CONTRIBUTIONS
FROM THE
CUSHMAN FOUNDATION
FOR
FORAMINIFERAL RESEARCH

VOLUME XVI, Part 4
October, 1965

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1965
CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

VOLUME XVI, PART 4, OCTOBER, 1965

306. A NEW MORPHOLOGIC VARIATION OF THE FORAMINIFER CIBICIDES LOBATULUS

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University of Washington, Department of Oceanography, Contribution No. 301

ABSTRACT

Samples taken in the northeast Pacific contained a new form which is a variation of the foraminifer Cibicides lobatulus (Walker and Jacob). A diagram of the life cycle of Cibicides lobatulus after Nyholm is given and the probable development of the new form is described and illustrated.

INTRODUCTION

In an examination of samples from the Washington, Oregon, British Columbia, and Alaska coasts, an attached foraminifer was noted which appeared to be a new species. Enbysk (1960) figured portions of this form in her unpublished thesis and suggested that it was an anomalinid. In later examination of samples the foraminifer was frequently found attached to pebbles and boulders. After examining several specimens, Miss Ruth Todd, U.S. National Museum, referred the author to an article by Nyholm (1961). This paper described several types of tests which Nyholm believes to be different phases of Cibicides lobatulus: a monothalamous test, a chambered test and a planorbulinoid test. All of these were found associated with the new form in the material from the Northeast Pacific, and it became apparent that this form was part of the complex life cycle of Cibicides lobatulus.

The illustrations were drawn by Janet Griffin. This study was supported by National Science Foundation Grant GP 337 and contract Nonr 083012 with the Office of Naval Research. Ten samples collected by the U.S. Bureau of Commercial Fisheries chartered vessel Tordenskjold in the Gulf of Alaska were examined in addition to selected samples from collections of the University of Washington's Department of Oceanography.

DESCRIPTION OF VARIANT

Test attached, first few chambers low and coiled. Later chambers uncoiled and expanded rapidly with development of heavy irregular ridges (Figures 1, 3, and 4, Plate 21). The change to the heavy chambers may be gradual or it may be abrupt. Early chambers are tectin and the next few have a thin calcareous layer over the dark reddish-brown tectin (Figure 2, Plate 21). Successive chambers have thicker calcareous walls and the final, heavily ridged chambers have an almost porcellaneous texture. The tectin layer is present under the calcareous layer in the final chambers. The aperture is round, with a lip of the same texture as the ridges. Under certain bottom conditions—apparently rocks and pebbles subject to influxes of fine sediment—a flexible arenaceous tube protrudes from the aperture. The tube is often broken but when preserved it may be as long as the test (Figure 4, Plate 21). Small specimens with only a few calcareous chambers were 0.4 mm. long and 0.3 mm. wide. Heavily ridged forms which meander across the rock surface were 2.3 mm. long and 1.5 mm. wide.

NOMENCLATURE

The work of Nyholm has raised interesting questions concerning the taxonomy of the Cibicididae and Planorbulinidae. Until these families can be restudied, it is most reasonable to use the parataxonomic category of forma as a stop-gap measure, as suggested by Boltovskoy (1961). As he has pointed out, forma has no status and does not enlarge our systematic household but still retains all the differences which are important in ecology and life-cycle studies. This new form, with its unusual ridges and aperture, occurs with such frequency that it seemed necessary to utilize some name. The Latin word for “tripe” was used, as it was descriptive, short, and not incumbered by references to any previously named allied genera. The new form is thus named: Cibicides lobatulus (Walker and Jacob), forma omasicus. This form and rough specimens of Cibicides lobatulus, like Figure 1, Plate 21, were probably the forms which Saidova (1964) referred to as Cibicides cicatricosus (Schwager), Cibicides tuberculate Natland, Dyocibicides biseriatis Cushman and Valentine, and perhaps even Anomalina polymorpha Costa from a station north of the Queen Charlotte Islands. This is quite near station BB110-38, which contained almost all the forms illustrated in this paper.

OCCURRENCE

This form was found along the Washington, Oregon, British Columbia and Alaska coasts at depths of 17 to 139 fathoms. It may occur shallower, but no samples were available. An attached form, it occurs on pebbles, rocks or hard bottom. All the available samples of this sediment type examined from the Washington, Oregon, and British Columbia coasts contained the above described variant. However, it was found in only five of the eleven
samples examined from the Alaskan coast, although the involute *Cibicides lobatulus* was present. No limiting factor could be detected, as the sediment type, depth, temperature and latitude were similar to other localities where the form did occur. Table 1 lists the locations and depths of the stations where *Cibicides lobatulus* forma *omasicus* was found. Samples from Cobb Seamount, which rises to 18.5 fathoms, contained many involute *Cibicides lobatulus* but none of the new form.

### TABLE 1
LOCATION OF STATIONS CONTAINING THE NEW FORM

<table>
<thead>
<tr>
<th>Station No.</th>
<th>Latitude (north)</th>
<th>Longitude (west)</th>
<th>Depth (fathoms)</th>
</tr>
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<tbody>
<tr>
<td>BB108-34</td>
<td>43°13.1'</td>
<td>124°36.0'</td>
<td>57</td>
</tr>
<tr>
<td>BB108-28</td>
<td>44°15.6'</td>
<td>124°35.8'</td>
<td>59</td>
</tr>
<tr>
<td>BB291-31</td>
<td>44°25.8'</td>
<td>124°39.4'</td>
<td>74</td>
</tr>
<tr>
<td>BB108-25</td>
<td>44°43.1'</td>
<td>124°23.6'</td>
<td>58</td>
</tr>
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<td>BB108-20</td>
<td>45°43.3'</td>
<td>124°19.3'</td>
<td>81</td>
</tr>
<tr>
<td>BB291-56</td>
<td>45°55.2'</td>
<td>124°33.0'</td>
<td>65</td>
</tr>
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<td>BB291-11</td>
<td>47°22.9'</td>
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<td>17</td>
</tr>
<tr>
<td>BB312-12</td>
<td>48°06.3'</td>
<td>125°13.5'</td>
<td>90</td>
</tr>
<tr>
<td>BB322-4</td>
<td>48°26.9'</td>
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</tr>
<tr>
<td>BB322-2</td>
<td>48°17.6'</td>
<td>123°58.8'</td>
<td>102</td>
</tr>
<tr>
<td>BB322-1</td>
<td>48°14.5'</td>
<td>123°39.1'</td>
<td>95</td>
</tr>
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<td>BB110-43</td>
<td>54°30.0'</td>
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<td>BB110-38</td>
<td>54°33.3'</td>
<td>133°17.0'</td>
<td>91</td>
</tr>
<tr>
<td>Tord 2-21</td>
<td>58°14.7'</td>
<td>137°10.5'</td>
<td>64</td>
</tr>
<tr>
<td>Tord 2-3</td>
<td>58°37.1'</td>
<td>137°56.5'</td>
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<td>Tord 2-14</td>
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<td>139°02.7'</td>
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<tr>
<td>Tord 2-8</td>
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<td>138°31.2'</td>
<td>59</td>
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<tr>
<td>BB110-7</td>
<td>59°53.7'</td>
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</table>

**LIFE CYCLE**

Text figure 1 diagrams the life cycle of *Cibicides lobatulus* as described by Nyholm (1961). The involute *Cibicides lobatulus* (Figure 1, Plate 22) is the microspheric form, or schizont. By asexual reproduction, four-chambered schizofoites with calcareous tests are produced, which, after adding chambers, become evolute megalospheric gamonts (Figure 2, Plate 22). However, some of the schizofoites do not develop into the gamont stage but act as schizonts and asexually produce more four-chambered schizofoites. These are identical with the other calcareous schizofoites and may develop into the thin-walled gamont stage. The gamont disintegrates to produce gametes. Two gametes presumably unite to form a zygote. This uninucleate mass apparently develops an agglutinated conform test. Under the conform test a four-chambered tectin test develops which adds calcareous chambers. As the calcareous test grows the agglutinated outer test breaks down, exposing the top of the involute calcareous test. In the mature involute *Cibicides lobatulus* schizont, only a fringe of the agglutinated material remains.

Nyholm found that the involute *Cibicides lobatulus* at certain times of the year decalcified its test walls and presumably transformed to a flat crust with irregular chambers (Figure 8, Plate 22). This form, previously considered to belong to the genus *Planorbolina*, is a resting schizont of *Cibicides lobatulus*. The cytoplasm is concentrated in the center, but when the resting schizont starts to emit schizofoites the protoplasm migrates, little by little, to the outer chambers, which become quite porous (Figure 7, Plate 22). The schizofoites are flat, four-chambered, tectin forms which later develop calcareous chambers. Some of the schizofoites develop into forms like the planorbulinoidal resting stage but are differentiated from the resting stages formed from the involute *Cibicides lobatulus* by their tectin centers. The same generation of schizofoites may, depending on the conditions of growth, develop into forms which have been called *Cyclobicides*, *Annulobicides* and *Rectobicides*. The new form, with the early tectin coiled portion, is most likely also of this generation. All these *Cibicides*-related forms produce schizofoites which are identical with the schizofoites produced by the planorbulinoidal resting schizont. Another variation these schizofoites may take is to become an evolute form like a gamont. Nyholm did not observe laboratory specimens of these forms emitting gametes, but identical forms collected from the field did produce them.

**ACCESSORY STRUCTURES**

In well preserved specimens, flexible arenaceous tubes were found extending from the tests. The conform stage often had a tube extending from the top (Figure 3, Plate 22), or, in later stages, from the apertural area. Usually one tube extended from the apertural area, but it was not uncommon to find it coming from another area, several tubes coming from one test, or branching tubes (Figure 4, Plate 22). The new ridged form also had an arenaceous tube coming from the aperture, but it was not ob-

**EXPLANATION OF PLATE 21**

<table>
<thead>
<tr>
<th>Figs.</th>
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<tbody>
<tr>
<td>1. <em>Cibicides lobatulus</em> forma <em>omasicus</em>. Typical specimen. Station BB 312-12</td>
<td>137</td>
</tr>
<tr>
<td>2. Young <em>C. lobatulus</em> forma <em>omasicus</em> with arenaceous tube. Station BB 110-38</td>
<td>137</td>
</tr>
<tr>
<td>3. <em>C. lobatulus</em> forma <em>omasicus</em>. Three specimens intergrown. Station BB 312-12</td>
<td>137</td>
</tr>
<tr>
<td>4. <em>C. lobatulus</em> forma <em>omasicus</em> with long arenaceous tube. Station BB 322-1</td>
<td>137</td>
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</tbody>
</table>
Cooper: A Variant of *Cibicides lobatulus*
Cooper: A Variant of Cibicides lobatulus
served to branch. Some of the rocks that were examined had a layer of sediment adhering to the surface. Almost all the specimens on these rocks had arenaceous tubes and the surface was a mass of branching and intertwining tubes. Many planorbilinooidal resting stages were found on this type of rock, but they had no tubes. This substantiates Nyholm's findings that they are resting schizonts and do not feed.

A variation of the involute *Cibicides lobatulus* was found which has a clear calcareous knob filling the umbilicus (Figure 5, Plate 22). A form with sinuous sutures, it is often covered with arenaceous material, as is the involute *Cibicides lobatulus*.

Foraminifera with tubes and calcareous knobs are illustrated in Figure 6, Plate 22. The three specimens were clustered in an area 1.5 mm. long and 1.2 mm. wide. The foremost has a knob and remnants of the arenaceous test, the middle is an involute *Cibicides lobatulus* with a circular test; the farthest form is completely covered with agglutinated material and has several tubes, some broken and others branching.

**SUMMARY**

In the complex life cycle of *Cibicides lobatulus*, Nyholm found that the different Cibicidinae genera, *Planorbulina*, and a form with an arenaceous coniform test are all related. The new form described in this paper apparently is a schizozoite of the planorbilinooidal resting schizont. The early tectin chambers, and the development of arenaceous tubes are indicative of this. The recurrent association of *Cibicides lobatulus*, the planorbilinooidal stage, and the ridged form is also significant. To add another generic or specific name to this group would be adding more confusion to the existing taxonomic disorder made apparent by Nyholm's work.

The use of *forma* is suggested as a stop-gap measure and the new form is called *Cibicides lobatulus* (Walker and Jacob), forma *omasicus*.

**REFERENCES CITED**


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**EXPLANATION OF PLATE 22**

<table>
<thead>
<tr>
<th>FIGS</th>
<th>PAGE</th>
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<tbody>
<tr>
<td>1. <em>Cibicides lobatulus</em> (Walker and Jacob). Typical microspheric form. Station T. 204</td>
<td>138</td>
</tr>
<tr>
<td>2. Gamont. Megalospheric form. Station BB 110-38</td>
<td>138</td>
</tr>
<tr>
<td>3. Coniform stage with short arenaceous tube. Station BB 110-38</td>
<td>138</td>
</tr>
<tr>
<td>4. Test covered with agglutinated material showing branching tubes. Station BB 110-38</td>
<td>138</td>
</tr>
<tr>
<td>5. <em>Cibicides lobatulus</em> with knob and remnants of agglutinated test and tube. Station BB 110-38</td>
<td>139</td>
</tr>
<tr>
<td>6. <em>Cibicides</em> group. Foremost: with knob and fringe of agglutinated material; middle: involute <em>Cibicides lobatulus</em> with a dark porous test; farthest: agglutinated test with branching tubes, some broken. Station BB 110-38</td>
<td>139</td>
</tr>
<tr>
<td>7. Planorbulinoid stage. Thick specimen showing dense center and porous outer chambers. Station BB 322-2</td>
<td>138</td>
</tr>
<tr>
<td>8. Planorbulinoid stage. Crust-like specimen showing some porous chambers. Station BB 322-2</td>
<td>138</td>
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</table>
TEXT FIGURE 1

Diagram of the life cycle of *Cibicides lobatulus* (Walker and Jacob) after Nyholm.
CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

VOLUME XVI, PART 4, OCTOBER, 1965

307. THE GENUS GLANDULINA IN THE UPPER CRETACEOUS OF VRIDHACHALAM AND PONDICHERRY, SOUTH INDIA

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ABSTRACT

Species of the genus Glandulina are described for the first time from the Upper Cretaceous Lower Ariyalur Stage of Vridhachalam and Pondicherry areas of South India. A new variety, Glandulina marginuliniformis (Frizzell) var. elongata Banerji, is noted. The systematic position of the genus Glandulina is also discussed.

INTRODUCTION

Little has been published on the Upper Cretaceous foraminifera of South India except for those from localities near Trichinopoly. The present paper deals only with the species of the genus Glandulina Cushman recorded for the first time from the various zones of Lower Ariyalur Stage of Vridhachalam and Pondicherry, South India. It is the writer’s intention to describe the Cretaceous foraminiferal fauna from each of these zones and sub-zones in the near future.

Samples were collected during 1960-62 from almost all the complete and best exposed sections in an area of about 50 sq. miles just north of the town of Vridhachalam and from an area of about 40 sq. miles just northwest of the town of Pondicherry, in Madras State, where the Lower Ariyalur Stage is best developed. The biostratigraphic relationships described herein were established on the basis of foraminifera recovered from these samples.

ACKNOWLEDGEMENTS

The material in this paper represents a portion of a study in partial fulfilment of the requirements for the degree of Doctor of Philosophy at the Indian Institute of Technology, Kharagpur, India. The writer wishes to express his gratitude to Dr. T. C. Bagchi, professor of Geology, who suggested the study as a long range program and supervised the thesis work. Sincere appreciation is due to Dr. Orville L. Bandy, Professor of Geology, University of Southern California, Los Angeles, for his critical comments on the systematic position of the genus Glandulina. For the illustrations, the writer is indebted to Dr. A. B. Mukherji. A research scholarship granted by the authorities of the Indian Institute of Technology, Kharagpur, is duly acknowledged.

BIOSTRATIGRAPHIC RELATIONSHIPS

Although the Upper Cretaceous strata exposed near Vridhachalam and Pondicherry, Madras State, South India, have been investigated for more than a century (Blanford, 1865), almost no work has been done on the smaller foraminifera from these localities. The present writer in 1960-62 undertook such a study to assist in interpreting the biostratigraphy of the area. About 30 genera and 90 species of foraminifera have been recorded from the Lower Ariyalur Stage (Upper Turonian to Lower Maastrichtian) of the Vridhachalam and Pondicherry areas of South India. On the basis of the foraminiferal assemblage the lithologically uniform Lower Ariyalur Stage, formerly considered to be paleontologically uniform as well, has been subdivided into five distinct biostratigraphic zones and sub-zones, as indicated in Table 1.

DISCUSSION

The systematic position of the genus Glandulina is somewhat interesting to note. Cushman (1950) placed this genus in the family Polymorphinidae and according to him the genus evolved from Pyru-
lina in the Tertiary. He described it as biserial initially and uniserial subsequently. But the type figure of Glandulina d'Orbigny unquestionably shows a uniserial chamber arrangement in section; this is more similar to the genus Pseudoglandulina described by Cushman (1955, p. 216) as follows:

"Test similar to Nodosaria but the chambers embraces, the last formed one making up a large proportion of the test, chambers uniserial throughout, aperture radiate, terminal."

Based on the study of the type section of the genus Glandulina and the description of Pseudoglandulina, Bandy (personal communication, September 17, 1962) considers the genus Pseudoglandulina a junior synonym of Glandulina d'Orbigny. Cushman, on the basis of morphology and chronology, advocates that the genus Pseudoglandulina has evolved as follows: Marginulina gave rise to Dentalina, Dentalina to Nodosaria, and Nodosaria to Pseudoglandulina. The present study of the genus Glandulina from Upper Cretaceous strata reveals that the genus has more affinity with Marginulina, Dentalina and Nodosaria and thus is placed in the family Nodosariidae.

SYSTEMATIC DESCRIPTION
Family NODOSARIIDAE Schultze, 1854
Genus Glandulina d'Orbigny, 1926
Glandulina inflata Bormann
Plate 23, figures 2 and 3
Glandulina inflata BORNEMANN, 1855, Deutsche geol. Gesell., Zeitschr., vol. 7, p. 320, pl. 12, figs. 6, 7.—FRIZZELL, p. 347, pl. 56, fig. 18.
Genotype: Nodosaria (Glandulina) laevigata D'ORBIGNY, 1826, p. 25
Test small, obovoid, consisting of linear series of strongly overlapping chambers; chambers 4 in number, initial chamber pointed, last chamber rounded and largest, about two-thirds the length of the test; sutures straight to slightly curved due to overlapping of chambers; wall smooth; aperture terminal, circular and radiate. Diameter 0.52 mm.; height 0.71 mm.

Occurrence.—Frizzell reported it from Upper Cretaceous of Peru. Studied specimens are from zone E of the Pondicherry area.

Glandulina marginuliniformis (Frizzell)
Plate 23, figure 7
Pseudoglandulina marginuliniformis FRIZZELL, pl. 56, figs. 20, 21a-b.
Test small, obovoid, consisting of a linear series of slightly overlapping chambers; chambers 4 to 5 in number, width of the chambers about two to three times the height, initial chamber pointed; sutures straight, little depressed; wall smooth, unornamented; aperture terminal, central, circular and slightly produced. Diameter 0.52 mm.; height 1.01 mm.

Occurrence.—Recorded by Frizzell from Upper Cretaceous of Peru. Studied specimens are from sub-zone D2 of Pondicherry.

Glandulina manifesta REUSS
Plate 23, figure 6
Glandulina manifesta REUSS, 1851, p. 6, pl. 1, fig. 4.
Test small, little enlarged and elongated, consisting of 5 chambers arranged in a linear fashion, initial chamber less pointed, last chamber largest, about one third of the total length of the test; sutures straight, visible and depressed; wall smooth, unornamented; aperture subcentral, circular to radiate and produced. Diameter 0.51 mm.; height 1.15 mm.

Occurrence.—In the Vridhachalam area this species is common in sub-zone D1. Similar occurrences have been noted from both sub-zones D1 and D2.

Glandulina mutabilis REUSS
Plate 23, figures 4 and 5
Glandulina mutabilis REUSS, 1863, p. 58, pl. 5, fig. 7-11.—EGGER, 1900, K. Bayer Akad. Wiss. München, Math-Physik, Kl. Abh., Bd. 21, p. 83, pl. 5, figs. 21, 29.—BROTTEN, 1938, Sveriges Geol. Undersöknings, ser. C., no. 396, p. 89, pl. 4, fig. 16.
Test small, elongate, more or less cylindrical in shape; chambers 5 in number, arranged in a linear fashion, initial chamber very bluntly rounded, last one globular and largest; sutures straight, transverse and depressed, wall smooth, unornamented; aperture terminal, radiate, subcentral, produced on a short pointed neck. Diameter 0.58 mm.; height 1.20 mm.

Occurrence.—Reuss reported it from the Upper Hills and Gault from Germany. It has also been reported from the Santonian of California. Studied specimens are from zone E of Pondicherry.

Glandulina pygmaea REUSS
Plate 23, figure 1
Glandulina pygmaea REUSS, 1851, Haidinger's naturwiss. Abh. vol. 4, p. 6, pl. 1, fig. 3.—BROT-
ZEN, 1936, no. 3P, p. 90, pl. 4, fig. 14.—TRUJILLO, 1960, p. 326, pl. 47, figs. 1a-b.

Test small, ovoidal, pointed at both ends; greatest diameter at the middle; chambers 4 in number, arranged in a linear fashion, strongly overlapping, initial chamber small and pointed, the last one two-thirds the total length of the test; sutures straight, slightly indistinct; wall smooth, unornamented; aperture terminal, central, radiate and produced. Diameter 0.34 mm.; height 0.88 mm.

Occurrence.—Recorded from the Upper Cretaceous of Lemberg, Ostgalizien, Poland, and also from Upper Cretaceous (Santonian) of Shasta County, California. In the Vridhachalam and Pondicherry areas it has been recorded from zone C only.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH
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308. A UNIQUE UPPER DEVONIAN UMBELLINA FROM THE WILLISTON BASIN OF MONTANA
DONALD F. TOOMEY
Research Center, Pan American Petroleum Company, Tulsa, Oklahoma

ABSTRACT
Thin-sections prepared from two well cores penetrating the Upper Devonian (Frasnian) Duperow Formation of northeastern Montana, have yielded many specimens of a unique Devonian foraminifer that is probably conspecific with the Russian form Umbellina bella (Maslov). The Duperow specimens differ from previously described forms by the possession of well developed lateral nodose projections. This unique morphological characteristic has not been mentioned or illustrated in any of the earlier descriptions. It is suggested that these projections may possibly have aided in stabilizing the mature organism for an attached benthonic existence. The Duperow umbellinid microfauna is thought to be a "normal" intergrading population, since all growth stages are believed to be represented. Only specimens that appear to be mature forms show well developed nodose projections.

The Duperow umbellinids are found in rocks that are classified as intraclastic lime wackestones. The associated fauna consists of amphiporids, echinodermal debris, brachiopod fragments, and ostracodes. The lithology and fauna is thought to be indicative of shallow water marine conditions.

A brief résumé of reported occurrences of Umbellina, and a list of described species is also included.

INTRODUCTION
Early in 1958, Dr. James Lee Wilson, of Shell Development Company, asked the writer to examine a series of thin-sections prepared from two well cores which penetrated the Upper Devonian (Frasnian) Duperow Formation in the Williston Basin of Montana. These thin-sections, seven in all, contain numerous remains of a distinctive microorganism with which both Dr. Wilson and I were totally unfamiliar. Fortunately, we were able to obtain a copy of a Soviet monograph by Bykova and Polenova (1955) which describes and illustrates similar forms from the Upper Devonian rocks of the Russian Platform. Study and comparison of the Duperow specimens with those described in the Russian paper demonstrated that both forms are identical. This microorganism is presently described under the foraminiferan genus Umbellina. However, some Duperow specimens differed from previously described Soviet forms in the possession of basal lateral nodose projections.

Further study of the Duperow thin-sections indicated that the umbellinid microfauna was a "normal" intergrading population containing various growth stages. It was noted that well developed nodose projections occur only on those forms which are thought to represent adult to gerontic individuals. No nodes are observed on those specimens which by their size and stage of development are thought to be juvenile. It is suggested that the lateral nodose projections may possibly have aided in stabilizing the mature organism for an attached benthonic existence.

The Duperow specimens are probably conspecific with the Russian form Umbellina bella (Maslov). The unique nodose specimens are thought to be mature individuals which represent the culminating growth stage of the organism.

EXPLANATION OF PLATE 23

<table>
<thead>
<tr>
<th>FIGS</th>
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<tr>
<td>1. Glandulina pygmaea Reuss, Hypotype, side and apertural views; from Globotruncana conca-vata zone. × 50</td>
<td>142</td>
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<tr>
<td>2-3. Glandulina inflata Bornemann, Hypotype, side and apertural views; from Globotruncana linneiana tricarinata zone. × 50</td>
<td>142</td>
</tr>
<tr>
<td>4-5. Glandulina mutabilis Reuss, Hypotype, side and apertural views; from Globotruncana linneiana tricarinata zone. × 35</td>
<td>142</td>
</tr>
<tr>
<td>6. Glandulina manifesta Reuss, Hypotype, side and apertural views; from subzone D1 of Globotruncana globigerinoides zone. × 35</td>
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</tr>
<tr>
<td>7. Glandulina marginuliniformis (Frizzell), Hypotype, side and apertural views, from subzone D2 of Globotruncana globigerinoides zone. × 35</td>
<td>142</td>
</tr>
<tr>
<td>8. Glandulina marginuliniformis (Frizzell) var. elongata Banerji n. var., Hypotype, side and apertural views; from the subzone D2 of Globotruncana globigerinoides zone. × 38</td>
<td>142</td>
</tr>
<tr>
<td>9. Glandulina marginuliniformis (Frizzell) var. elongata Banerji n. var., Holotype, side and apertural views; from subzone D2 of the Globotruncana globigerinoides zone. × 40</td>
<td>142</td>
</tr>
</tbody>
</table>
Banerji: *Glandulina* in South India
Toomey: Devonian *Umbellina* from Montana
HISTORY AND DESCRIPTION OF UMBELLINA

Superfamily ENDOTHYRACEA Brady, 1884
Family NODOSINELLIDAe Rhumbler, 1895
Subfamily UMBELLININAE Loeblich and Tappan, 1961
Genus Umbellina Loeblich and Tappan, 1961

In 1950, Maslov reported finding large numbers of a new form, of uncertain affinity, which he described as Umbella bella from the Evtianova-Livy strata (Frasnian) of Moscow and the Fammenian Stage of Kazakhstan (Semiz-Bugu). Later that same year, Lipina reported that the name Umbella bella was one of manuscript usage only, thus implying that the form had not been properly described originally. Reitlinger (1954) was the first worker to regard Umbella as a true foraminifer; she placed it in the family Lagenidae. In 1955, Bykova and Polenova felt that Maslov’s original description was not comprehensive enough, so they emended both the genus and the genotyp. Finally, in 1961, Loeblich and Tappan reported that the genus Umbella was preoccupied and proposed the new name Umbellina [type species Umbellina bella (Maslov) = Umbella bella Maslov, 1955]. To accommodate this form a new subfamily Umbellininae was also proposed. In addition, Umbellina was removed from the family Lagenidae and placed in the family Nodosinellidae. Umbellina was placed in the Nodosinellidae primarily because its test wall possesses a compound microstructure in which the prominent outer layer is fibrous. The genus was described as follows by Bykova and Polenova (1955):

"Test calcareous, single-chambered, sometimes has extra skeletal formation in the form of ribs or tubercules, and in places a thickening of the walls. Aperture is a simple rounded opening; in several species the aperture is closed by a small rounded plate or lid composed of the same material as the test. Aperture found at the end of a short neck in some specimens, or simply in the wall of the test. Test wall double. Inner wall thin, dark, fine-grained. Outer wall thick, light-colored, with a mass or bundles of thin radial canal-like pores which may be either straight or flared."

Description and Measurement of the Duperow Umbellinids:

The Duperow specimens agree closely with this description. They differ from Umbella bella (Maslov) in that some specimens (those that would be considered adult individuals) show a pronounced development of nodose flange-like projections extending outward from the base and sides of the test wall, most of which seem to have developed in a bizarre, almost haphazard manner. Specimens that are regarded as juvenile do not possess these unique lateral nodose projections. To consider the possession of lateral nodose projections as a basis for speculation, however, appears to be biologically unrealistic. Results of this preliminary study suggest that the lateral nodose projections develop as the organism reaches maturity and may in essence be considered a culminating phase of the organism’s growth. No apertural plates or lids were observed in situ, but numerous small arcuate calcareous fragments were strewn throughout the slides. These could possibly represent scattered apertural plates, but, more probably, they are fragmented tests of thin-shelled ostracodes.

Measurements of a few “typical mature specimens” are as follows: (in millimeters)

| Inner Wall Thickness | Greatest Thickness Outer Wall | Greatest Greatest Width |
|----------------------|-----------------------------|------------------------|------------------------|
| .031                 | .462                        | 1.001                  | .696                   |
| .022                 | .182                        | .696                   | .810                   |
| .013                 | .487                        | 1.098                  | .899                   |
| .020                 | .397                        | .997                   | .939                   |
| .011                 | .651                        | 1.221                  | .736                   |
| .015                 | .199                        | .800                   | .772                   |

Bykova and Polenova (1955) believe that the thickened umbellinid wall, the irregular and elongate shape, and the cap-like apertural plate or lid suggest that this form is probably an attached foraminifer, possibly analogous to opeculated brachiopods and pelecypods. However, since true apertural lids were not observed on any Duperow specimen, the contention that this form is opeculated must remain speculative. Furthermore, it should be noted that no thin-section photomicrograph of Umbellina published to date shows an apertural lid, although Ozonkowa (1962, p.115-116) reports that “specimens with lids covering the aperture were observed in some thin-sections.”

The umbellinid microfauna reported herein occurs in rocks that may be classified lithologically as intraclastic wackestones. Dunham (1962, p.116, pl. 5c) gives an illustration of this lithologic type.
from the identical umbellinid horizon and describes it as a slightly dolomitized, ostracod-lithiclast lime wackestone.

REPORTED OCCURRENCES OF UMBELLINA

As noted above, Maslov (1950) reported finding large numbers of Umbella bella from the Frasnian rocks of Moscow and the Fammenian rocks of Kazakhstan. Lipina (1950) briefly notes finding the same form from an Upper Devonian horizon on the Russian Platform and gave thin-section photomicrographs of U. bella. Reitlinger (1954) apparently accepted Maslov's original description of Umbella and described two species and one new variety under this genus. All of her forms are from the Upper Devonian (Frasnian) of the eastern part of the Russian Platform.

Bykova and Polenova (1955) found abundant Umbella in an Upper Devonian horizon in the Volga-Ural region. From this interval nine new species were described and illustrated by whole-specimen drawings and thin-section photomicrographs.

In 1959, Konolipina described five species of Umbella, of which one was new, from the Upper Devonian rocks of the Ukraine. Thin-section photomicrographs of all described forms were given.

Additional Soviet occurrences include the following: (a) Ilyina (1961) reports Umbella bella (Maslov) from a well penetrating Upper Devonian (Frasnian) sediments in the central region of the Russian Platform, (b) Menner (1961) reports U. ex. gr. bella (Maslov) from the Upper Devonian (Frasnian) sediments of the southwestern Siberian Platform, (c) Miklukho-Maklay (1961) notes the occurrence of Umbella from the Upper Devonian rocks of the Alay and Turkistan Ranges of central Asia, and (d) Shevchenko (1961) reports finding U. saccamminiformis (Bykova) in the Upper Devonian (Fammenian) rocks of the Stalingrad region of the Soviet Union.

From Poland, Ozonkowa (1962) reports the presence of three species of Umbellina from a thin limestone bed of Middle Devonian age (Givetian) from the eastern part of the Kielce-Lagow synclinorium, Holy Cross Mountains. Of the three described species, two are new. Ozonkowa notes that two forms described by Bykova and Polenova (U. baschkirica and U. pugatchovensis) may possibly be varieties of U. bella (Maslov). Thin-section photomicrographs and whole-specimen drawings of all described forms are given.

Two instances can be noted in which Umbellina has been incorrectly identified as a calcisphere: (1) Lombard and Monteyne (1952) illustrated and described a form as "Calcisphere Form A" from the Upper Devonian (Frasnian) rocks of Namur, Belgium, and (2) Konishi (1958) also illustrated and described a form as "Calcisphere Form A" from the Upper Devonian (Frasnian) Cooking Lake Formation, of Alberta, Canada. In both instances the forms described as calcispheres may now be placed under Umbellina, probably U. bella (Maslov).

Forms of the genus Umbellina occur in widely separated areas of the Soviet Union in rocks of Upper Devonian age (Frasnian-Fammenian). In Poland, Umbellina occurs in the Middle Devonian (Givetian) rocks of the Holy Cross Mountains. In western Europe, Umbellina is only found in the Upper Devonian (Frasnian) rocks of the Namur Region of Belgium. In North America, Umbellina occurs in the Upper Devonian (Frasnian) Cooking Lake Formation, Alberta, Canada; in two wells penetrating the Upper Devonian (Frasnian) Duperow Formation of eastern Montana, and in Duperow outcrop in the Sawtooth Range of northwestern Montana (personal communication by Dr. R. J. Stanton, Jr. 8/60).

At present, fifteen species and one variety of the genus Umbellina have been described in the literature. These are:

- Umbellina baschkirica (Bykova and Polenova)
- U. bella (Maslov)
- U. bykovae (Reitlinger)
- U. bykovae var. grandis (Reitlinger)
- U. famena (Bykova and Polenova)
- U. grandis (Bykova and Polenova)
- U. nana (Reitlinger)
- U. ollaria (Bykova and Polenova)
- U. ornata (Bykova and Polenova)
- U. patella (Bykova and Polenova)
- U. polonica Ozonkowa
- U. pugatchovensis (Bykova and Polenova)
- U. radiata (Konolipina)
- U. rotunda (Bykova and Polenova)
- U. saccamminiformis (Bykova and Polenova)
- U. sanctacruicensis Ozonkowa.

All of the above species have been described either from the Soviet Union or from Poland. It is indeed probable that some of them are synonyms, since they have been, for the most part, defined solely on the basis of random thin-section cuts. None have been formally described from North America; the Duperow occurrence reported in this paper represents the first recognition of the genus per se in North America.

CONCLUDING REMARKS

For some time this writer has entertained serious doubt as to whether or not Umbellina is actually a foraminifer. Thought has been given to the proposition that Umbellina might possibly be a charophyte oolithium. However, the distinctive umbellinid test wall microstructure, much like that of other members of the foraminiferal family Nodosinellidae, attests to its foraminiferal affinity. In addition, a cursory examination of the literature per-
taining to Paleozoic charophytes failed to reveal any forms possessing a similar wall microstructure. Most Paleozoic charophyte oögonia possess a wall microstructure recrystallized to blocky mosaic calcite; more rarely, a few forms show distinctive laminae of organic material. Nonetheless, forms recently illustrated by Perkins (1962, pl. 5, fig. 2) from the Middle Devonian (Jefferson Limestone) and considered by him as charophyte oögonia do appear to show some rather disturbing similarities to the umbellinids described above.

ADDENDUM

While this paper was in press, a short note appeared which briefly documented the occurrence of *Umbellina* from three well cores that penetrated the Duperow Formation in western North Dakota (Rich, M., 1965, “Calcispheres” from the Duperow Formation (Upper Devonian) in western North Dakota: Jour. Paleontology, v. 39, no. 1, p. 143-45, pl. 20).

It is of some interest to note that none of Rich’s umbellinids show the unique lateral nodose projections seen in the Montana umbellinids; however, both microfaunal assemblages do appear to occur in a similar rock type—intraclastic lime wackestone. In a concluding statement Rich (p. 144) states that *Umbellina* “may be a widespread index of the Late Devonian,” but evidence presented above (Ozonkowa, 1962) shows that *Umbellina* has also been found in rocks of Middle Devonian (Givetian) age from Poland.

REFERENCES


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

**CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH**

**VOLUME XVI, PART 4, OCTOBER, 1965**

309. **TWO SPECIES OF BRITISH RECENT FORAMINIFERIDA**

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**ABSTRACT**

The interpretation of *Nonion depressulus* (Walker and Jacob) is emended and a new species, *Protelphidium anglicum* n. sp., erected.

Superfamily CASSIDULINACEA d'Orbigny

Family NONIONIDAE Schultze

*Nonion depressulus* (Walker and Jacob) sensu stricto, emended diagnosis

Plate 25, figures 6, 7; Plate 26, figures 7, 8

"Nautilus spiralis utrinque . . ." Walker and Boys, 1784, Testacea minuta rariora, p. 19, fig. 68.

*Nautilus depressulus* Walker and Jacob, 1798, in Kannacher, Adam's essays on the microscope, ed. 2, p. 641, fig. 33.

Emended diagnosis based on topotype 1962.2.12.533 (Plate 25, figs. 6 and 7).

Test free, planispiral, compressed, bilaterally symmetrical, nearly involute; 10 chambers in the outer whorl, rapidly increasing in height as added, only slightly inflated; sutures distinct, initially only slightly depressed, but later becoming deeply depressed, recurved; aperture obscure, apparently a row of 3 or 4 minute pores at the base of the apertural face of the last chamber, which are not easily distinguished from the surrounding white granular material; periphery rounded, slightly lobate; umbilical regions slightly depressed and infilled with white granular material extending into the umbilical regions of the depressed sutures; wall transparent to opaque and white, calcareous, granular, perforate. Greatest diameter 0.313 mm., greatest thickness 0.104 mm.


Topotype Locality.—Beach sand, about 250 yds. west of Reculver, Reculver, Kent.

Discussion.—The full description given by Walker and Boys (1784) is: "Nautilus Spiralis utrinque subumbilicatus geniculis depressis plurimus — The spiral subumbilicated nautilus, with many depressed joints. The colour opaque white. From Reculver, very rare." Their figure, which is diagrammatic, shows a planispirally coiled form with 13 chambers visible in the outer whorl. The chambers increase rapidly in height as they are added; they are wide and thin and show no marked inflation. The periphery is very slightly lobed. The form appears to be more or less involute and the umbilicus is occupied by a plug (questionable). A copy of Walker and Boys' *Testacea minuta rariora* was examined and it was noticed that the figure reproduced in the Catalogue of Foraminifera (Ellis and Messina) is inaccurate: the right hand view gives the impression of the last chambers uncoiling; this was found not to be the case in the original plates. Walker and Jacob (1798) gave the valid binomial name *Nautilus depressulus* to this form.

The exact fate of the Walker and Boys collection is unknown, but it is certain that their specimens are lost. According to Sherborn (1940) the Sandwich types were in the Portland Museum, but the curator, Mr. H. Lidbetter, has no information on the collection. There appears always to have been doubt about the exact nature of *N. depressulus*, and the majority of authors have referred to it forms which are distinct. It was in an attempt to sort out the confusion that topotype material was collected. Walker and Boys obtained their specimens from Reculver in north Kent; the title of their book suggests that it was from the beach sands. Local information indicates that the cliffs at Reculver have receded about four miles in the past two hundred years, but this seems to be an exaggeration. Whitaker and Dowker (1885) believed the amount of erosion to be overestimated and stated, "In 1788, Mr. Boys found that the northern wall of the Roman Castrum, which was 80 yards from the church, had lately been overthrown by a fall of cliff." The double towers of the church (Reculver Towers) are still preserved, although they are on the edge of the present cliff, which is strongly de-

**EXPLANATION OF PLATE 25**

The scale for figures 1 - 6 equals 0.1 mm.

Figs.

1, 2. *Protelphidium anglicum* n. sp. Holotype, 1962.2.12.230. (1) apertural view, (2) side view. 149


The emended diagnosis is based on this specimen.

7. (Stereo pair) *Nonion depressulus* (Walker and Jacob) emended. Topotype, 1962.2.12.533. Side view. × 82. The emended diagnosis is based on this specimen. 148
Murray: New Recent British Foraminifera
Murray: New Recent British Foraminifera
fended by a sea wall and groyne. This suggests that only about 80 yards of land have been removed since Boys' time, which is important in assessing the value of the topotype material.

In April, 1961, samples were collected both from the foreshore and from the cliffs at Reculver. The cliffs consist of Thanet Sands and Woolwich Beds; the Thanet Sands also form much of the beach. Recent sand is not very abundant near high tide mark but increases seawards, where it is of the quicksand type. Some of the beach sand was preserved in alcohol so that living Foraminifera could be stained.

The foraminiferid faunas of the Thanet Sands and Woolwich Beds are abundant; at least 90% of the fauna of the beach sands consists of foraminiferids derived from these formations. Thus, all Recent forms are rare and, of these, few were found to be alive at the time of collection. However, in spite of the greater abundance of derived Tertiary forms, Walker and Boys seem mainly to have described the Recent forms. Haynes' suggestion (1956) that his specimen of Nonionella cretacea Cushman closely resembles Walker and Boys' figure of Nautilus depressulus is not accepted; the two are quite distinct.

The form herein taken to represent Nautilus depressulus is comparatively rare at Reculver and becomes progressively rarer toward Herne Bay. It is undoubtedly a Recent form, as many specimens gave a positive reaction when stained with rose Bengal. Also, in the unstained material, the protoplasm, green either with ingested food or symbiotic algae, was clearly seen.

One of the main differences between the topotype here described and Walker and Boys' original figure is that in the former there appear to be fewer chambers. In the topotypes examined, the number of chambers in the outer whorl was counted for 37 perfect specimens:

<table>
<thead>
<tr>
<th>Number of chambers</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
</tr>
</tbody>
</table>

The only other difference is that Walker and Boys described their type as 'opaque white.' This is of no significance, as the derived Tertiary and the Recent forms vary from opaque white to translucent or transparent. Opacity in this case is a secondary effect produced by slight etching of the calcareous test.

In the type collections of the British Museum of Natural History the forms normally referred to Nonion depressulus should be referred to Protelphidiun anglicum, while many of the specimens referred to Nonion asterizallus (Fichtel and Moll) rightly belong in Nonion depressulus. Milton placed specimens of this species in both N. depressulus and N. asterizallus. Nyi Nyi and Kureshy (1956) both referred it to Nonion asterizallus, but Harris (1958) correctly identified his specimens from the North Sea.

Macfadyen (1940) drew a comparison between topotypes of N. depressulus and N. orbicularis. However, his figure is too poor to identify. Nyi Nyi (1956) examined Macfadyen's topotype and expressed the view that it was not the same as that originally described by Walker and Jacob.

Superfamily ROTALIACEA Ehrenberg
Family ELPHIDIIDAE Galloway
Protelphidiun anglicum n. sp.
Plate 25, figures 1-5; Plate 26, figures 1-6
Nonionina crassula (Walker), WILLIAMSON, 1858, on the Recent Foraminifera of Great Britain. Ray Soc. pp. 33-34, pl. 3, figs. 70 and 71 (listed as Nonionina umbilicatula on p. 97) (non Nautilus crassula Walker and Jacob, 1798).

Nonionina depressula (Walker and Jacob), BRADY, 1884, Rep. voy. Challenger, Zool., vol. 9, pp. 725-6, pl. 109, fig. 6a, b, (in part); and of authors, in part. (non Nautilus depressula Walker and Jacob, 1798).

Description of holotype.—Plate 25, fig. 1, 2; Plate 26, fig. 1):
Test free, planispiral, bilaterally symmetrical, involute; 9 chambers visible in the last whorl, early ones not inflated, later becoming inflated; sutures distinct, flush or very slightly depressed in the early
portion, later becoming strongly depressed as the chambers become more inflated; umbilici depressed and partly infilled with white granular material which extends into the umbilical portions of the depressed sutures; aperture a row of 5 pores at the base of the apertural face of the last chamber, extending laterally toward the umbilici, partly obscured by a zone of small white granulations covering this part of the apertural face; wall transparent to opaque, calcareous, radiate and lamellar, finely perforate. Greatest diameter 0.400 mm., greatest thickness 0.188 mm.


Locality.—Sample 119/A/D, from the surface sediment about 400 feet east of the small arcuate island in the center of Christchurch Harbour, Hampshire, England.

Discussion.—It is unfortunate that the species described by Walker and Boys as “Nautilus spiralis utrineque ...” and later validly named Nautilus depressus by Walker and Jacob (see p. 148) is comparatively rare around British shores. The new species, Protelphidium anglicum, is very abundant all round the coast, particularly in areas of lowered salinities, and has previously been referred erroneously to Walker and Jacob’s species depressus by the majority of authors and to Nonionina crassula by Williamson. The latter author’s illustration is the best ever given, although the details of the aperture are far from clear.

Protelphidium anglicum is readily distinguished from Nonion depressus (Walker and Jacob) as here emended. The former is very much less compressed and has more inflated chambers. Although the average number of chambers in the outer whorl is the same (9), N. depressus is not completely involute, while in P. anglicum the umbilici tend to be deeper when not infilled with granular material. However, the major point of difference between the two species is in the wall structure: Nonion depressus has a calcareous granular wall, whereas Protelphidium anglicum has a calcareous radiate lamellar wall. It is this character which has led to placing this species in the genus Protelphidium Haynes, 1956. Haynes wrote (p. 86):

“The genus Protelphidium includes members of the Nonionidae which are radiate hyaline, involute, with or without multiple apertures but without sutural pores or retral processes. The genus differs from Nonion Montfort in being radiate hyaline not granular and in the development of multiple foraminas. It differs from Elphidiella Cushman, in its lack of sutural pores.”

Topotypes of the type species, Protelphidium holfkerti Haynes have been examined. In view of the wall structure, this genus should be placed in the family Elphidiidae (rather than the Nonionidae) although it has no retral processes.

Protelphidium anglicum is quite variable, as is shown by the 205 ‘living’ and dead paratypes mounted with the holotype. One of the principle trends of variation is the degree of inflation of the chambers and the concomitant degree of depression of the sutures. A count of the number of chambers in the outer whorl in 50 of the dead paratypes gave the following results:

<table>
<thead>
<tr>
<th>Number of chambers</th>
<th>Frequency</th>
</tr>
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<tbody>
<tr>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
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<tr>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
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</table>

Thus, the average specimen has either 8 or 9 chambers in the outer whorl.

Voorthuysen (1957) described and figured Nonion depressus (Walker and Jacob) forma asterotuberculatus from the Eemian of Holland. No types of this species have been examined and its wall structure is not known. However, apart from any other differences, it is described as having from 5 to 7 chambers, usually 6. Thus it barely overlaps with the number found in P. anglicum; it is not considered that it would be synonymous even if it proved to be a Protelphidium.

REFERENCES


Sherborn, C. D., 1940, Where is the ———— collection? Cambridge Univ. Press.


310. A NEW PLANKTONIC SPECIES (FORAMINIFERIDA) FROM THE PLIOCENE OF PACIFIC DEEP-SEA CORES

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ABSTRACT

The new planktonic species Pulleniatina spectabilis (Foraminifera) from the lower part of the Pliocene of Pacific deep-sea cores is described. This species appears to have a short range in the Pliocene and thus far has been found only in Pacific Ocean sediments.

INTRODUCTION

Pulleniatina spectabilis n. sp. is believed to be an excellent marker for the “lower” part of the Pliocene in equatorial deep-sea cores of the Pacific Ocean. The Miocene-Pliocene boundary is placed tentatively at the point where Sphaeroidinella dehiscentes (Parker and Jones) develops from Sphaeroidinellopsis subdehiscentes (Blow). According to Blow (1959, and personal communication), this evolution is observed in the lower part of the Trubi beds of Sicily which generally are considered to be basal Pliocene. Further work on Italian strata nearer the type locality of this boundary is needed before this datum can be used with certainty. Such work is also needed before we can place the Pliocene-Pleistocene boundary with exactness, beyond the reach of controversy. By using Blow’s datum for the lower boundary of the Pliocene and the boundary postulated by Ericson et al. (1963) for the upper one (at present their boundary has no tie-in with the Italian section) the range of P. spectabilis can be placed quite precisely. The species appears in the section at the same time, or shortly after, the appearance of S. dehiscentes. Transitional specimens between this new species and P. semiinvoluta Germeraad were found in the very uppermost Miocene and at the base of the Pliocene in one core. P. spectabilis disappears soon after the disappearance of Globigerina nepenthes Todd, well below the boundary suggested by Ericson et al. It must be remembered, however, that the section seen in deep-sea cores is greatly telescoped as compared to land sections, and it may be that the range of this species is even shorter than it appears to be at present. Blow (personal communication) says that this entire range occurs within the Neogene Zone N19 of Blow and Banner. This zone represents what they consider to be the lowest of three Pliocene zones.

Thus far, P. spectabilis has appeared in three cores between Longs. 168°02'E. to 119°11'W. and Lats. 14°16'S. to 7°17.7'N. It probably will be found eventually in Indian Ocean sediments because the faunas of that ocean show a close affinity with those of the Pacific. It seems rather doubtful that it will be found in the Atlantic region because it has not so far been observed either in the ocean sediments or at land localities in that general area.

This study was supported by the Office of Naval Research; it is a contribution of the Scripps Institution of Oceanography, and Contribution No. 50 of the Marine Foraminifera Laboratory. The figured specimens have been deposited in the U. S. National Museum, Washington, D.C.

Superfamily GLOBIGERINACEA Carpenter

Pulleniatina spectabilis n. sp.

Text figures 1-4

Test plano-convex, trochospiral in initial whorls, later streptospiral, left-coiling, consisting of 4-5 whorls, periphery sharply angled, lobulate with the outer edge of the chambers of the final whorl sometimes extending above those of previous chambers near the peripheral edge; chambers rounded and inflated in the earlier part of the test, later ones slightly inflated on involute side, angular and uninflated on evolute side, 4½ to 5½ in the final whorl, 4 in the initial whorl, up to about 19 in all; early sutures distinct on both sides, curving, later ones distinct on involute side but obscure on evolute side and only slightly curving; wall of adult smooth and somewhat polished, in young forms coarsely pitted with occasional short spines near the periphery; early apertures almost semicircular becoming increasingly narrow and elongate, very narrow in adult. Diameter up to 0.83 mm.; height up to 0.50 mm.

Holotype—(USNM 642379) from Core LSDH 78P, 100-102 cm., Lat. 4°31'S., Long. 168°22'E., at 3208 meters.

This species is quite distinct from its ancestor P. semiinvoluta Germeraad (text figs. 5, 6), differing from that species in its plano-convex test and narrowly angled periphery. P. spectabilis seems to have accelerated rapidly, because the plano-convexity appears early in the development of the test (text figs. 3, 4). Both these species and P. obliqui-
loculata (Parker and Jones) occur concurrently during parts of their ranges.

REFERENCES


TEXT FIGURES 1-6
Figs. 1-3, 5, × 60; 4, 6, × 77; a, b, side views; c, edge view.
Figs. 1-4, Pulleniatina spectabilis n. sp. 1, holotype (USNM 642379); 2-4, paratypes (USNM 642380, 642381, 642382). Fig. 2 represents a dissected specimen showing the streptospiral coiling; the two earlier apertures are shown from their outward aspect; the two later ones are seen from the interior side of the chambers; the final aperture is not shown in the figure.
Figs. 5, 6, Pulleniatina semiinvoluta Germeraad (USNM 642383, 642384).
All figured specimens are from the type locality of Pulleniatina spectabilis n. sp.
311. *NONIONELLA ASTRICITA*, NEW NAME FOR *NONIONELLA JAPONICA* (ASANO) VAR. *MEXICANA* 
CUSHMAN AND McCULLOCH PREOCCUPIED

IRENE McCULLOCH
Allan Hancock Foundation, Los Angeles, California, 90007

*Nonionella japonica* (Asano) var. *mexicana*
Cushman and McCulloch (Allan Hancock Pacific Exped. vol. 6, no. 3, 1940, p. 160, pl. 17, fig. 10)
(= *Nonionella mexicana* Cushman and McCulloch) is preoccupied by *Nonionella turgida mexicana*
(Cole) [originally *Nonion turgidus* (Williamson) var. *mexicanus* Cole, 1927]. The new name *Nonionella astricta* is proposed for *Nonionella japonica* (Asano) var. *mexicana* Cushman and McCulloch, 1940.
CORRECTIONS

The following corrections should be made in the paper "Globigerinoides quadrilobatus (d'Orbigny) and Related Forms: Their Taxonomy, Nomenclature and Stratigraphy," by F. T. Banner and W. H. Blow, published in July of this year (vol. 16, pt. 3, p. 115, Explanation of Plate 16):

1. All figures on plate 16 are reproduced at $\times 140$ linear, rather than $\times 50$.
2. In the description of fig. 1, delete "Same size as original."
3. In the description of fig. 3, read "intermediate" for "indeterminate."
Contributions from the Cushman Foundation for Foraminiferal Research

Recent Literature on the Foraminifera

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


Applin, Paul L., and Applin, Esther R. The Comanche series and associated rocks in the subsurface in central and south Florida.—U. S. Geol. Survey Prof. Paper 447, May 20, 1965, p. 1-84, pls. 1-11 (microfossils, logs, sections, maps), text figs. 1-53 (maps, geol. section, photomicrographs, core photographs), tables 1, 2.—Foraminifera, mostly in thin section, are recorded and illustrated.

Arni, P. L'evolution des Nummulitinae en tant que facteur de modification des dépôts littoraux.—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1963), 1965, p. 7-20, text figs. 1, 2 (range chart, block diagram).—Based on studies in the middle and lower Eocene of the Sirte Basin in Libya, 5 biotopes related to the nummulites bank are recognized, each with its characteristic fauna or faunas.

Contribution a la systématique des Nummulites s. 1.—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1963), 1965, p. 21-28, 1 table.—“Nummulites cordelées” are separated into 2 kinds: Chordoperculinoides new subgenus (type species Operculina bermudezi Palmer) erected to include the flat operculinid ones and the subgenus Ranikothalia to include the inflated ones with coarsely structured marginal plexus.


Banner, F. T., and Wood, G. V. Recrystallization in microfossiliferous limestones.—Geol. Jour., v. 4, pt. 1, March 18, 1964, p. 21-34, pls. 1-6, text fig. 1 (line diagrams), table 1.—Different family groups of Foraminifera are recrystallized selectively, those having Mg ions first. Various stages of recrystallization and obliteration of microfossils in Miocene limestones from Papua are illustrated.

Barbieri, F. Micropaleontologia del Liassic e Dogger del pozzo Ragusa 1 (Sicilia).—Riv. Ital. Paleont. Stratig., v. 70, No. 4, 1964, p. 709-830, pls. 56-66, text figs. 1-20 (map, columnar section, line drawings, correl. chart).—Illustrated systematic catalog includes 119 species of Foraminifera (3 new) but only 35 specifically identified.

Becker, Delia. Micropaleontologia del Superpatagoniense de las localidades Las Cuevas y Monte Entrance (Provincia de Santa Cruz).—Ameghiniana, Rev. Asoc. Pal. Argentina, tomo 3, No. 10, Dec. 1964, p. 319-351, pls. 1-6, text fig. 1 (map), tables 1-4 (check lists, range chart).—Includes illustrated catalog of 26 species of Foraminifera (none new) from the middle Miocene of southernmost Argentina.

Berggren, W. A. Some problems of Paleocene-Lower Eocene planktonic foraminiferal correlations.—Micropaleontology, v. 11, No. 3, July 1965, p. 278-300, pl. 1, text figs. 1-12 (correl. charts, phylogenetic diagrams, drawings), table 1.—Discussion of correlation between zones used in the Western Hemisphere and those of the Crimea and Caucasus. Five species of Globorotalia are discussed and illustrated from Mexia Clay. Phylogenetic diagrams from Subbotina, 1960, are copied.


Blow, W. H. Clavatorella, a new genus of the Globorotaliidae.—Micropaleontology, v. 11, No. 3, July 1965, p. 365-368, text figs. 1-5.—For species in which the aperture becomes umbilical-extraumbilical, the Neogene analogue of Clavihedbergella.
Twilight of foraminiferology.—Jour. Paleontol. —Quantitative study of both living and total of Foraminifera in Long Island Sound.—Smithsonian Institution, Washington, D.C., $1.50) .—No definite relationships between distribution and the physical or chemical factors of the environment were found. Distribution may be related to food supply. Fauna consists of 22 species and 1 variety, none new. Three zones are recognized in the change of relative abundance with depth of the major constituents: Elphidium clavatum, Buccella frigida, and Eggerella advena.


CASTELAIN, J. Aperçu stratigraphique et micropaléontologique du Bassin du Sénégal. Historique de la découverte paléontologique.—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1963), 1965, p. 135-159, pls. 1-4 (maps, geol. section, range chart), text fig. 1 (table).—Includes chart showing ranges of the major significant species of Foraminifera in stratigraphic units from Upper Jurassic to Quaternary.

CHANG, LI-SHO. A biostratigraphic study of the Tertiary in the Hengchun Peninsula, Taiwan, based on smaller Foraminifera (II: Middle Part).—Proc. Geol. Soc. China, No. 8, April 1965, p. 9-18, pls. 1-4, text figs. 1, 2 (map, section), tables 1-5.—Distribution and abundance of 181 species and subspecies of smaller Foraminifera are recorded in several sections, and about a third are illustrated. Three of the West Indian planktonic zones are recognized.

COLOMBO, ANNA. La facies di transizione della Marsica nord-orientale. I—Serie della Serra Sparvera e della Rocca di Chiaraano (with English abstract).—Geologica Romana, v. 3, 1964, p. 93-119, pls. 1, 2, text figs. 1-17 (map, schematic section, columnar sections, thin section photos).—Includes illustrations of foraminifera facies in Lower and Upper Cretaceous.

CONE, VITTORIO. Alcuni foraminiferi nuovi nel Pliocene nordpenninico. Contributo I (with English abstract).—Geologica Romana, v. 3, 1964, p. 279-295, pls. 1, 2, map, text figs. 1-9 (line drawings).—Fifteen new species and 2 new varieties. Two new genera erected in the Buliminidae: Spiroloxocestoma (type species S. croareae n. sp.) and Felsinella (type species F. diaphana n. sp.).


CONLIN, JAMES E., and CONKIN, BARBARA M. Devonian Foraminifera: Part 1, The Louisiana Limestone of Missouri and Illinois.—Bull. Am. Paleontology, v. 47, No. 213, March 20,
CONKIN, JAMES E., CONKIN, BARBARA M., and PIKE, JAMES W. Mississippiian Foraminifera of the United States. Part 2—The Hannibal Formation of northeastern Missouri and western Illinois.—Micropaleontology, v. 11, No. 3, July 1965, p. 335-359, text figs. 1-14 (map, section, columnar sections, check list, range charts, and abund. table, diagram), tables 1-31.—Illustrated catalog of 30 species (1 new).

DEVOTO, GUIDO. Il passaggio Cretaceo-Paleocene nei Monti Lepini e il problema relativo a Keramosphaera tergestina (Foraminifera) (with English abstract).—Geologica Romana, v. 3, 1964, p. 49-55, pls. 1-4, text figs. 1, 2 (drawing and photograph).—Species studied by serial dry peels shows identity between radial-structured and concentric-structured forms.

Zone ad Alveolinæae nel Cretaceo e Paleocene del Lazio cd Abruzzo centro-meridionali (with English abstract).—Geologica Romana, v. 3, 1964, p. 405-409, pls. 1, 2.—Five zones based on assemblages of alveolinids.

DOUGLAS, ROBERT, and SLITTER, WILLIAM V. Taxonomic revision of certain Discorbacea and Orbitoidae (Foraminifera).—Tulane Studies in Geol., v. 3, No. 3, May 25, 1965, p. 149-164, pls. 1-3, text figs. 1, 2.—Study to differentiate Discorbis, Rotarinella, Tachuolina, and Rosalina, the former two monolamellar and the latter two bilamellar. Laboratory experiments suggest that wall structure is a genetic character and is unaffected by environment. Rotarinella includes Gavelinopsis and Biapearverbis as synonyms and Rosalina includes Treptomphalus as a synonym. Rotarinella campanulata and Rosalina globularis are described and illustrated; each includes several species in synonymy.

DUPEUBLE, P.-A. Sur une association microfau­nique caractéristique de la Manche et des régions voisines.—Bull. Soc. Géol. Normandie, v. 54, Année 1964, p. 52-56, 1 text fig. (graph).—Foraminifera listed and a graph shows changing family composition from shore out to 60 meters.

FARINACCI, ANNA. Sulla posizione sistematica e stratigrafica di Protopeneroplis striata Weynschien, 1950 (Foraminifera) (with English abstract).—Geologica Romana, v. 3, 1964, p. 41-48, text figs. 1-5 (map, thin sections).—

Emendation of the genus and species based on specimens in the Jurassic of southern Latium.

FUNNELL, B. M. Studies in North Atlantic Geology and Palaeontology: 1. Upper Cretaceous.—Geol. Mag., v. 101, No. 5, Sept.-Oct. 1964, p. 421-434, text fig. 1 (map), table 1.—Depth interpretations of Upper Cretaceous sediments from the continental margin of North America suggest deposition in water less than 200 meters deep, and imply a continental shelf wider than at present. Even evidence from seamounts fails to support the existence of oceanic depths within the North Atlantic Basin. It is postulated that the North Atlantic was smaller (½ to ⅔ its present size) in the Upper Cretaceous and that the Mid-Atlantic Ridge was a post-Cretaceous addition to it.


GARCIA, JOSÉ LUIS SAVEDRA. Microfacies del Secundario y Terciario de la zona pirenaica española.—Mem. Instit. Geol. Min. España, t. 65, 1964, p. 1-217, text figs. 1-194.—An atlas of photomicrographs and drawings illustrating facies and microfossils in 78 samples from Triassic to Oligocene.

GIBSON, LEE B., and PERCIVAL, STEPHEN F., JR. La présent stratigraphique d'Orbitolina et de Praevalveolina dans le centre de la république de Somalie.—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1963), 1965, p. 335-346, pl. 1, text figs. 1, 2 (map, distrib. chart).—In Cenomanian and Albian.


GRÜN, WALTER, LAUER, GERHARD, NIEDERMAYR, GERHARD, and SCHNABEL, WOLFGANG. Die Kreide-Tertiär-Grenze im Wienerwaldfyllisch bei Hochstrass (Niederösterreich).—Verhandl. Austria Geol. Bundes., heft 2, 1964, p. 226-
HOTTINGER, L. Evolution et variation morphologique des Palmula et Flabellinella du Coniacien et du Santonien de Tarfaya (Maroc Méridional).—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1963), 1965, p. 101-111, pls. 1, 2, text figs. 1-5 (graphs, drawings).—Using Palmula cushmani and 2 new but undescribed species of Flabellinella (one with 2 subspecies), the evolution and variations are illustrated and represented graphically: number of juvenile chambers, degree of spire-angle, and size of protoculus.

JENKINS, D. GRAHAM. Planktonic Foraminifera and Tertiary intercontinental correlations.—Micropaleontology, v. 11, No. 3, July 1965, p. 265-277, pls. 1, 2, text figs. 1, 2 (maps).—Discussion of assumptions and hypotheses affecting the accuracy of correlations. World distribution of 8 short-ranging planktonics is plotted on maps.


LE CALVEZ, YOLANDE. Les Foraminifères, in Les Récifs Coralliens et le Lagon de l'île Mayotte (Archipel des Comores, Océan Indien).—Office Recherche Sci. Tech. Outre-Mer, Paris, 1965, p. 181-201, pls. 13-16, tables 16-24.—Distribution and abundance of 275 species around the island between shore and 78 meters are recorded. The study is based on 94 samples, grouped into 7 zones. Operculina mayottana n. sp. is described. Nearly 40 species are illustrated.

LEHMANN, ROGER. Résultats d'une étude des Globotruncanidés du Crétacé Supérieur de la province de Tarfaya (Maroc Occidental).—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1963), 1965, p. 113-117, text fig. 1 (illustrated zone chart).—The same 5 planktonic zones, already known between Cenomanian and Santonian in Tunis and Algeria, are present in Morocco.

LUTZE, GERHARD F. Zum Färben rezenter Foraminiferen.—Meyniana, Band 14, Dec. 1964, p. 43-47, text fig. 1 (graphs).—In Kieler Bucht living Cribronion turns green in rose bengal stain.

MARTıN EZ -PARDO, MARI E, McINNES, MINATO, MASAO, KATO, MAKOTO, and CONTRIBUTIONS FROM NAGY, OKIMURA, de Lam-Lam (Region de New Zealand Jour. Geol. Geophysics, v. 8, Micropaleontology, v. II, No.3, July 1965, 6.-An upper and a lower foraminiferal assemblage and the lit es, respectively correlated, by planktonic forams, drawings).-Evidence of a warm-water phase in late Maestrichtian time.


NAGY, JENŐ. Foraminifera in some bottom samples from shallow waters in Vestspitsbergen.—Norsk Polarinstıt. Arbok 1963, Oslo, 1965, p. 109-128, pls. 1, 2, text figs. 1-3 (maps, equipment diagram), table 1 (distrib. chart).—Quantitative analysis based on 45 samples from depths between shore and 51 meters, taken from 9 areas, mostly near glacial termini. Sixty species, none new, are recorded and most of them illustrated.

OBERHAUSER, RUDOLF. Zur Kenntnis der Foraminiferengattung Permodiscus, Trocholina, und Tria sina in der alpinen Trias und ihre Einordnung zu den Archaeisciden.—Verhandl. Austria Geol. Bundes., heft 2, 1964, p. 196-210, pls. 1-4, text figs. 1, 2 (diagrams).—Twelve species (5 new) are described.

OKIMURA, YUJI. Endothyroid Foraminifera, Endothyranopsis from Japan.—Geol. Rept. Hiroshima Univ., No. 14, Prof. Sotoji Imamura Mem. Vol., Feb. 1965, p. 253-264, pl. 21, text figs. 1, 2 (maps).—Two species, 1 new, and 2 indeterminate ones questionably included in the genus.


PUGACZEWSKA, HALINA. Les organismes sédentaires sur les rostres des Bélemnites du Crétacé Supérieur.—Acta Palaeont. Polonica, v. 10,

Stehli, F. G. Paleontologic technique for defining ancient ocean currents.—Science, v. 148, No. 3672, May 14, 1965, p. 943-946, text figs. 1-4 (maps).—Since taxonomic diversity (number of kinds) is greater under warm than under cold conditions, and since planktonic Foraminifera are involuntarily distributed by the cold and warm ocean currents they inhabit, the taxonomic diversity of planktonic Foraminifera in fossil deposits may aid in determining positions of glacial and interglacial ocean currents.

Stoljk, J. Contribution à l'étude des corrélations microfauniques du Tertiaire inférieur de la Nigeria Méridionale.—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1965), 1965, p. 247-275, pls. 1-3, text figs. 1-4 (maps, corrol. chart, range chart).—Zonation by planktonics is locally distinct from that of the West Indies. A new zone, based on Cassigerinelloita amekii gen. nov., sp. nov., and extending from uppermost lower Eocene to middle Eocene, is introduced.


Seiglie, George A. Algunos foraminíferos arenáceos recientes de Venezuela.—Bol. Inst. Ocean., Univ. Oriente [Cumaná, Venezuela], v. 3, Nos. 1/2, Dec. 1964, p. 5-14, pl. 1, text fig. 1.—Five species (3 new and 1 given a new name). Tetraaxiella ayalai gen. nov., sp. nov. is erected in the Troachatminidae.

Seiglie, George A., and Bermudez, Pedro J. Monografía de la família de Foraminíferos Glabrátellidae.—Geos, Univ. Central de Venezuela (Caracas), No. 12, May 1965, p. 15-65, pls. 1-14, text figs. 1-14.—Illustrated systematic catalog of 95 species (27 new) and 1 new systematic species in 14 genera of which the following are new: Glabrátellina (type species G. arcuata sp. nov.), Planoglabratella (type species Discorbis nakamurai Asano), Neoglabratella (type species Discorbis wiesneri Parr), Corrugatella (type species C. donosi sp. nov.), Fastigilla (type species Discorbis byramensis Cushman), Heronallenita (type species H. striatospinata sp. nov.), and Cladostriatella (type species C. mexicana sp. nov.).


CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

2. graph.—Foraminifera recorded in a deep-sea core in the Norwegian Sea with 7 horizons noted in the 271-cm. core.

Tewari, B. S., and Bhargava, O. N. Kutch Microfauna: Aquitanian Foraminifera from Waior, south-western Kutch.—Jour. Pal. Soc. India, v. 4 (1959), 1964, p. 6-11, pls. 1-3.—Twenty-three species (2 new) and 4 varieties (1 new).


Viotti, Carlo. Microfaunes et microfaciès du sondage Puerto Consado 1 (Maroc Méridional—Province de Tarfaya).—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1963), 1965, p. 29-60, pls. 1-10, text fig. 1 (columnar sections), table 1 (range chart), range chart, correl. chart.—Includes listing of Foraminifera from Cenomanian to Lower Jurassic, with thin section illustrations of some Jurassic species.

Viterbo, I. Examen micropaléontologique du Crétacé du Maroc Méridional (Bassin côtier de Tarfaya).—Mém. Bureau de Recherches Géol. et Min., No. 32, Colloque Internat. de Micropaléont. (Dakar, 6-11 mai 1963), 1965, p. 61-100, pls. 1-11, text figs. 1, 2 (maps), tables 1-3 (range charts).—Includes illustrations of assemblages of planktonic Foraminifera from various ages between Albian and Maestrichtian.


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