (locality KFM 698). No *Parafusulina antimonioensis* specimens were found in this bioherm but they were found in abundance in all other bioherms sampled (KFM 774, KFM 198, KFM 652, and KFM 502). We conclude, on the basis of the kinds and distribution of the fusulines in the Kettle Falls area, that the deposition of the siltstone unit of the Mission Argillite began in late Leonardian time and continued into early Guadalupian time.

The assignment of a Leonardian-Guadalupian age to the siltstone unit on the basis of the fusuline study is supported further by studies made on collections of other kinds of fossils from the same unit. Collections of brachiopods were taken by the senior author from the siltstone at five different localities shown in text figure 1. These fossils were identified by G. Arthur Cooper as follows:

Identification	*Locality (text fig. 1)*
Muirwoodia sp.	2, 4
Anidanthus minor Cooper	2, 3, 4
Rhyncopora sp. cf. *R. taylori* Girty	2, 3, 4, 5
Chonetes sp.	1, 3, 4

Cooper concluded (written communication) that "they are about late Leonard or early Word in age."

Dixon (1958) studied a collection of fossils from the siltstone one mile north of Kettle Falls (locality 6, text fig. 1). Table 1 summarizes his fossil identifications.

TABLE 1.

Phylum	*Class*	*Genus*	*Species*
Mollusca	Gastropoda	*Pleurotomaria* *Euphemites*	*euglyphea* *urii*
	Pelecypoda	*Pleurophorus*?	*tropidophorus*
	Scaphopoda	*Dentalium*	(*Plagioglypta*) sp.
Brachiopoda	Articulata	*Orthotetes* sp.	

Though Dixon "favors a lower or middle Permian age" for the collection he points out that "the *Dentalium* (*Plagioglypta*) sp. and *Pleurotomaria* are very suggestive of the same fauna that Girty (1908) collected from lower Guadalupian deposits of Texas."

SYSTEMATIC PALEONTOLOGY

Family FUSULINIDAE Möller, 1878

Subfamily FUSULININAE Rhumbler, 1895

Genus **Pseudofusulinella** Thompson, 1951

Pseudofusulinella stevensi Mills and Davis, n. sp.

Plate 7, figures 1-5

The following description is based upon specimens collected from the Mission Argillite at locality KFM 698, Kettle Falls, Washington.

Description.—The shell is inflated to elongate fusiform, with narrowly rounded to pointed polar ends, straight axis of coiling, and concave lateral slopes. Mature shells have at least seven volutions, a maximum length of 4.7 mm., a maximum width of 2.7 to 3.0 mm., and a form ratio of 1.7 to 1.9. The general shape of the shell is closely similar throughout all volutions, as is illustrated in Table 2 by the narrow range of variation in the form ratio from youth to maturity. The proloculus is small; its average inside diameter is 95 microns and its outside diameter is 145 microns.

The early volutions are very tightly coiled and quadrate in outline (Pl. 7, figs. 1, 3). Polar regions in the outer volutions are greatly extended. The increase in height of the chambers is quite uniform but rather rapid. The spirotheca is thin, averaging 60 microns in the outer volutions, composed of a tectum and a less dense lower layer; alveoli are entirely lacking.

Septa are thin, numerous and broadly wavy. As shown by figures 1 and 2, plate 7, fluting increases in intensity toward the poles and forms chamberlets in the basal parts of the chambers in the polar regions. Massive chomata and axial fillings (Pl. 7, fig. 1) form thick layers on top of the spirotheca. The chomata are asymmetrical with steep to overhanging tunnel sides and lower poleward slopes. The tunnel is singular, straight, and has an angle of from 7 degrees to 9 degrees in the seventh volution.

Table 2 lists the pertinent measurements for a number of specimens of *Pseudofusulinella stevensi* from locality KFM 698 (text figure 1).

Remarks.—The specimens of *P. stevensi* bear a very strong resemblance to *P. occidentalis* Thompson and Wheeler in size, shape, form ratio, the quadrate form of their tightly coiled inner volutions, kind of wall structure, and kind and degree of axial filling. The new species differs from *P. occidentalis* in the following ways:

1) the septal loops in *P. stevensi* are very much more numerous, more regular, and narrower than in *P. occidentalis;*

2) the volutions of *P. stevensi* are from 2 times to 3 times higher than those of *P. occidentalis;*

TABLE 2
MEASUREMENTS OF KETTLE FALLS SPECIMENS OF
PSEUDOFUSULINELLA STEVENSI N. SP.

	Specimen Number	Length mm.	Width mm.	Form Ratio	Proloculus Diameter mm. Outer	Proloculus Diameter mm. Inner	Tunnel Angle 7th Volution
Axial Sections:	KFM 698-7	4.2	2.2	1.9		.080	
	KFM 698-8	3.6	2.4	1.5			5°
	KFM 698-13a	3.9	3.0	1.3			
	KFM 698-13b	3.9	2.7	1.4			
	KFM 698-13c	4.7	2.7	1.7	.110	.072	9°
	KFM 698-14a	4.3	2.9	1.5	.155	.100	7°
	KFM 698-14b	4.5	2.4	1.9			
Sagittal Sections:	KFM 698-2		2.1			.110	
	KFM 698-7					.080	
	KFM 698-12a		1.8			.090	
	KFM 698-12b		2.0			.090	
	KFM 698-15		1.9		.170	.130	
	KFM 698-17		2.1			.105	

Specimen Number	**Volution Height (microns)**							**Form Ratio**						
Volution	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
KFM 698-7				120	130	180	200				1.9	1.9	1.9	1.9
KFM 698-8			120	130	150	200	200			1.7	1.8	1.7	1.7	1.5
KFM 698-13a		60	90	180	300	240	330		1.1	1.2	1.4	1.4	1.5	1.3
KFM 698-13b			120	120	210	300	240				1.0	1.1	1.0	1.4
KFM 698-13c			70	180	190	230	250			1.4	1.5	1.9	1.9	1.7
KFM 698-14a			150	90	190	220	300		1.4	1.1	1.2	1.3	1.6	1.5
KFM 698-14b			130	150	200	200	250			2.0	2.0	2.2	2.0	1.9
KFM 698-2		60	120	190	200	280								
KFM 698-12a	40	50	60	150	180	210								
KFM 698-12b	60	70	120	150	210									
KFM 698-15			100	110	150	180								

Specimen Number	**Wall Thickness (microns)**							
Volution	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
KFM 698-7			30	30	50	80		
KFM 698-8					50	30	20	
KFM 698-13a			40	60	60	60	60	
KFM 698-13b		40	50	60	80	80		
KFM 698-13c				30	60	50	50	
KFM 698-14a						90	100	80
KFM 698-14b						40	70	50
KFM 698-2	60	60	60	60	40			
KFM 698-12a	20	20	30	50	40			
KFM 698-12b	20	20	30	40	60	60		

3) the outer diameter of the proloculus of *P. stevensi* is much greater (145 microns) than that of *P. occidentalis* (89 microns);

4) the tunnel angle of mature specimens of *P. stevensi* is approximately half as large as the tunnel angle of *P. occidentalis*.

It is very unlikely that *P. stevensi* would ever be mistaken for *P. montis* Thompson and Wheeler. The latter has from 10 to 12 volutions, an exceedingly small proloculus (49 microns outside diameter), and many less and more irregular septa than *P. stevensi*.

P. stevensi was named after the county in which the specimens are found, Stevens County, Washington.

Occurrence.—This species is found in a limestone lens within the siltstone unit of the Mission Argillite, in association with *Schwagerina missionensis* Mills and Davis, n. sp. The location is the NE¼ SE¼ sec. 34, T. 37 N., R. 38 E. of Willamette meridian, Stevens County, Washington.

Types.—Washington State Univ. Paleo. Coll., KFM 698-13c (Holotype, pl. 7, fig. 1), KFM 698-14b (Paratype, pl. 7, fig. 2), KFM 698-14a (Paratype, pl. 7, fig. 3), KFM 698-15a (Paratype, pl. 7, fig. 4).

Subfamily SCHWAGERININAE 1930

Genus **Schwagerina** Möller, 1877
emend. Dunbar and Skinner, 1936

Schwagerina missionensis Mills and Davis, n. sp.

Plate 8, figures 1-5

The pertinent statistical data for specimens of this species are summarized in Table 3.

TABLE 3
MEASUREMENTS OF THE KETTLE FALLS SPECIMENS OF *SCHWAGERINA MISSIONENSIS* N. SP.

Specimen Number	Length mm.	Width mm.	Form Ratio	Proloculus Diameter mm. Outer	Proloculus Diameter mm. Inner	Tunnel Angle 6th Volution
KFM 698-13	9.2	4.2	2.2	.310	.250	34°
KFM 698-14	10.5	3.7	2.8			38°
KFM 698-15	9.7	4.1	2.4	.200	.120	30°
KFM 698-17a	9.2	4.4	2.1	.220 x .315	.160 x .255	
KFM 698-17b	7.1	3.7	1.9	.170 x .230	.120 x .170	
KFM 698-2a				.310	.250	
KFM 698-2b				.360	.300	
KFM 698-6				.300	.240	
KFM 698-12				.250	.180	
KFM 698-17c				.270	.210	
Averages:	9.1	4.0	2.3	.266		34°

Specimen Number	Volution Height (microns)							Form Ratio						
Volution	1	2	3	4	5	6	7	1	2	3	4	5	6	7
KFM 698-13	120	140	170	200	250							2.4	2.3	2.2
KFM 698-14		200	220	290	360							2.8	2.8	
KFM 698-15	120	160	200	270	310	410						2.7	2.5	2.4
KFM 698-17a	120	170	270	300	300	360								
KFM 698-2a	150	180	200	300	300	300								
KFM 698-6	120	180	210	240										
KFM 698-12	150	210	300	360	450									
KFM 698-17c	90	180	210	270										

Specimen Number	Wall Thickness (microns)						
Volution	1	2	3	4	5	6	7
KFM 698-13	50	70	80	90	100	120	
KFM 698-14			80	80	100		
KFM 698-15	30	50	60	80	90	100	
KFM 698-17a	30	40	60	80	90	90	
KFM 698-17b			40	60	90	100	
KFM 698-2a	30	50	70	90			
KFM 698-2b	30	60	60	70	60	70	
KFM 698-6	20	30	40				
KFM 698-12	40	60	60	70	100	130	
KFM 698-17c	30	60	60	60			

Description.—Adult specimens of 7 volutions, from locality KFM 698 (text fig. 1), Kettle Falls, Washington, have lengths that range from 7.1 mm. to 10.5 mm. and average 9.1 mm. The diameter ranges from 3.7 mm. to 4.4 mm. and averages 4.0 mm. The average form ratio for the seventh volution is 2.3. The middle part commonly has the shape of a cylinder from which there is a rather uniform slope to the subacute to subrounded poles (Pl. 8, figs. 1, 2).

The proloculi are large and spherical to slightly elliptical; and in the specimens examined, they range between 170 microns and 360 microns outside diameter. The average outside diameter of the proloculi of 10 specimens is 266 microns.

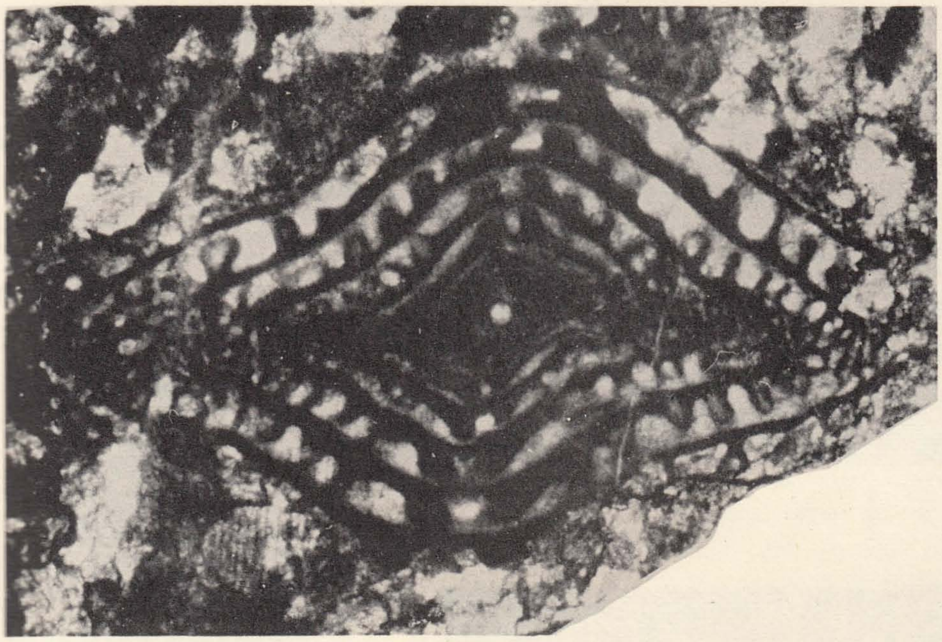
The initial volution is high (Pl. 8, figs. 1, 3) and succeeding volutions continue to increase in height. The wall is rather thin, increasing gradually from a thickness of 30 microns in the first whorl to 100 microns in the sixth whorl. It consists of a tectum and a well-developed keriotheca.

EXPLANATION OF PLATE 7

All figures × 20

Figs.		Page
1-5.	*Pseudofusulinella stevensi* Mills and Davis, n. sp.	44

1. Axial section of holotype, specimen KFM 698-13c
2. Axial section of paratype, specimen KFM 698-14b
3. Axial section of paratype, specimen KFM 698-14a
4. Sagittal section, paratype, specimen KFM 698-15a
5. Sagittal section, paratype, specimen KFM 698-12a and KFM 698-12b



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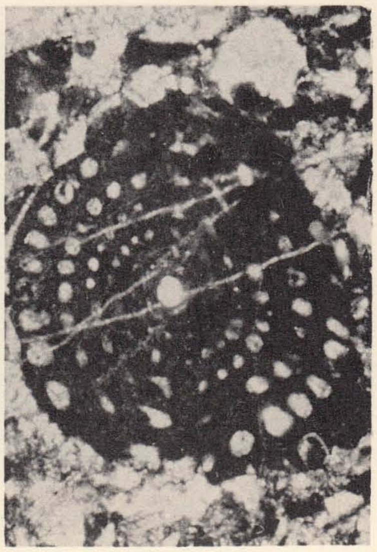

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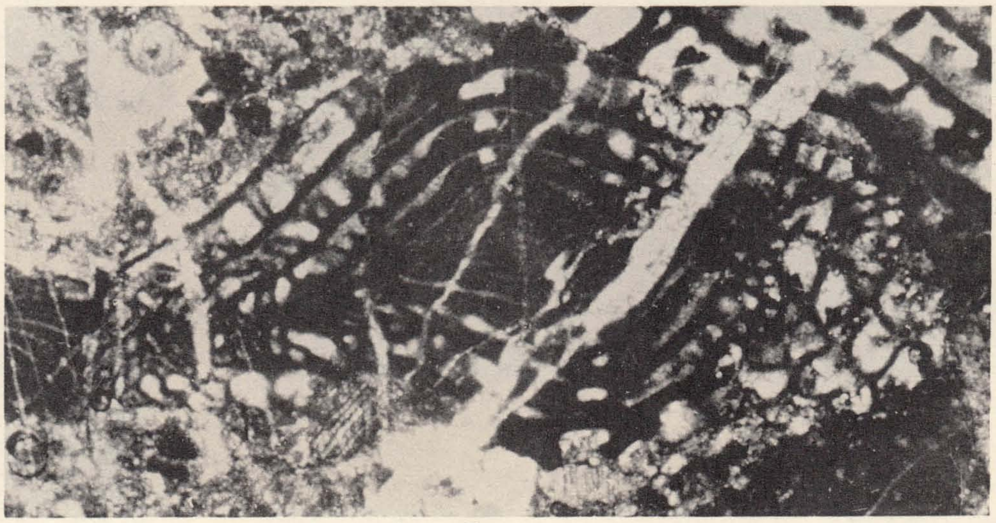

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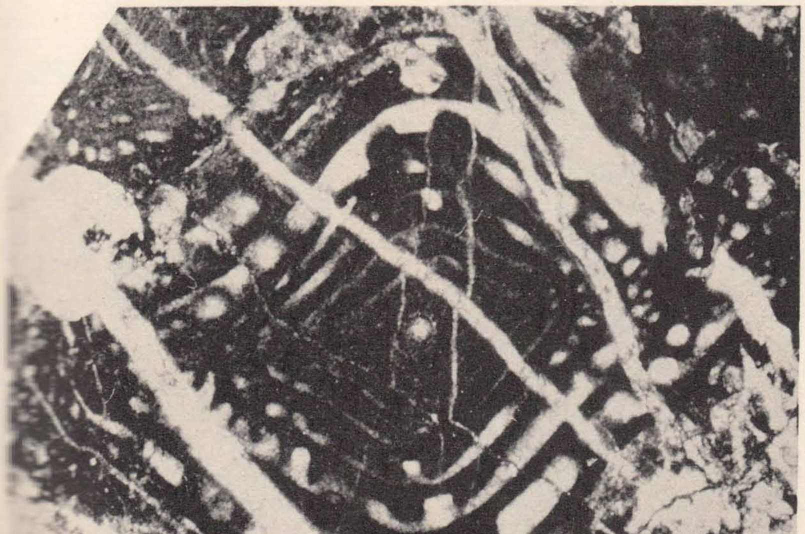

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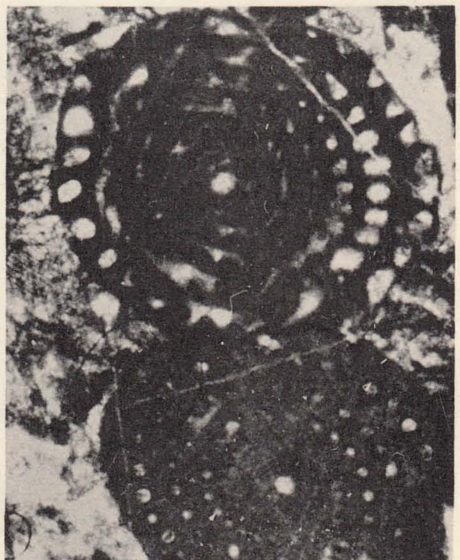

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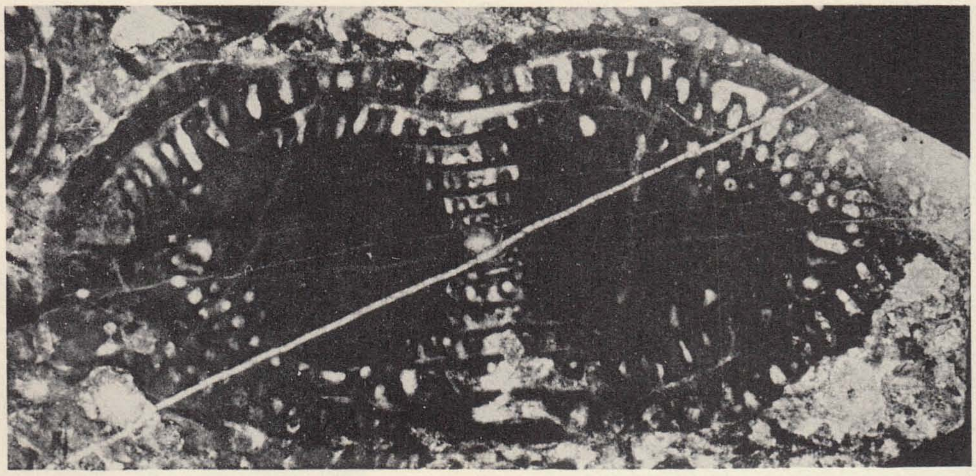
Mills and Davis: Permian fossils, Washington



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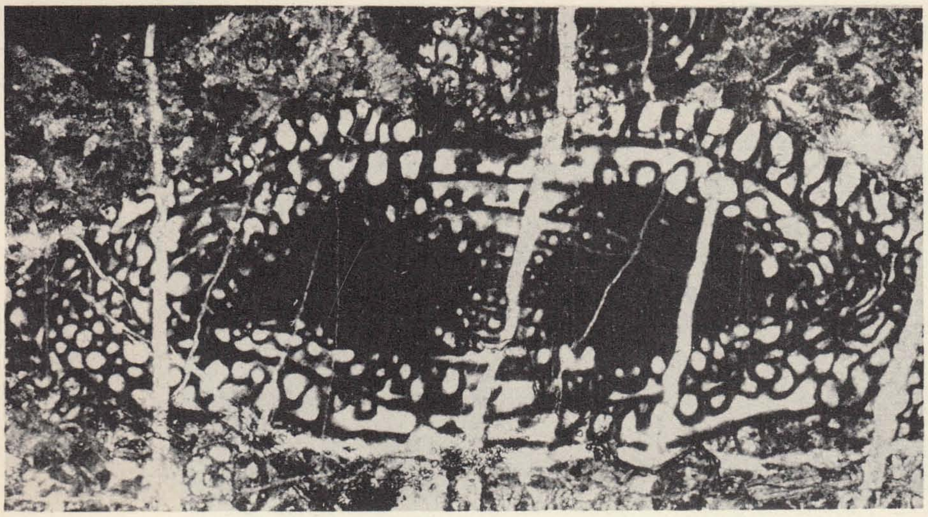

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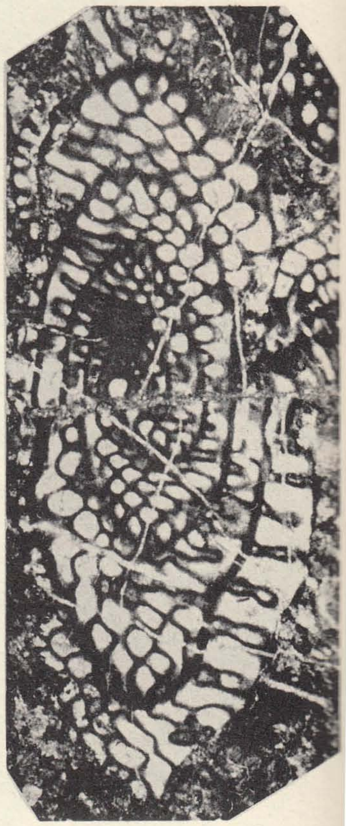

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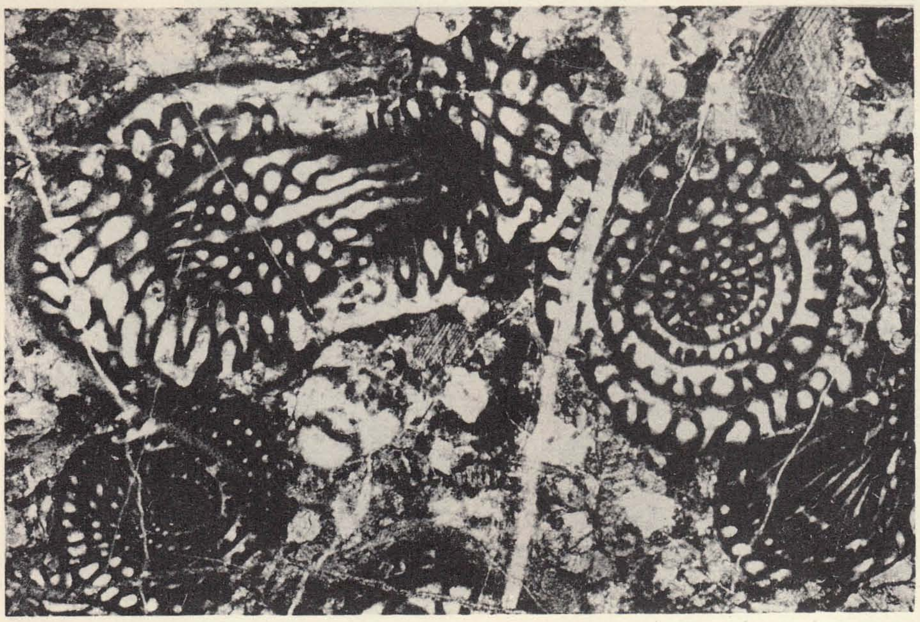

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Mills and Davis: Permian fossils, Washington

The septal folds are strong and high so that in axial sections the septal loops are high, narrow, and slightly flattened (Pl. 8, figs. 1, 2, 4). In tangential slices (Pl. 8, figs. 3, 5) the meridional chambers are divided basally into regular, cell-like chamberlets. Cuniculi are lacking. A well-developed tunnel has a tunnel angle in the sixth volution that ranges (three specimens) from 30 degrees to 38 degrees.

Remarks.—In most respects the specimens of *S. missionensis* are very similar to *S. guembeli* Dunbar and Skinner. The test of *S. missionensis* is larger, the septa more numerous and more regular, and the walls are somewhat thicker than in *S. guembeli.* The greatest dissimilarity, however, is the amount of axial filling, which is much larger than in *S. guembeli.* Professor Carl O. Dunbar, Peabody Museum of Natural History, Yale University, examined the illustrations of *S. missionensis* and reports (1961, written communication),

> ". . . in many axial sections of this species (*S. guembeli* Dunbar and Skinner) studied I have never seen one with such massive fillings as represented in your illustrations."

S. missionensis was named after the Mission Argillite in which it is found.

Occurrence.—This species is found in a limestone lens within the siltstone unit of the Mission Argillite formation, in association with *Pseudofusulinella stevensi.* The location is the NE¼ SE¼ sec. 34, T. 37 N., R. 38 E. of Willamette meridian, Stevens County, Washington.

Types.—Washington State Univ. Paleo. Coll., KFM 698-13 (Holotype, pl. 8, fig. 1), KFM 698-14 (Paratype, pl. 8, fig. 2), KFM 698-12 (Paratype, pl. 8, fig. 3), KFM 698-15 (Paratype, pl. 8, fig. 4), KFM 698-15b (Paratype, pl. 8, fig. 5).

Genus **Parafusulina** Dunbar and Skinner, 1931

Parafusulina antimonioensis Dunbar, 1953

Plate 9, figures 1-5; plate 10, figures 1-6;
plate 11, figures 1-3

Parafusulina antimonioensis DUNBAR, 1953, Smithsonian Inst.; Misc. Coll., Washington, D. C., vol. 119, no. 2, (Publ. 4108), p. 15.

The following description is based upon the study of twenty-nine specimens from the four localities (KFM 198, KFM 502, KFM 652 and KFM 774) shown on text figure 1. Although this species is reported to display marked dimorphism (Dunbar, 1953), only megalospheric forms were found at Kettle Falls. Table 4 summarizes the pertinent statistical data for the twenty-nine specimens.

Description.—Adult megalospheric shells commonly have eight volutions. Average lengths range (table 4) from 19.3 mm. to 25.6 mm., although they occasionally reach 30.0 mm. Average widths of specimens from the four localities range from 2.25 mm. to 3.3 mm.; the maximum width measured was 3.6 mm. The form ratio commonly ranges from 7.9 to 11.1 and has a maximum of 12.5; it increases rapidly throughout the shell's growth, as is well shown by text figure 2.

Commonly the axis is strongly arched or even rather sharply bent at the middle. As a result of this bending, thin sections of a single specimen may be axial for one half of the specimen and oblique for the other half (Pl. 9, figs. 1, 2, 3).

The proloculi are large, averaging from 376 microns to 502 microns in outside diameter. Most are spherical (Pl. 9, figs. 1, 2, 3; pl. 10, fig. 4), although many are elliptical or strongly flattened (Pl. 10, fig. 3; pl. 11, fig. 2) or highly irregular (Pl. 9, figs. 4, 5; pl. 10, fig. 2).

The volutions are low and tightly coiled across the middle of the shell, rising more rapidly near the poles (Pl. 9, fig. 3; pl. 10, fig. 4). The spiral wall is thin, as indicated in the table of measurements (table 4), seldom exceeding 80 microns in the outer volutions. It is distinctly alveolar, which is normal for the genus. The septa are intensely and regularly folded from pole to pole and number 15 in the first volution, 39 in the sixth and seventh volutions. Cuniculi are well developed throughout the shell (Pl. 9, fig. 2).

The tunnel is fairly well marked in all volutions except for the outer one where septal loops remain (Pl. 10, figs. 4, 6). The tunnel angle in the outer volutions ranges between 48 and 60 degrees. Chomata are completely lacking at all stages of growth.

A slender and somewhat irregular zone of axial filling (Pl. 10, fig. 5) is normal for the species (Dunbar, 1953). When the longitudinal section is not quite axial (Pl. 9, fig. 2) or is axial for only one-half of the length of an arched test (Pl. 9, fig. 3), the axial filling is partially missed.

EXPLANATION OF PLATE 8

All figures × 10

FIGS. PAGE

1-5. *Schwagerina missionensis* Mills and Davis, n. sp. 45

1. Axial section of holotype showing characteristic cylindrical middle part and pronounced secondary deposits, specimen KFM 698-13.
2. Axial section of paratype, specimen KFM 698-14.
3. Tangential and sagittal sections of paratypes showing chamberlets and high initial volution, specimen KFM 698-12.
4. Axial section of paratype, half specimen, showing tunnel and lack of chomata, specimen KFM 698-15.
5. Oblique section of paratype showing chamberlets, specimen KFM 698-15b.

TABLE 4
MEASUREMENTS OF KETTLE FALLS SPECIMENS OF *PARAFUSULINA ANTIMONIOENSIS* DUNBAR

Specimen Number	**Length mm.**	**Width mm.**	**Form Ratio**	**Proloculus Outer Diameter**
KFM 198 (average of 11 specimens)	19.3	2.54	7.86	.376
KFM 652 (average of 9 specimens)	25.6	3.3	7.9	.502
KFM 502 (average of 7 specimens)	24.0	2.25	11.1	.435
KFM 774 (average of 2 specimens)	24.0	3.0	8.1	.420
Maximum of all KFM specimens	30.0	3.6	12.5	.900

Specimen Number	**Volution Height (microns)**								**Form Ratio**							
Volution	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
KFM 198 (11 specimens) ..	106	118	160	186	206	243	246	300	2.7	4.8	5.9	5.9	6.3	7.9	8.5	
KFM 652 (9 specimens)	127	177	192	214	260	320	335	210	3.3	4.7	5.3	6.8	7.0	8.4	8.1	
KFM 502 (7 specimens)	90	110	140	180	240	270	330	300	4.0	5.3	5.3	6.2	7.2	7.4	9.0	
KFM 774 (2 specimens)	100	100	190	200	200	270	300	240	2.6	4.1	4.3	5.6	7.2	7.7	8.3	8.2

Specimen Number	**Septal Count**								**Wall Thickness (microns)**							
Volution	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
KFM 198 (11 specimens) ...	14	26	29	30	32	37			30	30	44	56	72	80	93	120
KFM 652 (9 specimens)	16	25	31	34	38	42	39		36	43	53	61	70	70	78	70
KFM 502 (7 specimens)									30	40	40	60	60	60	60	
KFM 774 (2 specimens)									45	45	65	70	75	70	50	

Sagittal sections (Pl. 9, figs. 4, 5; pl. 10, figs. 1, 2, 3) are commonly subcircular to elliptical with low tightly coiled whorls and slender chambers.

Remarks.—The identification of our specimens as the genus *Parafusulina* is based principally on the wall structure, the well-developed cuniculi, and the single tunnel. The identification of the species is based on the length of test, form ratio, size of proloculus, and other characteristics. The length of the test is probably the most striking single characteristic for specific identification. Lengths commonly in excess of 18 mm., for the genus *Parafusulina,* are known to be characteristic of only five species—*P. antimonioensis* Dunbar, *P. californica* (Staff), *P. dunbari* Needham, *P. kingorum* Dunbar and Skinner, and *P. wordensis* Dunbar and Skinner. In order to determine to which of these five species our specimens belong, the form ratio for each volution of each of these species and for the Kettle Falls specimens has been plotted in text figure 2. This figure shows that the Kettle Falls specimens have form ratios that correspond only to those of *P. antimonioensis.* Furthermore, other characteristics of the Kettle Falls specimens, such as proloculus diameter and axial filling, conform to *P. antimonioensis* and to no other giant species.

The Kettle Falls specimens differ, however, from the holotype and paratypes of *P. antimonioensis* in having a smaller diameter and a larger tunnel angle. Dunbar (1953) reports that the adult megalospheric shells "attain a diameter of 4.5 to 5.0.," about 1.5 to 2 times larger than the Kettle Falls specimens. Somewhat contrary to this statement is the fact that the diameters that he records (Dunbar, 1953) in his table of measurements do not exceed 3.8 mm. This diameter (3.8 mm.), although still somewhat larger than that of our widest specimen (3.6 mm.), does not differ sufficiently from ours to jeopardize the validity of the identification of the Kettle Falls specimens as *P. antimonioensis.* Similarly, although Dunbar reports tunnel angles only about half as large as those found in the Kettle Falls fossils, he emphasizes the generally inadequate record of the tunnel angle in his specimens and says that "the actual margins of the tunnel could only be recognized in a few whorls." We believe that there is a significant difference in the tunnel angles of Dunbar's specimens and ours but that this difference

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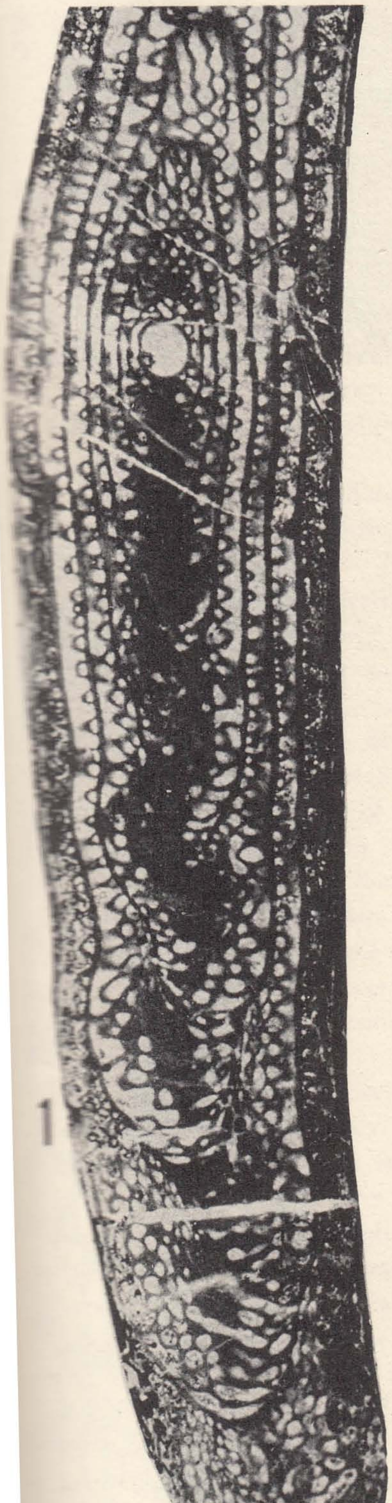
EXPLANATION OF PLATE 9

Figures 1, 2, 4 and 5 × 10
Figure 3 × 5

Figs.		Page
1-5.	*Parafusulina antimonioensis* Dunbar	47

1. Axial section showing arched test, axial filling, polar expansion of volutions, tunnel, and spherical proloculus, collection KFM 652-3.
2. Oblique section showing cuniculi, collection KFM 652-3.
3. Axial-oblique section, collection KFM 652-3.
4. Sagittal section showing flattened proloculus, collection KFM 652-2.
5. Sagittal section, collection KFM 652-7.



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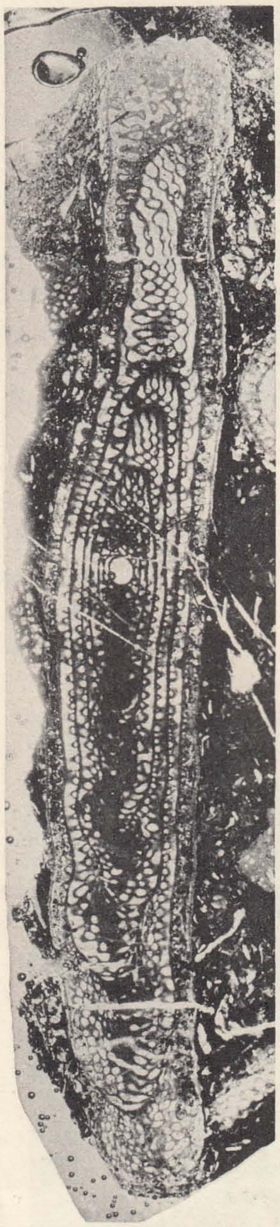

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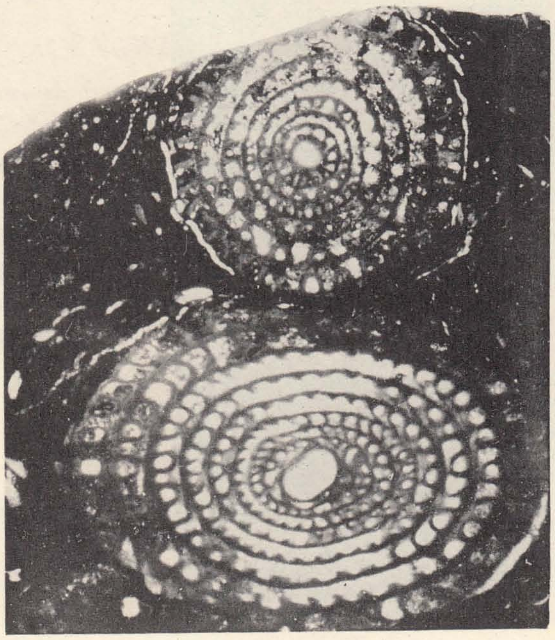

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Mills and Davis: Permian fossils, Washington

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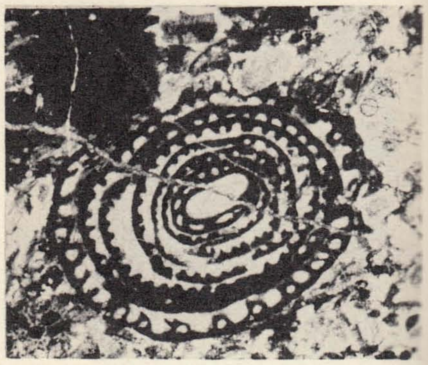

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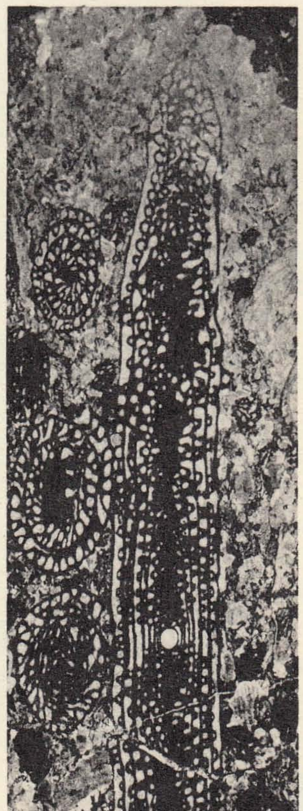

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Mills and Davis: Permian fossils, Washington

alone is not prejudicial to our identification of the Kettle Falls specimens as *P. antimonioensis*.

Parafusulina dunbari Needham, 1937

Parafusulina dunbari NEEDHAM, 1937, New Mexico Bur. Mines and Min. Res. Bull. 14, p. 56, pl. 11, figs. 5-11, pl. 12, figs. 1, 2, Middle Permian (Word), Delaware Mountain Sandstone and Dog Canyon Limestone.

We found no specimens of this species in our collections. However, McLaughlin and Simons (1951, p. 514-519) illustrate specimens, which they collected from the Kettle Falls area, that they identify as *P. dunbari* Needham. We believe that their specific identification is in error.

The McLaughlin and Simons' collection came from an impure siliceous limestone in the SW ¼, sec. 10 and NE ¼, sec. 16, T. 36 N., R. 38 E., northeast of Kettle Falls. The approximate positions of their collection localities are shown as MS on text figure 1 of this paper. We did not collect any specimens from these collection localities and their collection is not available for restudy; the doubt that we express as to the validity of their specific identification is based principally upon a study of their illustrations and, to a lesser degree, upon their descriptions.

The McLaughlin and Simons' specimens meet the specifications of *P. dunbari* Needham so far as their range of length, width, height of volutions, and thickness of spirotheca are concerned, but they differ markedly from *P. dunbari* Needham in possessing axial filling and large proloculi. It appears that McLaughlin and Simons were not entirely satisfied with their specific identification for they write that "the only apparent discrepancy is the large proloculum diameters of some of the Washington specimens. These appear to be megalospheric (see plate 76, fig. 5)." We interpret this statement to mean that they consider the specimens with unusually large proloculi to be megalospheric forms. That these are not microspheric, but are normal megalospheric forms, is proven by the presence of a distinct tunnel, a feature never possessed by microspheric dimorphs (Dunbar, Skinner, and King, 1935, p. 177). Furthermore, even the smallest proloculi in the McLaughlin and Simons' specimens are much too large to belong to microspheric forms and the number of volutions is normal for megalospheric forms. All of their specimens are megalospheric. The "discrepancy" in their identification is real, not "apparent." In addition to possessing larger proloculi than are typical of *P. dunbari* Needham, McLaughlin and Simons' specimens have a slender axial filling (McLaughlin and Simons, 1951, pl. 76, fig. 1), a feature not possessed by *P. dunbari.* The axial filling is not well displayed by plate 76 because the section is not quite axial. Nevertheless, its presence is quite unmistakable.

The question remains, if the specimens described and illustrated by McLaughlin and Simons are not *P. dunbari,* what are they? We believe them to be the same species as ours—*P. antimonioensis.* Although they have, on the average, larger proloculi (593 microns in diameter) than our specimens (435 microns in diameter), their range in size of proloculi is well within the range of size (376-900 microns in diameter) of proloculi in our specimens. The specimens *described* by McLaughlin and Simons differ from our specimens of *P. antimonioensis* in having a smaller form ratio. However, the specimens *illustrated* by McLaughlin and Simons (1951, pl. 76, figs. 1, 3) have form ratios, according to measurements made by us on their illustrations, of about 5.8 in the fourth volution. This is greater than any form ratio given by them in their table and is comparable to that of *P. antimonioensis* Dunbar from our collections (Table 4, text fig. 2) and from the species type locality. Had the sections illustrated by McLaughlin and Simons been truly axial, rather than slightly oblique, the measured form ratios of their specimens would be still higher.

Because the specimens *illustrated* by McLaughlin and Simons have sizes of proloculi and form ratios within the range of our specimens of *P. antimonioensis* and because they are quite similar to ours in other characteristics, we believe that their illustrated specimens are *P. antimonioensis.*

ACKNOWLEDGEMENTS

The National Science Foundation provided funds, under an Undergraduate Research Participation Grant, that defrayed costs and encouraged the participation of the junior author in the study of the fusulines. The Washington State Division of Mines and Geology provided opportunity to the senior author to map the

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EXPLANATION OF PLATE 10

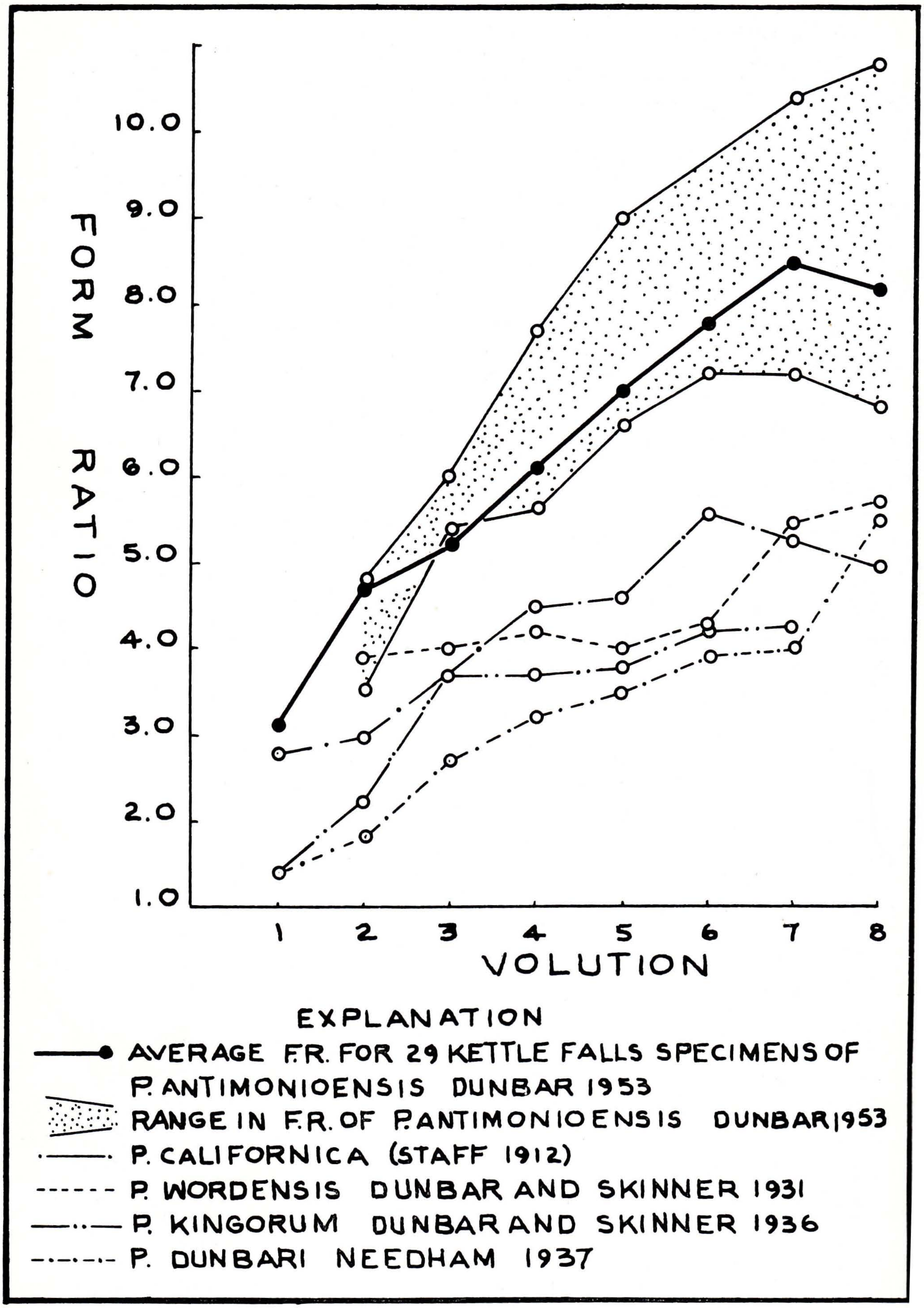
Figures 1, 2, 3, 4 and 6 × 10
Figure 5 × 5

FIGS.		PAGE
1-6.	*Parafusulina antimonioensis* Dunbar	47

1, 2 and 3. Sagittal sections showing irregular proloculi, collections KFM 198-16, KFM 198-20 and KFM 198-4, respectively.

4. Axial section showing axial filling, polar expansion and spherical proloculus, collection KFM 198-12.

5 and 6. Axial sections showing axial filling, tunnel, and spherical proloculus, collection KFM 198-1.



TEXT FIGURE 2

The graph compares the average form ratio of 29 specimens of *Parafusulina* from the Kettle Falls area with the average form ratio of five known giant species of *Parafusulina*.

area and make the collections. We are indebted to each of these organizations for their support. We are also very grateful to Professor Carl O. Dunbar, Peabody Museum of Natural History, Yale University, for his helpful suggestions relative to the establishment of the two new species.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XIII, PART 2, APRIL, 1962

242. NOTE ON A SUPPOSED "ALGAL-FORAMINIFERAL CONSORTIUM" FROM THE PERMIAN OF WEST TEXAS

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ABSTRACT

A previously described "algal-foraminiferal consortium" from so-called "algal balls" in the Permian Hueco limestone of west Texas was re-examined. Results from a study of the insoluble residues, petrology, and microfaunal elements indicate: (1) the reported "algal balls" are not primarily of algal origin but, instead, represent a gregarious colony of the marine polychaete **Spirorbis** and encrusting Foraminifera that were ripped up from the ocean floor during storm action and rolled around to form a spherical mass which was later incorporated into what is believed to be a representative intertidal deposit, (2) the foraminifer encrusting the spirorbid colony cannot be referred to the Jurassic?-Recent foraminiferal genus **Nubecularia** but more correctly is referred to the Late Paleozoic tubular encrusting genus **Calcitornella**, and (3) the so-called "algal balls" cannot be considered as an algal-foraminiferal consortium.

INTRODUCTION

Johnson (1950) described an algal-foraminiferal consortium from so-called "algal balls" in the Permian (Wolfcampian) Hueco Limestone of west Texas. Reexamination of the "algal balls" from the same locality at Vinton Canyon, northern Franklin Mountains, El Paso County, Texas, has caused the writer to question some of Johnson's basic conclusions, namely, (1) whether the so-called "algal balls" are primarily of algal origin, (2) whether the foraminifer referred by Johnson to the Jurassic?-Recent genus *Nubecularia* is a valid identification, and (3) whether the "algal balls" are really illustrative of an algal-foraminiferal consortium.

Late in 1957, the writer visited the locality and collected many of the "algal balls"; subsequent collections, plus a measured sequence of more than 200 feet from the base of the Permian through the "algal ball" horizon, have aided in making paleoecologic observations and in outlining the origin of the "algal balls." In addition, 78 large (2-inch by 3-inch) thin sections and 50 insoluble residues were prepared and examined.

DESCRIPTION OF "BALLS"

The forms referred to by Johnson as "algal balls" are subspherical to spherical calcareous masses ranging in size from 1½ to almost 3½ inches in diameter. They are very abundant in one bed of the Vinton Canyon sequence (however, a small reverse fault has repeated the "algal ball" bed) where they weather out and are strewn over the surface. The masses are irregularly covered by round protuberances. When they are cracked open they appear as a jumbled mass of tubelike organisms set in a clear calcite matrix and possessing a narrow, dark, concentric band along the outer edge.

Thin section examination of the "algal balls" reveals that the dominant tubelike form can be assigned to the marine polychaete *Spirorbis*. Most of the worm tubes are silicified and can be obtained *in toto* from dilute acid insoluble residues. The average size of *Spirobis* so obtained is just under 1 mm. in diameter. The tubes show one complete whorl with the characteristic upswing in the end portion of the whorl. Two and three whorl forms were also noted but were not common. All specimens show the distinctive flattened ventral-attachment side so diagnostic of the spirorbids.

Johnson (1950) reported that the dark concentric band along the outer edge of the "algal balls" could be referred to the encrusting plumose foraminiferal genus *Nubecularia*. In this same paper, he described and illustrated the new species *N. permiana* and referred all of the "algal ball" encrusting foraminiferal forms to this species. His basis for identifying the encrusting foraminifer as *Nubecularia* dates from an earlier paper (Johnson, 1947), in which he claims that Howchin (1893) had described and illustrated the same material from the Permo-Carboniferous of Tasmania. Howchin had compared his form to the Recent species *N. lucifuga* DeFrance, but he believed that the Late Paleozoic form was sufficiently different to warrant assigning it to a new variety *stephensi*. Johnson was apparently unaware that Chapman, Howchin, & Parr (1934, p. 183), after careful revision of the earlier works, had transferred this Late Paleozoic *Nubecularia* to the genus *Calcitornella*. Still later, Crespin (1958) restudied the original collections and concluded that the form in question was definitely referable to *Calcitornella stephensi* (Howchin) and not

EXPLANATION OF PLATE 11

Figure 1 × 5
Figure 2 and 3 × 10

FIGS. PAGE

1-3. *Parafusulina antimonioensis* Dunbar 47

All figures are illustration of same specimen showing axial filling, polar expansion of volution and irregular proloculus, collection KFM 502-4.

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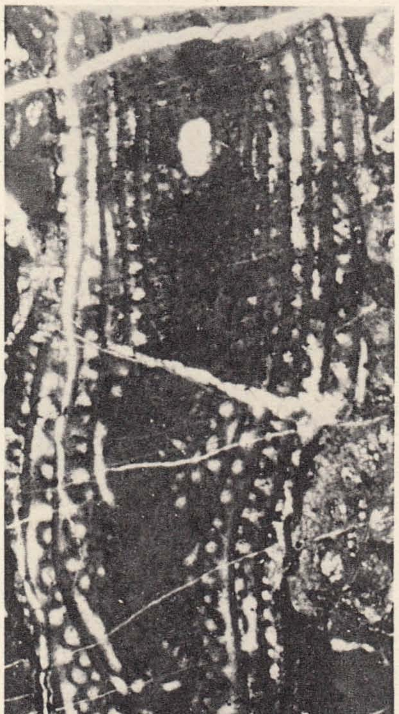

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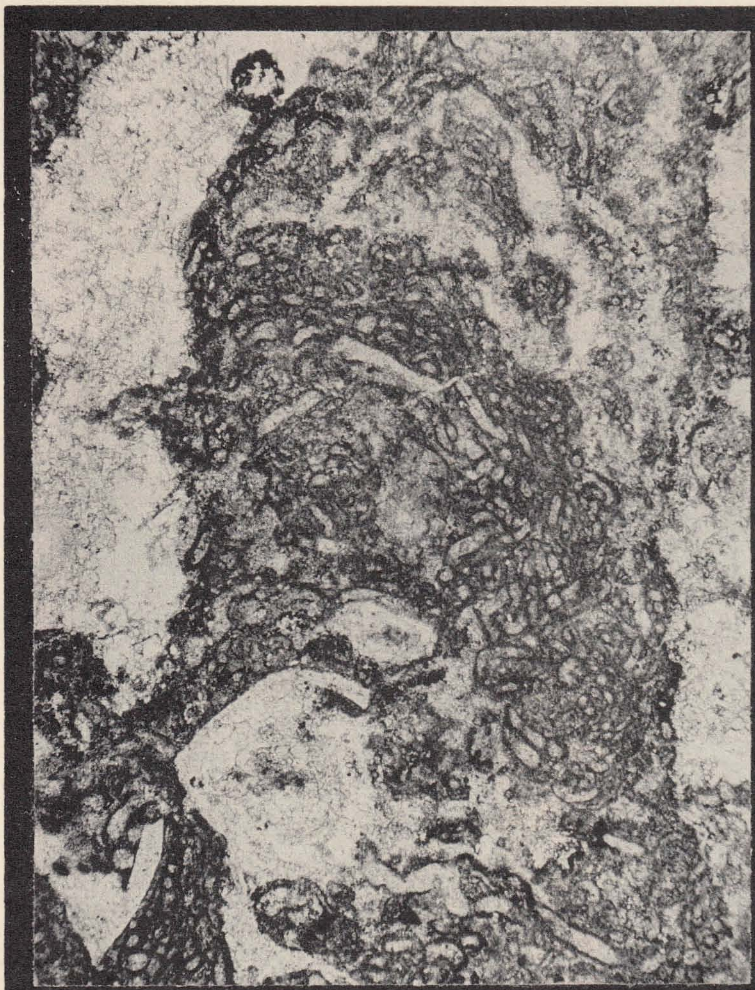
Mills and Davis: Permian fossils, Washington



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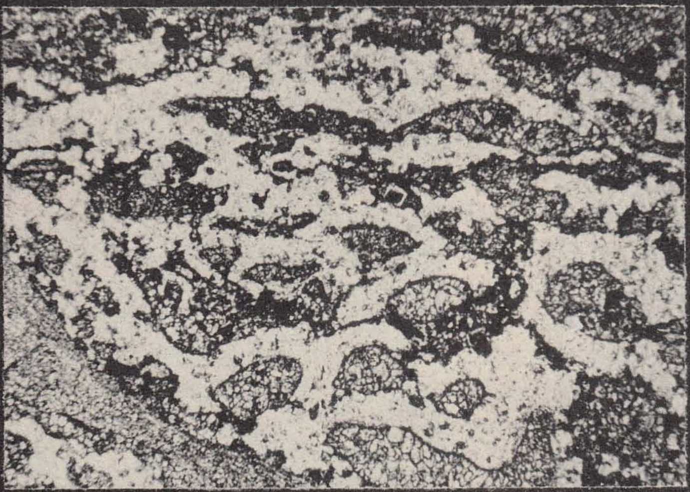

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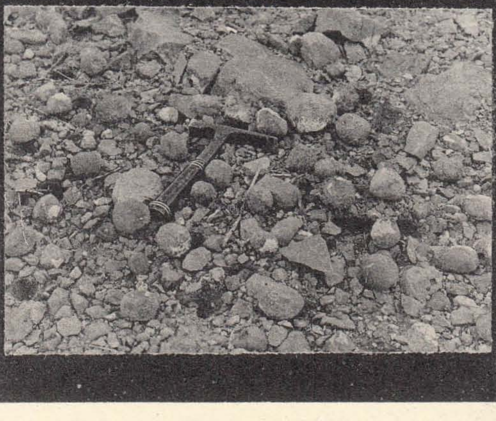

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Toomey: "Algal-foraminiferal consortium," Permian, Texas to *Nubecularia.* To add further complexities, Reitlinger (1950) described a new genus *Palaeonubecularia* from the Middle Carboniferous of the Russian Platform which appears to be a similar form to that which Johnson had previously described under the genus *Nubecularia.* Reitlinger's original description leaves much to be desired and in addition is ambiguous. The reasons for the separation of the two forms are given as follows:

> "The Paleozoic forms have a wall that is dark, dense, and of a different degree of granularity, while among the Tertiary *Nubecularia* the wall is homogenous and a yellowish-brown color. It is true that sometimes certain Paleozoic forms also have walls with a brownish cast."

It is very probable that Reitlinger's *Palaeonubecularia* is also a synonym of *Calcitornella* and that she was unaware of the revision of Howchin's earlier identification of a "Late Paleozoic *Nubecularia.*" Accordingly, the Vinton Canyon colonial, plumose calcitornellids should be referred to *Calcitornella permiana* (Johnson). It is unfortunate that no whole specimens are available so that the gross morphology can be more closely studied.

Agglutinated encrusting Foraminifera were abundantly represented in the insoluble residues. The following species were identified:

Ammovertella inclusa
(Cushman & Waters) - abundant
A. labyrintha Ireland - rare
Ammodiscella sp. cf. *A. virgilensis* Ireland - common
Serpulopsis sp. - rare

Although Johnson (1950) reported that the thin sections of the "algal balls" he examined consisted of an "intimate intergrowth of Foraminifera and algae," this writer has been unable to verify this in any of the thin sections that he examined. In fact, with the exception of a few very small threads of *Girvanella* (found along the outer edge of one thin section), no algal remains were observed. Hence, it is believed that algae are not responsible for the binding together of the "balls" and, therefore, the "balls" should not be referred to as "algal balls."

DEPOSITIONAL ENVIRONMENT

According to Carson (1959, p. 75), modern-day spirorbids are inhabitants of the intertidal zone. However, it may be added that *Spirorbis* also occurs abundantly within the very shallow neritic zone. Within this zone, in more tropical regions, the common species of turtle grass (*Thalassia testudinum*) supports a varied epifauna of which *Spirorbis* makes up a considerable portion. This raises the question to what organism or plant did the Permian spirorbids attach themselves. In thin section, algae or shell fragments, both of which would form ideal attachment surfaces, are decidedly lacking. Possibly these were destroyed during diagenesis or it may be that the spirorbids adhered to one another by some form of mucilaginous secretion. The fact remains that there definitely had to be an attachment surface for the worm tubes. As a working hypothesis, it is suggested that the spirorbids were clumped together, probably on seaweed, and that they in turn were encrusted by calcitornellid Foraminifera which further tended to bind the colonies together. During heavy wave and storm action, the plants were ripped up from the ocean floor and rolled around and ultimately moulded into a somewhat cohesive spherical mass. At this stage, most of the spirorbids were probably killed off. However, the well-developed concentric bands of plumose Foraminifera continued to grow as the "ball" was gently rolled back and forth along the ocean bottom, indicating that the Foraminifera were unaffected by vigorous uprooting. Indeed, they seemed to have thrived and to have taken over the colony altogether, thus, further binding the mass together more effectively. The sparry calcite that is so conspicuous in thin section seems to fill either primary voids or those left by boring organisms, or both.

The host rock in which the spirorbid colonies are embedded is petrologically and faunally distinct from the "balls." The host bed is composed wholly of small pelecypods within a sparry calcite matrix. The occurrence of abundant very small pelecypods might possibly be analogous to the modern-day vast accumulations of the small pelecypod *Donax* living along the edge of the intertidal zone. It also is very probable that once the balls were formed, and at the mercy of the waves and currents, they would eventually come to rest within the intertidal zone. Here, with continued transgression they would be buried and become mixed with the indigenous fauna of this harsh environmental realm. The lack of any mud matrix strongly suggests the effective winnowing away of sediment in this environment where substrate mobility was continual.

Briefly outlined, the genesis of the "balls" may be given as follows:

1. Gregarious colonies of *Spirorbis* commensally attached to seaweed at relatively shallow water depths.

EXPLANATION OF PLATE 12

FIGS.		PAGE
1-3.	Plumose, encrusting, colonial foraminifer *Calcitornella permiana* (Johnson); shell fragments are remains of marine polychaete *Spirorbis.* 1, 3 × 31; 2, × 16.	52
4.	*Calcitornella permiana* (Johnson); acetate peel, taken with plane polarized light, × 125.	52
5.	"Balls" weathering-out from host rock.	52
6.	Surface strewn with weathered-out "balls."	52

2. Spirorbids encrusted with calcitornellid Foraminifera (possibly a symbiotic relationship).
3. Seaweed meadows ripped up by wave and storm action; flora and fauna incorporated into compact mass as it is rolled along the ocean's floor.
4. Spirorbids killed by vigorous wave action, but encrusting Foraminifera take over and continue to grow around entire colony as it is continually agitated.
5. Mass "thrown up" at water's edge; at this point the "ball" probably is bored by other benthonic organisms and the seaweed probably rots.
6. With continued transgression of the sea, the "balls" are incorporated with the intertidal fauna as a distinctive sediment.

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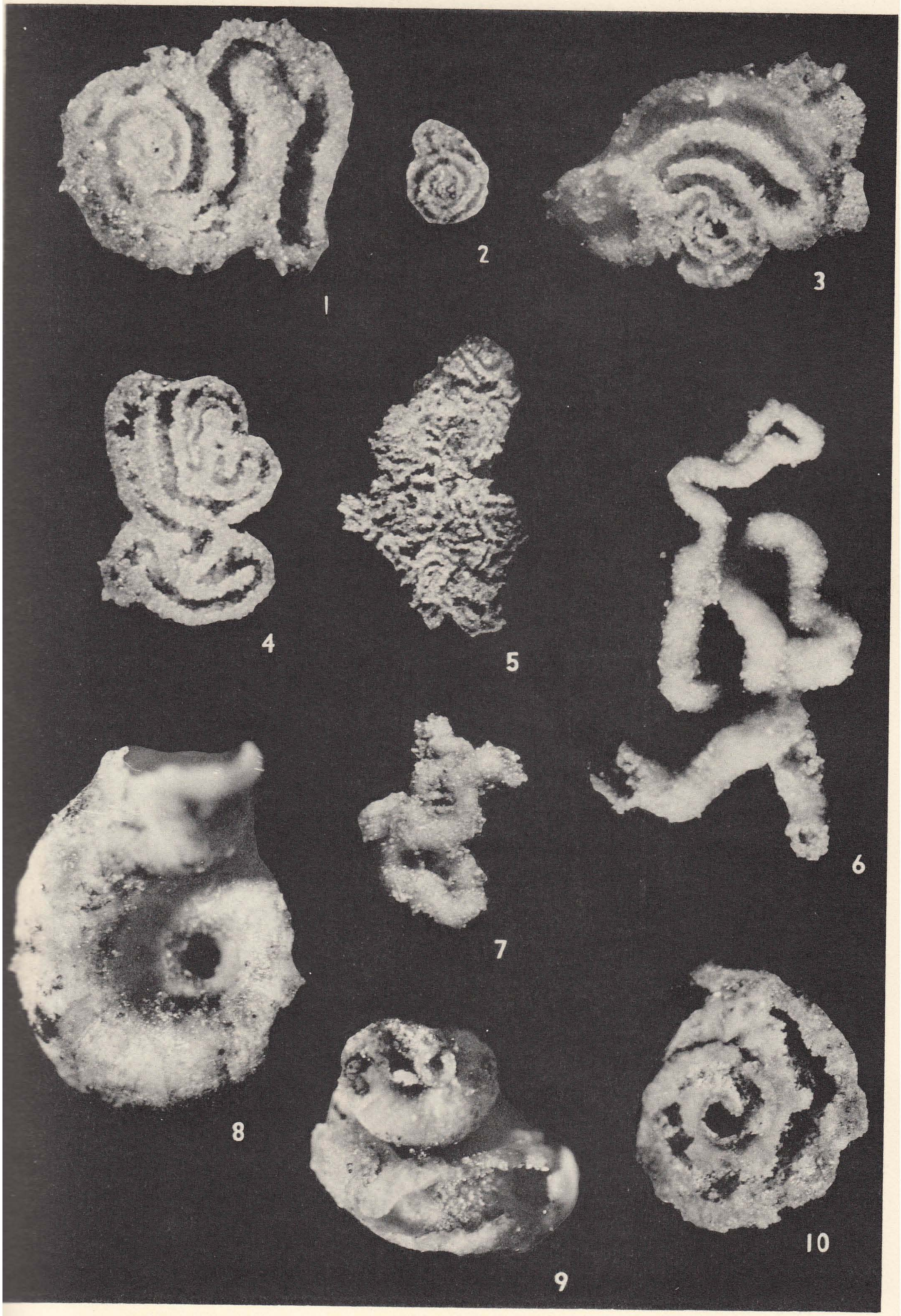
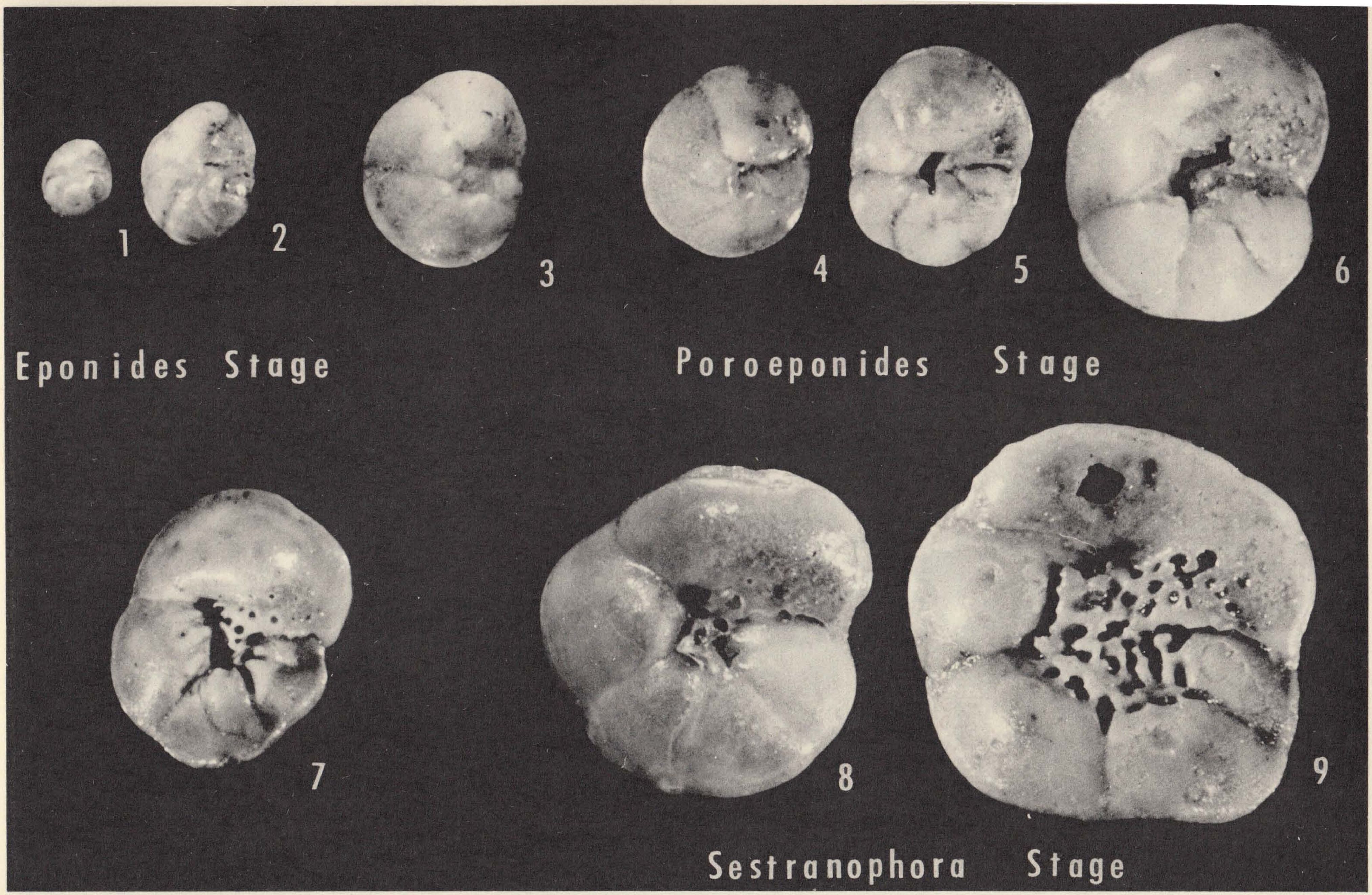
EXPLANATION OF PLATE 13

Figs.		Page
1, 3, 4.	*Ammovertella inclusa* (Cushman & Waters); ventral attachment surface; × 44.	53
2.	*Ammodiscella* sp. cf. *A. virgilensis* Ireland; ventral attachment surface; × 44.	53
5.	*Ammovertella labyrintha* Ireland; ventral attachment surface; × 22.	53
6, 7.	*Serpulopsis* sp.; dorsal surface; × 44.	53
8, 10.	Marine polychaete *Spirorbis* sp., × 22 (silicified specimens); 8, dorsal surface; 9, two whorl form; 10, ventral attachment surface.	52



Toomey: "Algal-foraminiferal consortium," Permian, Texas



Resig: Development of *Eponides repandus*

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XIII, PART 2, APRIL, 1962

243. THE MORPHOLOGICAL DEVELOPMENT OF *EPONIDES REPANDUS* (FICHTEL AND MOLL), 1798[1]

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ABSTRACT

Morphological stages in the development of the test of **Eponides repandus** (Fichtel and Moll) are illustrated in a sequence of specimens obtained from a southern California offshore sample. Intermediate stages in the sequence have been commonly assigned to **Poroeponides cribrorepandus** Asano and Uchio and the final stage has been described as **Sestranophora arnoldi** by Loeblich and Tappan. It is proposed that the latter species are synonymous with **Eponides repandus.**

Representatives of the final stage were absent from a number of samples bearing the species. The degree of development of the test is probably the result of environmental factors and should not be regarded as a generic distinction.

INTRODUCTION

Specimens of *Eponides repandus* showing changes in the morphology of the test were obtained from a residual Pleistocene deposit in 294 feet of water southwest of Point Dume, California (AHF 5506, 34° 00′ 40″ N. Latitude, 118° 56′ 00″ W. Longitude). A taxonomic problem arises in that early stages of development have been referred to *Eponides repandus* by many workers; intermediate stages to *Poroeponides cribrorepandus* by Asano and Uchio (*in* Asano, 1951); and the end product to *Sestranophora arnoldi* by Loeblich and Tappan (1957). If it is accepted that the original figure of *Eponides repandus* by Fichtel and Moll (= *Nautilus repandus*) is the *Eponides repandus* of authors and the type species of *Eponides* as designated by Montfort (1808), then this name should be valid for all growth stages of the species. In support of this line of reasoning is the original description of *Eponides repandus* in which Fichtel and Moll mention a small hole on the face of the ultimate chamber. Although they express some uncertainty as to the nature of this hole, it may possibly have been the forerunner of greater pore development on the septal face in later growth stages.

All specimens illustrated in this report were obtained from a single sediment sample. Tests exhibiting these growth stages were noted in additional samples from the southern California shelf and from the Pleistocene Santa Barbara Formation as exposed at Bathhouse Beach. In several samples obtained from the shelf, however, the specimens did not show test growth to the final stage. The incomplete development of the animal in certain localities has probably been responsible for the variety of nomenclature assigned to the species.

The writer is indebted to Dr. Orville Bandy for consultation during the course of the study.

TEST MORPHOLOGY

In a sequence of tests which represent the growth of the animal to the final stage (Plate 14), a gradation may be noted between forms typically assigned to the species *Eponides repandus, Poroeponides cribrorepandus,* and *Sestranophora arnoldi.* The morphological changes are most notable on the ventral side of the test, in the umbilical region and on the septa.

Juvenile forms of the species, representing types which have been called *Eponides repandus* (pl. 14, figs. 1, 2), are characterized by being involute ventrally, having curved, flush, limbate sutures, and an aperture which is a slit at the base of the last septal face. The aperture tends to broaden slightly toward the center of the test and is surmounted by a slight lip. The smallest forms (0.31 mm.) have no accessory openings on the face of the ultimate chamber, whereas slightly larger forms (0.56 mm.) have 3 or 4 accessory openings in this position.

A transitional form between the early stages and those which have been considered the adult stages of *Poroeponides cribrorepandus* shows the development of a small depression in the umbilical region (pl. 14, fig. 3). In this form, the aperture retains its earlier characteristics and 4 or 5 accessory openings are present on the face of the ultimate chamber. The curved, limbate sutures tend to become slightly depressed in the later portion of the test, which has increased in size to 0.78 mm.

In the stage of development which has been described as *Poroeponides cribrorepandus* (pl. 14, figs. 4, 5, 6), the umbilicus has become a dominant feature and in the larger specimens may be approximately 1/5

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[1] This investigation is part of a foraminiferal study supported by a research grant (RG—5508) from the Division of Medical Sciences, Public Health Service.

EXPLANATION OF PLATE 14

FIGS.		PAGE
1-9.	*Eponides repandus* (Fichtel and Moll). × 32. Pleistocene; S. W. of Point Dume, California; 291 feet.	55

the width of the test. Also in larger specimens, the test tends to become depressed about the umbilicus. As before, the aperture is a slit at the base of the last septal face, extending into the umbilicus. Ten or more accessory openings are present on the face of the ultimate chamber. The sutures are limbate and curved in the early portion, tending to become straight and slightly depressed in the later portion of the test. The diameters of the specimens representing this stage are 0.84, 0.87, and 1.20 mm.

In a specimen representing a form transitional to the end product (pl. 14, fig. 7), the aperture remains a slit at the base of the last chamber, extending from near the periphery into the umbilicus. Numerous openings are visible on the second latest chamber, on the face of the ultimate chamber, and on a portion of the last chamber which has become extended over the umbilicus. Ventrally the test is more depressed than in the specimens previously described and there is a tendency for the last chamber to decrease in height. Sutural lines are fine, straighter than in the previous specimens, and strongly depressed. The size of the individual representing this stage is 1.00 mm.

The largest specimens of the growth series are 1.50 and 2.30 mm. in diameter and represent forms which have been described as *Sestranophora arnoldi* (pl. 14, figs. 8, 9). In these specimens the umbilicus has been completely covered by perforated plates arising from the extensions of the inner portions of the chambers. In the largest specimen, the covered umbilical region composes ⅓ of the diameter of the test. Numerous openings are present on the lower portion of the ultimate chamber, which has been greatly flattened and widened to compose about ⅓ of the area of the exposed chambers. Because of a decreasing radius vector, the flattened later chambers make the test circular in plan view.

DISCUSSION

Morphological changes noted in the sequence of foraminiferal specimens are in order of their appearance:

1. General increase in individual size from 0.31 to 2.03 mm. in diameter.
2. Development of accessory openings on the face of the ultimate chamber.
3. Development of an umbilicus.
4. Straightening and depression of sutures and loss of limbations.
5. Development of a circular test outline through depression and widening of the ultimate chamber.
6. Development of a series of umbilical plates arising from the inner portions of the chambers and perforated by openings.

Because of the gradation exhibited in the appearance of these characteristics within the specimens, which were obtained from a single sediment sample, it is concluded that the individuals represent growth stages of a single species of Foraminifera. A single specific name should be assigned to all members of the sequence.

The earliest name available for the species is *Eponides repandus* (Fichtel and Moll), described in 1798. As illustrated by the authors, the ventral side of the type resembles that of the younger forms of the sequence of this report. In their description, a small opening was noted on the face of the last chamber. The German text states: "Opposite the aperture, in the outer angle of the apertural face, there is located a very small round hole which can only be seen with the highest magnification; whether this is accidental or the opening of a nerve-tube cannot be decided with certainty, partly because of extreme smallness and also partly because we have only one specimen to observe at the time." The dorsal side of the holotype, however, appears to be involute and the resulting test form bears little resemblance to any genera of the type region (Mediterranean), or to any other foraminifers of the world. This led Cushman (1927) to conclude that the dorsal side had been misdrawn and was in fact evolute. His conclusion is partly substantiated by the fact that the authors refer to the "outermost coil" of the type specimen, using terminology generally applied to rotaloid forms. A further discussion of the nature of *Eponides repandus* has been presented by Redmond (1949) and Hofker (1950), the former expressing belief that the original type figure was accurate. The problem involves not only the nature of the identity of *Eponides repandus* but the nature of the genus *Eponides,* as this species was designated as the type species by Montfort (1808).

In 1944, Cushman erected the genus *Poroeponides* to represent rotaloid forms having an open umbilicus, a slit-like aperture at the base of the last-formed chamber near the umbilicus, and numerous rounded openings scattered over the ventral face in the adult. Asano and Uchio (*in* Asano, 1951) described the species *Poroeponides cribrorepandus* and noted the similarity of its form to *Eponides repandus* with the exception of the numerous openings on the apertural face. If the "hole" mentioned by Fichtel and Moll on the apertural face of *Eponides repandus* is accepted as the initial phase of development of the accessory openings, it would appear that there is no valid distinction between *Poroeponides cribrorepandus* and *Eponides repandus.*

The most recent genus connected with the problem is *Sestranophora,* with the type species *Sestranophora arnoldi* Loeblich and Tappan (1957) described from the Santa Barbara Formation. This species was noted by the authors to differ from *Eponides repandus* in being twice as large, having less limbate sutures, an umbilicus with complicated sieve plates, and supplementary apertures on the face of the ultimate chamber. It was described as differing from the type species of *Poroeponides* in being twice as large, having a less enlarged final chamber, a wider umbilicus with an umbilical sieve plate, and a more restricted series of supplementary apertural pores. From the sequence of tests figured herein, it may be noted that the morphological differences mentioned by Loeblich and Tappan appear as growth stages rather than as generic differences.

It is the writer's opinion that the name *Eponides repandus* has priority over other names applied to the growth stages of the species under discussion. Reiss (1960) has proposed the genus *Eponidopsis* to include those species resembling the early specimens of the sequence presented here without development of accessory structures in the adult chambers. He noted the similarity of *Eponidopsis spp.* and *Eponides repandus* in such internal properties as a finely perforate wall composed of radially fibrous calcite, double-layered septa, and primary intraseptal and peristomal passages. As an alternative, the possession of accessory openings on the septal face and further development of an umbilical sieve plate could be considered a characteristic of the particular species rather than of all representatives of the genus *Eponides*. It is quite probable that ecological factors control the degree of development of the species as the individuals bearing sieve plates occur less commonly than the more simple forms having only accessory openings.

In Pleistocene deposits of southern California, the species has been recorded as: *Eponides repandus* (Fichtel and Moll) by Cushman and Gray (1946) from Timms Point, *Pulvinulina repanda* (Fichtel and Moll) and *Pulvinulina puncticulata* (d'Orbigny) by Bagg (1912) from Timms Point, and *Globorotalia grandis* Galloway and Wissler by Galloway and Wissler (1927) from deposits at Lomita Quarry. *Eponides repandus* is of world-wide occurrence (Cushman, 1931). Tests showing the complete sequence of development were observed by the writer in recent sediment from the seafloor east of Tierra del Fuego, indicating the widespread nature of this development. In the fossil record, McLean (1956), studying Miocene Foraminifera of the Yorktown Formation of Virginia, noted a series of specimens gradational between *Poroeponides lateralis* and the type of test figured by Brady in the "Challenger Report." He concluded that all variants were the same species.

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244. THE ORIGIN OF *GLOBIGERINA PSEUDOBULLOIDES* PLUMMER

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ABSTRACT

Globigerina pseudobulloides Plummer has developed from true **Globigerina (Globigerinella)** and is not related to **Globorotalia.**

Topotype specimens of *Globigerina pseudobulloides* Plummer (1926, p. 133, pl. 8, fig. 9), described for the first time from the Midway of Texas, have a wall structure typical of the latest known forms (marked honeycomb structure in all chambers up to the last-formed one, text fig. d). It has been possible to trace the species downward through the Paleocene and Danian of Denmark into the white chalk below (uppermost Cretaceous, Hofker, 1960c, p. 120, pl. 2) where it is very small, with a thin test wall, having fine pores with small pustules between them. Here, the species is found with the latest forms of *G. aspera* (Ehrenberg) which show the same structure of the test wall and a more or less peripheral, small, rounded aperture. On the other hand, the aperture of *G. pseudobulloides* is distinctly ventral though also small and rounded, with a covering lip which in this first stage of development is rather narrow.

Bukowa (1960, p. 319, pl. 6) believes that the first stages of *G. pseudobulloides* developed from *G.* (*Globigerinella*) *aspera* and that during the Paleocene and Eocene the species developed into a more and more typical *Globigerina,* ending up once more in forms which show the "*Globigerinella*" structure.

The author (Hofker, 1957, p. 415, text fig. 470, *G. aspera* f. *trochoidea*), on the other hand, has shown that *G.* (*G.*) *aspera* descended from a trochoid form occurring in the Cenomanian. It gradually changed this structure into a planispiral form during the Upper Cretaceous (*G. aspera* f. *plana, op. cit.* p. 417, text fig. 475). In the lower Maestrichtian, a descendant of this form is *G. biforaminata* Hofker but even in the uppermost layers of the Cretaceous (the Cr 4 in Holland and the *Pseudotextularia* zone in Denmark and Germany), the planispiral form with a small rounded aperture is found with *G. biforaminata.*

In order to test Bukowa's theory, the author studied many specimens of the typical *aspera* form which is found in the white chalk as well as in the overlying lower Maestrichtian Tuff Chalk and in the Lower Danian of Denmark. The early and later forms of typical *G. pseudobulloides* were also studied from the above formations and the Lower Paleocene of Denmark. These were compared with the topotype specimens from the Midway.

These studies confirm Bukowa's ideas. The wall structure of the latest forms of *G. aspera* is identical with that of the first stages of *G. pseudobulloides* (thin wall with fine pores and pustules between the pores, text figs. a, b). Moreover, the first stages of *G. pseudobulloides* from the Lower Danian and the Lower Maestrichtian Tuff Chalk (believed by the author to be contemporaneous, Hofker, 1959b, 1960c) have a nearly planispiral arrangement of chambers throughout the test (text fig. b). Gradually throughout these formations, the tests become more and more trochoidal (text fig. c) until in the Paleocene they reach a typically trochoidal structure in transverse section (text fig. d). During this time the walls become thicker and thicker and the outer texture increasingly honeycomb in structure. In addition, as already stated (Hofker, 1960c, pl. 2), the successive individuals increase in size, thus, reaching a stage which tends towards *G. varianta* Subbotina, as is also stated by Bukowa.

This development, which can be traced from the white chalk through the Maestrichtian Tuff Chalk into the overlying Paleocene in Holland (Hofker, 1959c) and from the white chalk through the type Danian into the overlying Paleocene in Denmark (Hofker, 1960b, text figs. 17-20, 22, 36-38), suggests that a gens of *Globigerina* (the *aspera* gens) developed from a trochoidal form in the Lower Cretaceous into a planispiral form in the Upper Cretaceous. *It did not disappear at the Cretaceous-Tertiary boundary,* but suddenly once again developed a ventral aperture with a covering lip such as was found in its first stages (in f. *trochoidea* where the lips covering the ventral apertures also are distinct; see Hofker, 1957, text figs. 470, 471). This form gradually changed from a planispiral to a trochoidal form during the Danian, becoming typically trochoidal in the Upper Danian and Paleocene. Whether or not the forms of the *G. varianta* group gave rise to more and more globular forms cannot be decided here, but it is true that, in the Upper Paleocene of Trinidad, typical descendants of the *pseudobulloides* group become increasingly globular while the number of chambers in the last-formed whorl decreases from 5 to 4. A similar reduction of the number of chambers together with a change from a trochoidal into a globular form was described for *G. triloculinoides* during the Danian (Hofker, 1960c, pp. 120, 121, pl. 3). We do not yet know the ancestral form of *G. daubjergensis* Brönnimann which suddenly appears as very small globular specimens in the upper white chalk and lowest Danian in Denmark and Holland. It may be that this ancestor was some small, trochoidal form in the upper white chalk which up to now has been overlooked.

Once again it is obvious that a genus like *"Globigerinella"* cannot have any biologic meaning. A single biologic unit, the gens *G. aspera,* gradually changes from *Globigerina* (Bolli, 1959, pp. 266, 267, pl. 22, fig. 2, called these first stages *Praeglobotruncana* but did not give a background for that generic name) into *"Globigerinella"* which in turn changes back gradually into a trochoid *Globigerina* (see also Hofker, 1959a, p. 4).

Bolli *et al.* (1957) place *G. pseudobulloides* in the genus *Globorotalia.* They consider that the lips over the aperture are fundamental structures and do not realize that such lips also are found in *"Praeglobotruncana"* as well as in many species which they refer to *Globigerina* and *Globoquadrina.* Moreover, the type species of *Globorotalia, G. tumida* Brady, has quite a different aperture for here the lip separates a protoforamen from a deuteroforamen, so that this form has a foramen compositum. In addition, *G. tumida,* together with many other true species of *Globorotalia,* has a poreless keel at the periphery, which *Globigerina pseudobulloides* never does. The descent of *G. pseudobulloides* from a true *Globigerina* (*"Globigerinella"*) clearly shows that the characteristics given by Bolli *et al.* (1957) for *Globorotalia,* viz. the apertural features, not only have been incompletely described but also are not typical for *Globorotalia. Globigerina pseudobulloides* is a true *Globigerina* with a single aperture covered by a thin lip which very probably does not separate a protoforaminal part from a deuteroforaminal part. In true *Globorotalia,* on the other hand, we find such a separating lip. In addition, Bolli *et al.* (1957) did not consider the poreless periphery which as has been shown previously (Hofker, 1961) is related to quite a different method of floating than is developed in the globigerines, where the floating apparatus consists of thin spines. True *Globorotalia* never develops spines when living.

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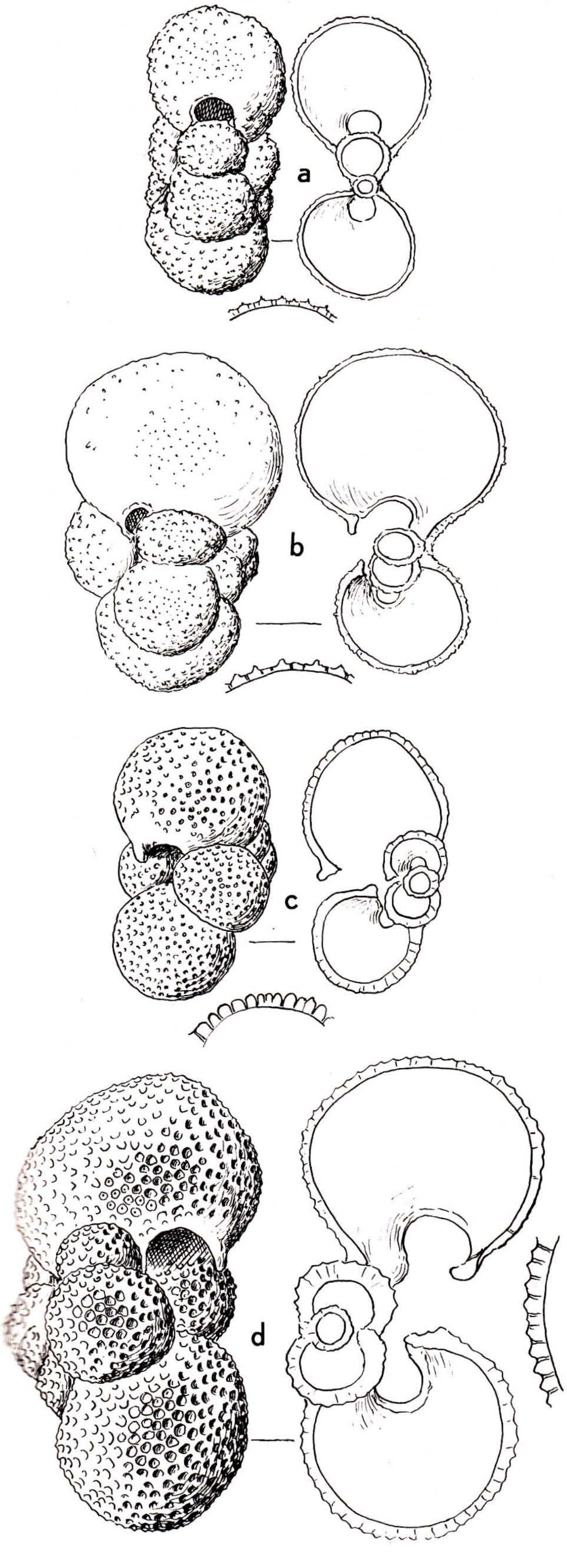

TEXT FIGURES a - d

For each specimen, the apertural face, surface structure, and a transverse section are given, × 125; an enlarged portion of the wall shown in the transverse section also is given, showing the change in structure and the increase in thickness, × 165.

Fig. a, *Globigerina aspera* (Ehrenberg), 3 m. below the boundary of the White Chalk and the Danian; Stevns Klint, Sealand, Denmark.

Figs. b-d, *Globigerina pseudobulloides* Plummer. b, Hofker sample 1053, lowest Danian, same locality as a; c, Hofker sample 868, Mygind, Jutland, Denmark, Upper Danian, small specimen; d, sample collected by Plummer, Midway Formation, Texas.

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245. WHAT IS *PSEUDOVALVULINERIA* BROTZEN, 1942?

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ABSTRACT

A study of the type species of **Pseudovalvulineria** Brotzen and **Gavelinella** Brotzen shows that both are referable to **Gavelinella.**

D'Orbigny (1840, p. 36, pl. 3, figs. 20-22) first described *Rosalina lorneiana* from Montereau in the Paris Basin, France. His somewhat schematic figure shows a slightly oval test having a flat dorsal side and an umbilical ventral side. The sutures on the dorsal side, which shows 7 chambers in the last-formed whorl, are strongly oblique; on the ventral side, the sutures are rounded and end in distinct umbilical plates which cover the umbilical hollow. The periphery is rounded, lobulate, especially in the last-formed part of the test.

Later the species was described, again from Montereau, by Marie (1941, p. 216, pl. 33, fig. 314), as follows:

> "Test à côté spiral dénué d'ornamentation et à côté ombilical orné, à la surface des loges, de grosses côtes larges, imperforées, à sommet arrondi, occupant toutes leurs extrémités ombilicales et disparaissant brusquement avant les trois dernières, mais dont le relief, notable vers le centre du test, diminue rapidement à la périférie. Loges à face aperturale bombée. Ombilic profond à bords inclinés."

Marie called the species *Discorbis lorneiana* (d'Orbigny).

In the meantime, Brotzen (1936, p. 178-181, pl. 12, figs. 1, 2; text fig. 64) described a quite different species which he referred to *Anomalina lorneiana* d'Orbigny. This species, found in the Coniacian-Santonian of southern Sweden, was later renamed *Gavelinella tumida* Brotzen (1942, p. 47, fig. 15). In the same paper, Brotzen (1942, p. 20) designated *Rosalina lorneiana* d'Orbigny as the type species of his genus *Pseudovalvulineria,* as follows:

> "Genotyp *Rosalina lorneiana* D'Orbigny 1840 S. 36 Taf. III Fig. 20-22. Schale auf beiden Seiten gewölbt, mit zugeschärftem oder gerundetem Rand. Nabel flach, nie bis in die älteren Windungen reichend, bei evoluten Formen oft durch einen Nabelknopf geschlossen. Septalmündung interiormarginal, sich in eine Umbilicalmündung fortsetzend. Umbilicalmündung nur bei den letzten Kammern vorhanden oft auf die letzte reduziert. Über der Umbilicalmündung stets starke Lippen, die bei älteren Kammern Leisten oder Rippen werden und im Zentrum der Nabelseite einen Kranz bilden. Einige Formen haben in der Jugend eine Nabelbildung wie bei *Gavelinella. Pseudovalvulineria* unterscheidet sich von *Valvulineria* durch den Nabel und von *Gavelinella* durch den nie durchgehenden Nabel und durch den Nabelknopf. Zur Gattung *Pseudovalvulineria* gehören unter anderen *Anomalina pseudopapillosa* Carsey 1926 und *Rosalina clementiana* D'Orbigny 1840. Sehr typische Vertreter der Gattung finden sich schon im Gault und zahlreich im unteren Cenoman, sind aber bisher noch nicht beschreiben."

In a sample from Montereau, kindly sent to me by Dr. Hay who collected it (Hay, B-13, Montereau, Monte surville above quai du Seine), the species is the most abundant of the rotaliids.

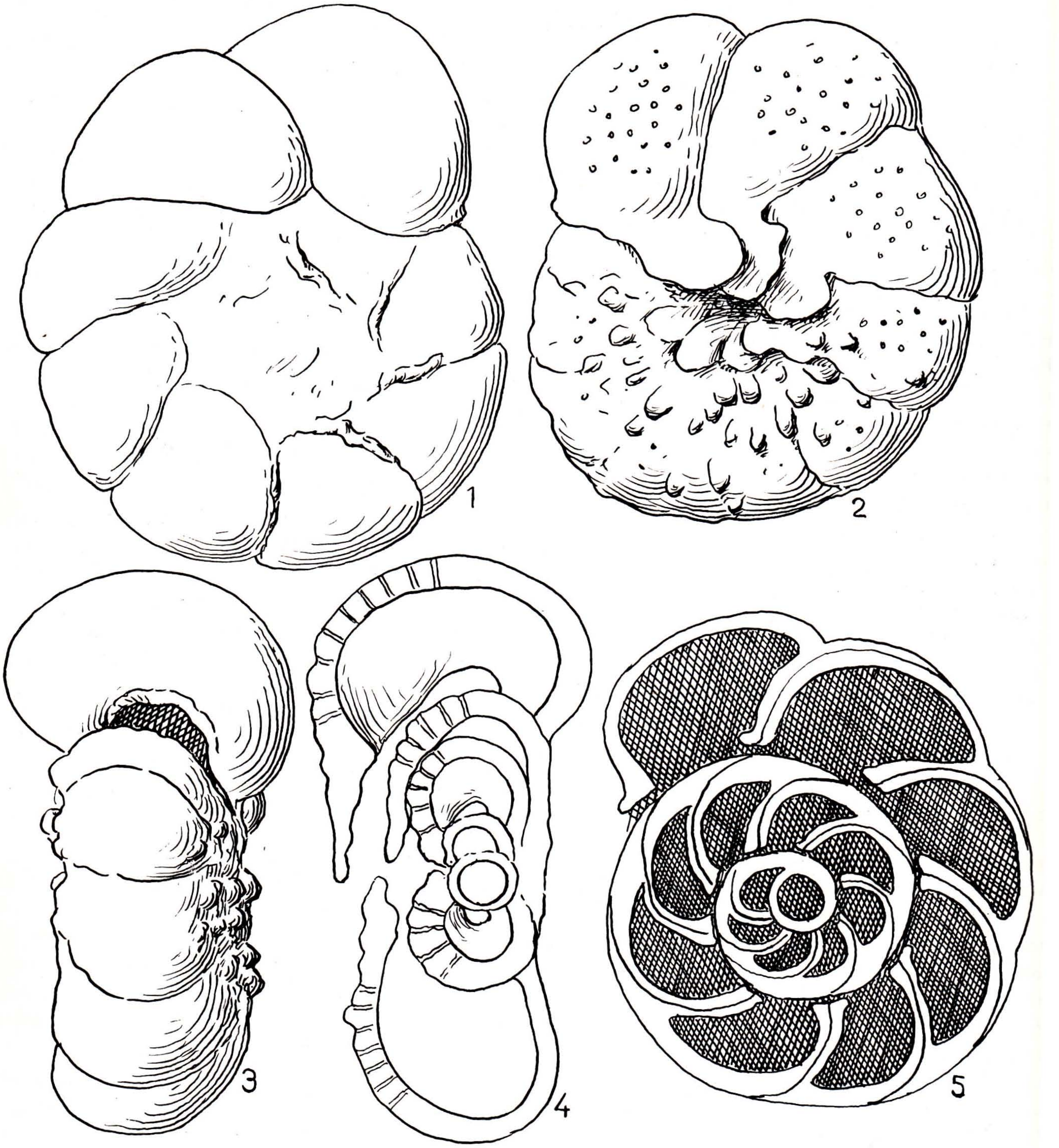
Description of *"Rosalina" lorneiana* d'Orbigny:

Test rounded to slightly oval. Dorsal side somewhat flattened; the sutures of the last-formed whorl slightly depressed and oblique, in earlier chambers somewhat raised to form slight ridges; wall poreless. The periphery is rounded. The inflated last-formed chamber shows an open to slit-like aperture which extends under the umbilical lip towards the umbilical hollow on the ventral side; thus, the aperture is marginal-umbilical.

On the ventral side, the chambers are more inflated, with distinctly depressed radial sutures between the last-formed chambers. Each chamber forms, over a part of the umbilical cavity, a flat, distinct umbilical lip which is rounded and distinctly bent backward and which also covers a part of the previous lip. In older chambers, these lips are slightly thickened and fuse, more or less, with ridges and chalk knobs covering the greater part of the ventral side. Distinct pores are seen in the walls of the ventral side but not in the lips.

In transverse section, the umbilicus is shallow and is covered from the beginning by the thickened lips; no chalk knob, such as is found in all species of *Gavelinopsis,* is formed in the umbilical hollow. Horizontal sections reveal double septal walls, such as are found in the Gavelinellidae.

There are no differences between the type species of *Pseudovalvulineria* and that of *Gavelinella, Discorbis pertusa* Marsson, 1878. I (Hofker, 1957, pp. 281-316) have given a detailed analysis of *Gavelinella.* The characteristics of that very homogenous genus are: flat, trochoidal tests; dorsal side without pores (only some very advanced species may develop pores on the dorsal side of the last-formed chambers); ventral side with pores; umbilicus open but may be partly covered by umbilical lips over the umbilical apertures; umbilicus never filled by a chalk knob; septal walls always double; aperture marginal and umbilical, the umbilical part covered by the umbilical lips; on the dorsal



TEXT FIGURES 1 - 5

Gavelinella lorneiana (d'Orbigny); from the type locality, Montereau, Upper Campanian, France; × 57. 1, dorsal side. 2, ventral side. 3, apertural face. 4, transverse section of this individual, showing the deep umbilicus, the umbilical lips covering the umbilical hollow, and the marginal-umbilical apertures. 5, horizontal section of another test, showing the double septa.

side, the chambers may be evolute, partly involute, or completely involute.

A transverse section of *Gavelinella lorneiana* shows without doubt that, just as in the case of *G. pertusa* (see Hofker, 1957, p. 292, fig. 346), the umbilicus is shallow and extends down to the ventral wall of the proloculus. For this reason, Brotzen's theory that the difference between *Gavelinella* and *Pseudovalvulineria* is found in the deeper umbilical hollow of the former genus is not justified. Nor is a ventral umbilical knob characteristic of *Pseudovalvulineria,* as postulated by Brotzen, since the type species lacks such a knob. This is why Vasilenko (1954) refers so many species to *Anomalina* (*Pseudovalvulineria*), with or without a ventral knob. Brotzen (1942, p. 20) mentions as additional typical species of *Pseudovalvulineria: Anomalina pseudopapillosa* Carsey, 1926 (a species without a ventral chalk knob) and *Rosalina clementiana* d'Orbigny, 1840 (also lacking the ventral chalk knob and referable [see Hofker, 1957, pp. 294-297] to *Gaveli-*

nella; Gavelinella lorneiana appears to be a descendant of this species).

Thus, the type species of *Pseudovalvulineria* is a true *Gavelinella.* It is fortunate that Brotzen (1942, pp. 19, 20) mentions *Gavelinella* nov. gen. first for otherwise all its species would have to be referred to *Pseudovalvulineria.*

I have mentioned *Gavelinella lorneiana* on several occasions: Hofker (1956b, p. 224, fig. 53), the Maestrichtian form of the species; (1956b, p. 210), where *G. lorneiana* is mentioned as a descendant of *G. clementiana;* (1956a), the latest form of the species, from the *Pseudotextularia*-zone. In all these publications I had the true form in mind and referred it to *Gavelinella.*

The conclusion is that *Pseudovalvulineria* has no generic status. Some of its species should be referred to *Gavelinella,* others mentioned by authors should be referred to *Gavelinopsis.*

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RECENT LITERATURE ON THE FORAMINIFERA

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

Alexandrowicz, Stefan. Stratigraphy of Chodenice and Grabowiec beds at Chelm on the Raba River (English summary of Polish text).—Kwart. Geol., Poland Instyt. Geol., Warsaw, tom 5, No. 3, 1961, p. 646-667, pls. 1, 2 (assemblages), text figs. 1-3 (section, diagrams), tables 1-3 (distrib. tables, correl. chart).—Lists and photographs of assemblages of Tortonian age.

Microfauna of ceritic clays from Nowosielica near Kolomyja (English summary of Russian text).—Bull. Acad. Polonaise Sci., ser. sci. geol. et geogr., v. 9, No. 3, 1961, p. 177-182, text figs. 1, 2 (map, outline drawings).—A monotonous assemblage of *Streblus beccarii* (2 forms) in upper Tortonian clays.

Berggren, W. A., and Kurtén, B. Notes on the biometry of *Globigerina yeguaensis*.—Stockholm Contrib. in Geol., v. 8:1, Aug. 25, 1961, p. 1-16, text figs. 1-6 (drawings, graphs).—Statistical analysis of 5 morphologic variant groups (probably infraspecific variants) in *G. yeguaensis* from the lower Eocene of Denmark confirms the existence of groups recognized by subjective observation.

Bergquist, Harlan R. Early Cretaceous (middle Neocomian) microfossils in south-central Alaska. —U. S. Geol. Survey Prof. Paper 424-D, Nov. 6, 1961, art. 374, p. D236-D237, 1 fig. (map), 1 table.—Included are 19 species (11 indeterminate) of smaller Foraminifera.

Foraminiferal zonation in Matanuska Formation, Squaw Creek-Nelchina River area, south-central Alaska.—Am. Assoc. Petroleum Geologists Bull., v. 45, No. 12, Dec. 1961, p. 1994-2011, text figs. 1-3 (maps, correl. chart), table 1.—Five tentative zones are set up in a sequence possibly ranging from late Turonian to Maestrichtian. Occurrence and abundance in the zones are indicated for about 75 species.

Blaicher, Jadwiga. Microfauna of *Globigerina* marls from region of Podzamcze fold (Carpathians) (English summary of Polish text).—Kwart. Geol., Poland Instyt. Geol., Warsaw, tom 5, No. 3, 1961, p. 602-612, pls. 1-3 (assemblages), text figs. 1-3 (charts).—Of late Eocene age.

Blank, M. I. Opisanie Novykh Vidov Foraminifer iz Srednejurskikh Otlozhenij Severo-Zapadnoj Okrainy Donethkogo Krjazha i Vostochnoj Chasti Dneprovsko-Donethkoj Vpadiny.—Russia Vses. Nauchno-issl. Geol. Neft. Inst. (VNIGRI), Trudy, vyp. 29, tom 3, 1961, p. 207-221, pls. 1, 2.—Descriptions and illustrations of 9 species and subspecies, all new, from the Middle Jurassic.

Bondareva, T. P., Nemkov, G. I., and Samodurov, V. I. The age of the Tasaran series of the Northern Near-Aralian (in Russian).—Doklady Akad. Nauk SSSR, tom 140, No. 4, 1961, p. 892-894, text fig. 1 (pl.), figs. 1-14.—Several nummulites are illustrated.

Brönnimann, P., and Stradner, H. Die Foraminiferen- und Discoasteridenzonen von Kuba und ihre interkontinentale Korrelation.—Erdoel-Zeitschrift, Wien-Hamburg, Heft 10, Oct. 1960, p. 364-369, 1 pl., 2 text figs., correl. chart.

Brotzen, F. Correlation problems of the Danian.—Congreso Geol. Internat., XX Ses., Ciudad de Mexico, 1956, El Sistema Cretacico, un symposium, primer tomo, 1959, p. 1-8, 1 correl. chart, 1 distrib. chart.—A few species characteristic of the Danian are listed. Ranges between Paleocene and Maestrichtian of certain species, both exclusive and inclusive in their ranges, are shown from various regions.

Bykova, N. K. K Voprosu o Thiklichnosti Filogeneticheskogo Razvitija u Foraminifer.—Geol. Sbornik 5, Russia Vses. neft. nauchno-issl. geol. instit. (VNIGRI), Trudy, vyp. 163, 1960, p. 309-327, pls. 1-7.—Includes illustrated evolution diagrams showing relationships (a) between *Caucasina* and *Pseudoparrella,* (b) between species of *Uvigerina* in evolutionary lines from middle Eocene to lower Oligocene, (c) between species of *Globigerina* in evolutionary lines from Maestrichtian to upper Eocene, and (d) between species of *Globigerina* in Oligocene lineages.

Caneva, P., and Vapcarova, Ja. Stratigraphy of the Upper Cretaceous and Paleogens near Dalgodelci village, district of Lom, according to microfaunistic data (English summary of Bulgarian text).—Review of the Bulgarian Geol. Soc., v. 22, pt. 2, 1961, p. 117-124, pls. 1-4.—Nine horizons are recognized, mostly by planktonic Foraminifera, between Cenomanian and middle Eocene. Typical assemblages are illustrated.

Chatterji, A. K. The occurrence of *Lepidocyclina* in India.—Micropaleontology, v. 7, No. 4, Oct. 18, 1961, p. 421-434, pls. 1-4, tables 1-16 (distribution and measurements).—Five species (2 new and 1 having a new variety) described from the Burdigalian of Kathiawar.

Cicha, Ivan. Die Mikrobiostratigraphie des Miozäns des Gebietes von Ostrava (German summary of Czech text).—Sbornik Ustred. ustavu geol., v. 26, ser. paleo., 1959 (1961), p. 193-239, pls. 1-8 (assemblages, distrib. and abund. chart), text figs. 1-7 (charts showing range and abundance, correl. chart), correl. table.—Recognition of 3 zones within the lower Tortonian is based on quantitative analysis of species. Typical assemblages are illustrated.

Cole, W. Storrs. An analysis of certain taxonomic problems in the larger Foraminifera.—Bull. Amer. Pal., v. 43, No. 197, Nov. 10, 1961, p. 373-407, pls. 28-39, tables 1, 2.—Certain characters used in separating camerinid genera are shown to be not valid as generic distinctions. Four formerly recognized species are included as synonyms (probably ecologic variants) of *Lepidocyclina* (*L.*) *canellei* Lemoine and R. Douvillé.

Cummings, R. H. The foraminiferal zones of the Carboniferous sequence of the Archerbeck Borehole, Canonbie, Dumfriesshire.—Bull. Great Britain Geol. Survey, No. 18, 1961, p. 107-128, pl. 4 (distrib. and abund. chart), text figs. 1, 2 (range chart, graph).—Based on smaller Foraminifera present in thin sections.

Dain, L. G. Znachenie Foraminifer dlja stratigrafii Vostochnoj Polosy Russkoj Platformy.—Russia Vses. Nauchno-issl. Geol. Neft. Inst. (VNIGRI), Trudy, vyp. 29, tom 3, 1961, p. 168-176, 1 table. —Lists Foraminifera assemblages characteristic of ammonite zones between Bajocian and Upper Jurassic.

Drooger, C. W. Die biostratigraphischen Grundlagen der Gliederung des marinen Neogens an den Typlokalitäten.—Mitteil. Geol. Gesellschaft Wien, Band 52, 1959 (1960), p. 105-114, text fig. 1 (range chart).—Includes range chart showing stratigraphic distribution of *Miogypsina, Nephrolepidina,* and the most important planktonics in the Mediterranean region between Chattian and Plaisancian.

Miogypsina in Hungary.—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, Phys. Sci., v. 64, No. 3, 1961, p. 417-427, text figs. 1-10 (map, geol. section, drawings).—Supporting correlation with Chattian deposits of Germany.

Emiliani, Cesare. Cenozoic climatic changes as indicated by the stratigraphy and chronology of deep-sea cores of *Globigerina*-ooze facies.—Ann. New York Acad. Sci., v. 95, Art. 1, Oct. 5, 1961, p. 521-536, text figs. 1-10 (graphs).

Fujimoto, Haruyoshi, and Igô, Hisayoshi. The fusulinid zones in the Japanese Carboniferous.—Quatrième Congrès pour l'avancement des études de stratigraphie et de Géologie du Carbonifère, Heerlen, Sept. 15-20, 1958, Compte Rendu, tome 1, 1960, p. 201-205, text fig. 1 (correl. chart).

Furrer, Max A. *Siphogenerita,* new genus, and a revision of California Cretaceous "*Siphogenerinoides*" (Foraminiferida).—Proc. Biol. Soc. Washington, v. 74, Dec. 8, 1961, p. 267-274, figs. 1-11 (pl.), text fig. A.—*Siphogenerita* is initially triserial and has a discontinuous internal siphon. All the California species are placed in the new genus, type species *Siphogenerinoides clarki* Cushman and Campbell.

Girelli, Maurizio. Considerazioni stratigrafiche e micropaleontologiche preliminari sui banchi rossi nell'Appennino Tortonese-Pavese (English summary of Italian text).—Boll. Soc. Geol. Ital., v. 79, fasc. 3, 1960, p. 181-193, pls. 1, 2.—Lists of Foraminifera and photographs of assemblages from the Eocene.

Girelli, M., and Pizzochero, M. L. La serie mediomiocenica di Pomaro Monferrato.—Boll. Soc. Geol. Ital., v. 79, fasc. 3, 1960, p. 203-230, pls. 1-5, map, range chart, distrib. table.—The section is divided into 3 planktonic zones (one subdivided into 2 subzones) and typical examples of the 4 assemblages are photographed. Occurrence and abundance of about 140 species are plotted for 9 samples.

Glazunova, A. E., Balakhmatova, V. T., Lipman, R. Kh., Romanova, V. I., and Chochlova, I. A. Stratigrafiia i fauna melovykh otlozhenii Zapadno-Sibirskoi nizmennosti.—Russia Vses. nauchno-issl. geol. instit., Trudy, n. ser., tom 29, 1960, p. 1-347, pls. 1-52, figs. 1-13 (map, line drawings), tables 1, 2.—Illustrated catalog includes, in the Foraminifera section (p. 45-123, pls. 1-25), 99 species (39 new), 11 subspecies (10 new), and 17 varieties (11 new) from the Lower and Upper Cretaceous of western Siberia.

Gordon, W. A. Planktonic Foraminifera and the correlation of the middle Tertiary rocks of Puerto Rico.—Micropaleontology, v. 7, No. 4, Oct. 18, 1961, p. 451-460, pls. 1, 2, text-figs. 1-3 (map, range chart, correl. diagram).—Sequences from northern and southern parts of the island are correlated by means of 15 planktonic species and subspecies (none described as new) of early to middle Miocene age (Aquitanian to Helvetian).

Grigelis, A. A., Lübimova, P. S., and Rygina, P. T. Opisanija Novykh Vidov Jurskikh i Melovykh Foraminifer i Ostrakod.—Russia Vses. Nauchno-issl. Geol. Neft. Inst. (VNIGRI), Trudy, vyp. 29, tom 3, 1961, p. 193-201, pls. 1, 2.—Describes 8 new Foraminifera from the Jurassic and Cretaceous, all but one by Rygina.

Gutschick, Raymond C., Weiner, John L., and Young, Leighton. Lower Mississippian arenaceous Foraminifera from Oklahoma, Texas, and

Montana.—Jour. Paleontology, v. 35, No. 6, Nov. 1961, p. 1193-1221, pls. 147-150, text figs. 1-5 (correl. chart, columnar sections, drawings of fossils). —Descriptions and illustrations of 34 species (12 new) from the Welden, Chappel, and Lodgepole limestones in Oklahoma, central Texas, and southwestern Montana respectively. The combined faunas, included with the closely related one of the Rockford limestone of Indiana, previously described, total 49 species in the Lower Mississippian of the United States.

Halicki, B., and Brodniewicz, I. La stratigraphie du Pleistocène supérieur dans la région péribaltique méridionale.—Bull. Acad. Polonaise Sci., ser. sci. geol. et geogr., v. 9, No. 3, 1961, p. 163-169, text figs. 1-3 (graphs).—The fluctuating abundance of 7 foraminifers in a section is shown graphically.

Herrick, S. M. A stratigraphically significant association of smaller Foraminifera from western Florida.—U. S. Geol. Survey Prof. Paper 424-D, Nov. 6, 1961, art. 376, p. D239.—An association of 4 lagenid species indicating late middle Eocene.

Hiltermann, H. Biostratigraphie der NW-Deutschen Oberkreide mittels Foraminiferen.—Congreso Geol. Internat., XX Ses., Ciudad de Mexico, 1956, El Sistema Cretacico, un symposium, primer tomo, 1959, p. 135-148, text figs. 1-4 (charts showing variation, evolution, and ranges).—Graphic illustration of evolutionary connections between species of *Bolivinoides* and *Neoflabellina* and zonation of the German Upper Cretaceous chiefly by species of these two genera.

Ishii, Ken-ichi. Fusulinids from the Middle Upper Carboniferous Itadorigawa Group in western Shikoku, Japan, Part III. Stratigraphy and Concluding Remarks.—Jour. Inst. Polytechnics, Osaka City Univ., ser. G, Geoscience, v. 5, No. 1, March 1961, p. 31-52, text figs. 1-3 (maps, range chart), table 1 (correl. table).

Jacobsen, John M. Vertical distribution of Foraminifera in the lower chalk member of Austin Formation, southern Dallas County, Texas: Jour. Graduate Research Center, Dallas, v. 29, No. 3, Dec. 1961, p. 179-187, pl. 1 (correl. chart), fig. 1 (diagram), table 1.—Quantitative analysis of some 40 samples reveals a dominantly planktonic assemblage, a composite fauna of about 50 species.

Jasionowicz, Jan. *Globigerina* marls from region of Podzamcze fold (Middle Carpathians) (English summary of Polish text).—Kwart. Geol., Poland Instyt. Geol., Warsaw, tom 5, No. 3, 1961, p. 631-645, text figs. 1-3 (map, columnar sections).—Constituting an important and widespread correlative horizon in the middle of the Bartonian.

Julius, Charles. La microfaune de Foraminifères de quelques gisements classiques d'âge burdigalien dans le Bordelais.—Bull. Soc. Géol. France, sér. 7, tome 2, No. 7, Oct. 6, 1961, p. 942-946, distrib. table.—Species recorded quantitatively from 3 localities.

Kaever, Mathias. Morphologie, Taxionomie und Biostratigraphie von *Globorotalites* und *Conorotalites* (Kreide-Foram.).—Geol. Jahrb., Band 78, Sept. 1961, p. 387-438, pls. 18-21, text figs. 1-8 (distrib. and abund. chart, range chart, graphs, phylogenetic diagram, drawings), tables 1-3.—Monographic treatment including discussion of ecology. Description and illustration of 4 species of *Conorotalites* and 9 of *Globorotalites* (2 new and 1 indeterminate).

Lee, John J., Pierce, Stanley, Tentchoff, Marilyn, and McLaughlin, John J. A. Growth and physiology of Foraminifera in the laboratory: Part 1 —Collection and maintenance.—Micropaleontology, v. 7, No. 4, Oct. 18, 1961, p. 461-466, text-figs. 1, 2 (cultures), graph.—Describes techniques for establishing axenic (without other organisms) and synxenic cultures (where all associated organisms are known). Discusses favorable and unfavorable reactions to various food organisms and substances.

Lipman, R. Kh., Burtman, E. S., and Khokhlova, I. A. Stratigrafija i fauna Paleogenovykh Otlozhenij Zapadno-Sibirskoj Nizmennosti.—Russia Vses. nauchno-issl. geol. instit., Trudy, n. ser., tom 28, 1960, p. 1-230, pls. 1-23, text figs. 1-7 (map, columnar sections, correl. table), tables 1-4.—Includes a section by Lipman (p. 40-69, pls. 1-9) of formal descriptions and illustrations of 44 smaller Foraminifera from the Paleogene of western Siberia, 7 new and 6 indeterminate. Six microfossil zones are recognized between lower Paleocene and lower Oligocene.

MacGillavry, H. J. Danger of world-wide correlations based on evolving features.—Congreso Geol. Internat., XX Ses., Ciudad de Mexico, 1956, El Sistema Cretacico, un symposium, primer tomo, 1959, p. 77-83, text figs. 1-4 (graphs).—Two features (size of the two initial chambers and number of adauxiliary chambers), as occurring in two species of *Lepidorbitoides,* are used to illustrate the author's thesis.

Maync, W. Foraminiferal key biozones in the Lower Cretaceous of the western hemisphere and the Tethys province.—Congreso Geol. Internat., XX Ses., Ciudad de Mexico, 1956, El Sistema Cretacico, un symposium, primer tomo, 1959, p. 85-111, text figs. 1-3 (maps).—Worldwide distributions are plotted for *Spirocyclammina, Choffatella, Pseudocyclammina, Orbitolina, Dictyoconus,* and *Coskinolina.*

Méhes, Kalman. A new *Nummulites* species from the Eocene of Dorog, North Hungary (English summary of Hungarian text).—Földtani Közlöny, Budapest, Köt. 91, Füz. 3, Aug.-Sept. 1961, p. 328-331, pl. 14, text fig. 1 (graph).—*N. rozlozsniki,* a new small striated species.

Miklukho-Maclay, A. D. Stratigraphy of Permian deposits of Middle Asia (in Russian with English summary).—Vestnik Leningrad Univ., Ser. Geol. Geog., No. 12, vyp. 2, 1961, p. 18-41, tables 1, 2.—Zonation by fusulinids.

Minard, James P., Owens, James P., and Todd, Ruth. Redefinition of the Mount Laurel sand (Upper Cretaceous) in New Jersey.—U. S. Geol. Survey Prof. Paper 424-C, Nov. 6, 1961, art. 173, p. C64-C67, 2 figs. (columnar section, graph), 2 tables.—Foraminifera from the *Ostrea* bed at the base of the Mount Laurel show mixed Taylor and Navarro affinities while Foraminifera from the *Exogyra* beds near the top have dominantly Navarro affinities.

Mjatliuk, E. V. Opisanie Novyke Vidov Foraminifer Verkhnejurskikh i Nizhnemelovykh Otlozhenij Russkoj Platformy.—Russia Vses. Nauchno-issl. Geol. Neft. Inst. (VNIGRI), Trudy, vyp. 29, tom 3, 1961, p. 142-157, pls. 1-3.—Describes 17 new species from Upper Jurassic and Lower Cretaceous.

Mound, Michael C. Arenaceous Foraminifera from the Brassfield Limestone (Albion) of southeastern Indiana.—Indiana Geol. Survey Bull. No. 23, Sept. 1961, p. 1-38, pls. 1-3, text figs. 1-5 (map, graph, drawings), tables 1-3.—Illustrated systematic catalog includes 26 species, 3 new. Two new genera are erected and included in the Saccamminidae: *Stomasphaera* (type species *S. brassfieldensis* n. sp.) and *Amphicervicis* (type species *A. elliptica* n. sp.). Study based on insoluble residues from 8 localities.

Nitecki, Matthew H. Catalogue of type specimens of Foraminifera in the Walker Museum of Paleontology.—Fieldiana (Chicago Nat. Hist. Mus.): Geology, v. 13, No. 2, Sept. 28, 1961, p. 109-160.

Nørvang, Aksel. Schizamminidae, a new family of Foraminifera.—Atlantide Rept. No. 6, Sci. Results Danish Exped. Coasts of Tropical West Africa 1945-46, Copenhagen, 1961, p. 169-201, pls. 6-9, text figs. 1, 2 (maps).—Descriptions and illustrations of 7 species (3 new) of *Schizammina* and 2 (1 new) of *Jullienella,* taken by the "Galathea" and the "Atlantide" mostly from off Tropical West Africa. This important and interesting paper discusses basis for classification of these peculiar and localized forms of large agglutinated unilocular foraminifers having no interior lining but an outer tectine covering.

Nyholm, Karl-Georg. Morphogenesis and biology of the foraminifer *Cibicides lobatulus.*—Zool. Bidrag från Uppsala, Band 33, 1961, p. 157-196, pls. 1-5, text figs. 1-21.—Study based on a 4-year series of monthly collections from ascidians in the Gullmar Fjord. The species exists in 3 forms: (a) zygotes in an agglutinated *Webbina*-like chamber, (b) an attached chambered test in the form of any of the many *Cibicides*-related genera, such as *Dyocibicides, Annulocibicides, Cyclocibicides, Stichocibicides,* or *Rectocibicides,* depending on growth conditions, and (c) a planorbulinoid test (a resting schizont) resulting from the dissolution of the calcareous wall of the *Cibicides* test and subsequent reforming of chamber walls.

Odrzywolska-Bienkowa, Ewa. Zechstein microfauna from Mielnik bore-hole (English summary of Polish text).—Kwart. Geol., Poland Instyt. Geol., Warsaw, tom 5, No. 3, 1961, p. 539-549, pls. 1-5, tables 1, 2.—Includes 4 species of Foraminifera.

Petrovic, Miodrag, and Zivkovic, Milutin. Beitrag zur Kenntnis der Eozänen Foraminiferen aus der Umgebung von Cipjan, Buj und Nova Vas (Istrien) (German summary of Jugoslavian text).—Ann. Geol. de la Penin. Balkan., Instit. Geol. Univ. Beograd, tome 27, 1960, p. 285-294, pls. 1-3, text figs. 1-3 (map, photos).—Alveolines and nummulites.

Reichelt, Rudolf. Die bayerische Flyschzone im Ammergau.—Geologica Bavarica, No. 41, 1960, p. 55-98, pls. 1-3 (thin sections), text figs. 1-12 (maps, columnar sections, geol. sections, photos).—Foraminifera assemblages illustrated in thin section.

Reiss, Z., and Issar, A. Subsurface Quaternary correlations in the Tel Aviv region.—Israel Geol. Survey Bull. No. 32, April 1961, p. 10-26, map, range chart, 8 well logs and frequency graphs.—Six distinct foraminiferal assemblages are recognized between Calabrian and post-Tyrrhenian. With the well logs are included graphs to show (a) frequency of Quaternary and redeposited Foraminifera, (b) frequency of 5 groups of Quaternary Foraminifera: (1) *Ammonia,* (2) Elphidiidae and Nonionidae, (3) porcellaneous forms, (4) planktonic forms, and (5) all other forms.

Reiss, Z., Klug, K., and Merling, P. Recent Foraminifera from the Mediterranean and Red Sea coasts of Israel.—Israel Geol. Survey Bull. No. 32, April 1961, p. 27, 28, text figs. 1, 2 (distrib. charts).—The plotted occurrences of 76 species in 11 samples from the Mediterranean coast and of 98 species in 29 samples from the Gulf of Eilat.

Reyment, R. A. Quadrivariate principal component analysis of *Globigerina yeguaensis.*—Stockholm Contrib. in Geol., v. 8:2, Oct. 1, 1961, p. 17-26.—The four dimensions are maximum breadth of test, maximum height of test, length of aperture, and maximum inflation of test. The study is based on

60 specimens from a single sample of Eocene clay from Denmark.

Rich, Mark. Stratigraphic section and fusulinids of the Bird Spring formation near Lee Canyon, Clark County, Nevada.—Jour. Paleontology, v. 35, No. 6, Nov. 1961, p. 1159-1180, pls. 142-146, text figs. 1-4 (maps, columnar sections).—Presence of all major fusulinid zones indicate continuous deposition from Late Mississippian through Pennsylvanian and into the Leonardian part of the Permian.

Rigo, Manuel, and Barbieri, Francesco. Stratigrafia pratica applicata in Sicilia.—Boll. Serv. Geol. Ital., v. 80, Anno 1958, fasc. 2-3, 1959, p. 351-385, pls. 1-14, text figs. 1-10 (maps, columnar sections, geol. sections, correl. chart).—Illustrations of assemblages and lists of species from zones and subzones based on smaller and larger Foraminifera and other organisms between Tortonian and Middle Triassic.

Rosholt, J. N., Emiliani, C., Geiss, J., Koczy, F. F., and Wangersky, P. J. Absolute dating of deep-sea cores by the Pa^{231}/Th^{230} method.—Jour. Geology, v. 69, No. 2, March 1961, p. 162-185, text figs. 1-8 (graphs), tables 1-10.—A method based on the clay component of the sediment, exceeding by twice the C^{14} chronology. Synchronism between the foraminiferal component and the clay component is exceptional because of reworked material in the clay component. Two deep-sea cores from the Caribbean, about 600 km. apart, give results consistent with each other and with the C^{14} chronology, and identical at stratigraphically equivalent levels in the two cores.

Schaub, Hans. Acerca de algunos Nummulites y Assilinas de la monografia y coleccion de d'Archiac (with English abstract).—Notas y Communic. Inst. Geol. y Minero de España, Madrid, No. 62, 1961, p. 171-193, pls. 1-4, text fig. 1 (line drawings), 1 range chart with drawings.—Restudy of original and other material. Redescription of *Nummulites cousisensis* D'Archiac, 1886, and *Assilina leymeriei* (D'Archiac and Haime), 1853.

Skinner, Hubert C. Revision of "*Proteonina difflugiformis*."—Jour. Paleontology, v. 35, No. 6, Nov. 1961, p. 1238-1240.—This species, previously shown to belong in *Reophax,* is restricted to the form having a fine-grained test. Three subspecies (2 of them new) are recognized on the basis of the composition and grain size of the test wall.

Skipp, Betty A. L. Stratigraphic distribution of endothyrid Foraminifera in Carboniferous rocks of the Mackay quadrangle, Idaho.—U. S. Geol. Survey Prof. Paper 424-C, Nov. 6, 1961, art. 236, p. C239-C244, 3 figs. (map, columnar sections, drawings of thin sections).—Illustrations of generically-determined forms useful for distinction of beds between Osage and Morrow.

Sohn, I. G., Herrick, S. M., and Lambert, T. W. Replaced Paleocene Foraminifera in the Jackson Purchase area, Kentucky.—U. S. Geol. Survey Prof. Paper 424-B, Oct. 13, 1961, art. 94, p. B227-B228.

v. Stackelberg, Ulrich. Oberkreide und Alttertiär des Helvetikums am bayerischen Alpenrand im Westen von Tölz.—Geologica Bavarica, No. 41, 1960, p. 3-54, geol. map, text figs. 1-20 (map, geol. sections, correl. chart, thin section photos, mollusk photos).—Foraminifera assemblages are listed and illustrated in thin section.

Thompson, M. L. Pennsylvanian fusulinids from Ward Hunt Island.—Jour. Paleontology, v. 35, No. 6, Nov. 1961, p. 1130-1136, pls. 135, 136, text fig. 1 (map).—Five new species from the southern margin of the Arctic Ocean.

Todd, Ruth. Foraminifera from Onotoa Atoll, Gilbert Islands.—U. S. Geol. Survey Prof. Paper 354-H, 1961 (Jan. 19, 1962), p. 171-191, pls. 22-25, text figs. 40, 41 (map, diagram), tables 1, 2. —Quantitative analysis of Recent Foraminifera from beaches, reefs and the shallow lagoon floor with some preserved and stained samples permitting recognition of living places of species.

Uchio, Takayasu. Foraminiferal assemblage of Semata-no-seki Shell Bed (Pleistocene) and its stratigraphical significance (in Japanese with English abstract).—Prof. Jiro Makiyama Mem. Vol., July 1961, p. 239-247, text fig. 1 (map), tables 1, 2.—Warm-water fauna intercalated between cold water faunas below and above.

Vella, Paul. Upper Oligocene and Miocene uvigerinid Foraminifera from Raukumara Peninsula, New Zealand.—Micropaleontology, v. 7, No. 4, Oct. 18, 1961, p. 467-482, pls. 1, 2, text-figs. 1-5 (correl. and range charts, drawings).—Describes and illustrates 29 species (19 new) and 3 new subspecies of uvigerinids classified in 8 genera, 5 of which are new: *Hofkeruva* (type species *H. mata* n. sp.); *Norcottia* (type species *Hopkinsina mioindex* Finlay, 1947); *Miniuva* (type species *M. minima* n. sp.); *Ruatoria* (type species *R. ruatoria* n. sp.); *Ciperozea* (type species *Siphogenerina ongleyi* Finlay, 1939). *Hofkeruva* is further subdivided into 4 subgenera: *Hofkeruva, Laminiuva, Tereuva,* and *Trigonouva.*

Venglinsky, I. V. Significance of Globigerinidae for the stratification of the Transcarpathian Miocene deposits (English summary of Ukrainian text).—Dopovidi Akad. Nauk Ukrain. RSR, Kiev, No. 7, 1961, p. 946-950, text figs. 1, 2 (chart, columnar section).—Use of the West Indian globigerinid zonation.

Vyalov, O. S., Pishvanova, L. S., Petrashkevich, M. I., and Grishkevich, G. N. Scheme of the stra tigraphy of the Transcarpathian Miocene (English summary of Ukrainian text).—Dopovidi Akad. Nauk Ukrain. RSR, Kiev, No. 10, 1961, p. 1338-1341, tables 1, 2.—Includes horizons of smaller Foraminifera.

ZERNETSKY, B. F. New data on the occurrence of middle Eocene Nummulitidae in the Black Sea area depression (English summary of Ukrainian text).—Dopovidi Akad. Nauk Ukrain. RSR, Kiev, No. 7, 1961, p. 938-940.

New finds of the genus *Pseudosiderolites* in the south of the USSR and their signifiance for stratigraphy (English summary of Ukrainian text).—Dopovidi Akad. Nauk Ukrain. RSR, Kiev, No. 10, 1961, p. 1367.—Resulting in the reassignment of the enclosing rocks to the lower Maestrichtian.

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