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The microstratigraphy of the cretaceous system of Zululand

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times necessary to repeat the whole procedure several times for the very hard rocks from the lowest levels. The macerated rock is washed through four sieves of mesh sizes 30, 60, 120, 240. The various fractions thus obtained are weighed and are then ready for study. The difference between 50 grams and the sum of four final fractions gives the weight of the sub-240 mesh fraction. The 30 and 60 mesh fractions are next examined microscopically and all of the foraminifera are isolated. Assemblages were isolated and form a collection which was donated to the Bernard Price Institute for Palaeontological Research. The morphotypes described in the text are part of the writer's private collection. The camera lucida drawings in the tables were made by the writer.

For the stratigraphic subdivision of the succession Simpson's Index no. 2 was applied. This consists in comparing one assemblage with each of the others successively, by applying the formula

$$\frac{C}{N_1} \times 100$$

where C is the number of taxa common to the two assemblages and N_1 is the number of taxa in the sample with which the comparison is being made, i.e. the standard.

SYSTEMATIC PART

Generic attributions are made according to the classification given by Loeblich and Tappan (1964). Whenever a species has been changed from one genus to another, this was made in accordance with Loeblich and Tappan's definition. Any explanation of such changes would only be a repetition of these authors' words, and therefore no explanation shall be given.

Identifications at the specific level were made mainly with Ellis and Messina's Catalogue of Foraminifera, and also with various publications. A synonymy for the species is not given as a limited number of publications is available to the writer, and the synonymy would therefore be incomplete and consist of a repetition of these publications. However, all the publications that were used are mentioned and reported in the bibliography. References to the publications in which each species was first described are given where possible. Many of these are unavailable and have been taken from the Zoological Records. These will be marked with an asterisk (*).

All the specimens are in the writer's personal collection which will be referred to as P.C. in the text.

Family HORMOSINIDAE

Subfamily HORMOSININAE

Genus HORMOSINA Brady 1879

HORMOSINA sp.

Pl. 1 Fig. 1

DESCRIPTION

The wall is coarsely agglutinated and can have much or very little cement. The chambers are rounded, and the sutures very strongly constricted. The aperture is terminal and rounded or can be slit-like on long neck.

FIGURED SPECIMEN: Bh. A., 8921; P.C. Slide No. 55a.

Genus REOPHAX Montfort 1808

REOPHAX sp.

Pl. 1 Fig. 2

DESCRIPTION

The test is big, coarsely agglutinated, not very rough, with very little cement. The axis of the test is straight. The test is formed of four pear-shaped chambers which increase rapidly in size, the last one much higher than the second last. The first suture is thin and obscure, later the sutures become more and more constricted. The aperture is terminal and slit-like.

FIGURED SPECIMEN: Bh. A., 8928: P.C. Slide No. 64a.

Family LITUOLIDAE

Subfamily LITUOLINAE

Genus AMMOBACULITES Cushman 1918

AMMOBACULITES cf. GOODLANDENSIS Cushman & Alexander 1930

Pl. I Fig. 3

DESCRIPTION

The test is planispiral, partially evolute, very strongly depressed. The periphery is rounded, the wall is very coarsely agglutinated, rough with very little cement. The sutures are thin and depressed, or obscure. The apertural characters are indistinct. The aperture is at times obscure and at times it appears to be large and irregular, areal in position. This, however, could be due to damaged tests. The coiling being evolute, there is a shallow and rather wide umbilicus. The characteristic of this morphotype is the very depressed test. A section has not been cut.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

The holotype of A. goodlandensis is from the Lower Cretaceous System, Goodland Formation (Texas).

FIGURED SPECIMEN: Bh. A., 2059'; P.C. Slide No. 38a.

Genus HAPLOPHRAGMIUM Reuss 1860

HAPLOPHRAGMIUM RIMOSA (Marsson) 1878

Pl. I Fig. 4

DESCRIPTION

The test is ovate, rather big. The wall is coarsely agglutinated, rough, with very little cement. The coiling is irregular, probably streptospiral. Only one chamber belongs to the univerial stage because its aperture is terminal and slit-like. It is probably a juvenile specimen.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

The holotype of H. rimosa is from the Cretaceous System, Weisse Schreibkreide (the Schreibkreide extends from the Cenomanian to the Maestrichtian Stage), Baltic Region.

FIGURED SPECIMEN: Bh. A., 596'; P.C. Slide No. 41b.

Genus TRIPLASIA Reuss 1854

TRIPLASIA sp.

Pl. I Fig. 5

DESCRIPTION

The test is big, finely agglutinated, smooth with sharp edges. The sides are diverging at first, then sub-parallel. The early stage is obscure. The sutures are thin and arched, slightly depressed. The sides are flat or very slightly concave. The aperture is terminal, with lip.

FIGURED SPECIMEN: Bh. A., 292'; P. C. Slide No. 36a.

Family TEXTULARIIDAE

Subfamily SPIROPLECTAMMININAE

Genus SPIROPLECTAMMINA Cushman 1927

SPIROPLECTAMMINA KNEBELI Le Roy var. LONGA Said & Kenawy 1956

Pl. I Fig. 6

DESCRIPTION

The test is small, flaring, strongly depressed, with sharp margins, very finely agglutinated, with much cement, smooth. The coiled stage is very clearly visible, formed of a round proloculum followed by five coiled chambers. After this the biserial stage follows with seven or eight pairs of chambers which increase rapidly in width and more slowly in height. The sutures are flush and inclined downwards. The aperture is an interio-marginal slit with a small lip.

COMPARISON

All the Zululand specimens correspond very well with the description as given by the AA. Spiroplectammina knebeli and its variety longa are similar to S. laevis and longa, but differ in the less rounded apertural view.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

U. Maestrichtian - Danian of Egypt (Said and Kenawy, loc. cit.)

FIGURED SPECIMEN: Bh. A., 292', 282'; P.C. Slide No. 50d.

SPIROPLECTAMMINA sp.

Pl. I Fig. 7

DESCRIPTION

Test large, strongly flaring, not depressed, with acute edges and very thick in the centre. Coiled stage completely enrolled, with five, easily distinguishable, visible chambers. Biserial stage formed of seven pairs of chambers, low and broad, increasing rapidly in width. Sutures clear, flush in the coiled stage. In the biserial stage, sutures slightly thickened and depressed, curved downwards. Aperture a low interiomarginal slit with lip. The sharp edges bear an irregular flange. Wall rather coarsely agglutinated, smooth.

FIGURED SPECIMEN: Bh. A., 292'; P.C. Slide No. 50e.

Subfamily TEXTULARIINAE

Genus TEXTULARIA Defrance in de Blainville 1824

TEXTULARIA SEMICOMPLANATA Carsey 1926

Pl. II Fig. 1

DESCRIPTION

Test small, depressed, gently flaring. About eight pairs of chambers are present, increasing slowly in size, low and broad, the last pair much higher than the second-last. The sutures are thin and slightly depressed, not very clear. The periphery is slightly lobate in the late stages. The aperture is an interiomarginal arch. The wall is finely agglutinated, rough.

COMPARISON

The Zululand specimens are very similar in every respect to the ones described and illustrated by Cushman. The species has been referred to Spiroplectammina but was originally described as a Textularia and it is here considered as such.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

Navarro-Taylor (Maestrichtian-Campanian) of the Gulf Coast, United States of America (Cushman, 1946).

FIGURED SPECIMEN: Bh. A., 385'; P.C. Slide No. 7b.

TEXTULARIA sp.

Pl. II Fig. 2

DESCRIPTION

The test is biserial, long and slender and not depressed. The periphery is lobate and the test is rounded in cross-section. There are seven pairs of thick chambers, increasing slowly in size, with the last pair much bigger than the second last pair. The sutures are very clear in the late stages of growth, thin and straight, inclined downwards and constricted. In the early stages they are usually not very clear. The wall is agglutinated with very little cement and is quite smooth. The aperture is indistinct.

COMPARISON

This species is differentiated from T. semicomplanata by its long and very slender test and its almost circular cross-section.

FIGURED SPECIMEN: Bh. A., 394'; P.C. Slide No. 7c.

Family ATAXOPHRAGMIIDAE

Subfamily VERNEUILININAE

Genus VERNEUILINA d'Orbigny in de la Sagra 1839

VERNEUILINA MUNSTERI Reuss 1854

Pl. II Fig. 3

DESCRIPTION

The test is small and stout, very finely agglutinated and smooth. The cross-section is triangular with very sharp edges. The sutures are rather thick, flush, and darker than the wall. They are inclined downwards and straight. The chambers become more overlapping as they are added and often in apertural view the first chamber of the last triplet is barely visible. The aperture is a very small interiomarginal arch.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

Not known.

FIGURED SPECIMEN: Bh. A., 2165', P.C. Slide No. 36Aa.

Genus GAUDRYINA d'Orbigny in de la Sagra 1839

GAUDRYINA BETTENSTAEDTI Hagn 1953

Pl. II Fig. 4

DESCRIPTION

The test is rather big, strongly flaring. It is triangular in cross-section up to the last pair of chambers, which are rounded, and can have more or less sharp edges. The triserial stage is small and rather obscure. At the end of it one of the edges is twisted. The biserial stage consists of three pairs

of chambers which are low and broad, and rapidly become broader. The sutures are very strongly depressed and inclined downward. The last pair of chambers is slightly domed. The aperture is a low interiomarginal arch.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

The holotype of G. bettenstaedti is from the Upper Cretaceous System, Upper Senonian Stage to the Lower part of the Upper Campanian Stage of Germany.

FIGURED SPECIMEN: Bh. A., 786'; P.C. Slide No. 49b.

VARIATIONS

Morphotype B_2 Pl. II Fig. 5

Morphotype B_2 differs in being more coarsely agglutinated, although smooth, in its almost flush sutures; in the periphery being more rounded, and in having at times a gently curved axis.

FIGURED SPECIMEN: Bh. A., 489'; P.C. Slide No. $49b_2$.

Subfamily GLOBOTEXTULARIINAE

Genus DOROTHIA Plummer 1931

DOROTHIA OXYCONA (Reuss) 1860

Pl. II Fig. 6

DESCRIPTION

The test is small, conical, very finely agglutinated, smooth. The early stage is trochospiral with three chambers per whorl, later becoming biserial with very low and broad chambers. The chambers are non-overlapping and flattened. The sutures are not

short interio-marginal slit, central in position.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

Dorothia oxycona is known from the Toolonga Calcilutite and Gingin Chalk of Australia (Belford, 1960), Upper and Lower Cretaceous, Europe (Neagu, 1965), Austin chalk of the Gulf Coast (Cushman, 1946) and the Victoria Series, Australia (Taylor, 1964).

FIGURED SPECIMEN: Bh. A., 292'; P.C. Slide No. 43a.

DOROTHIA cf. OVATA Barnard & Banner 1953

Pl. II Fig. 7

DESCRIPTION

The test is small, finely agglutinated, smooth. The early stage is obscure and later is biserial. The chambers are highly domed and strongly overlapping. The sutures are indistinct. The aperture is a short interiomarginal slit, slightly protruding. The apertural face is steep and forms an angle with the chamber's wall.

COMPARISON

The Zululand specimens are obscure in the early stage, but are very similar to D. ovata in general appearance and apertural characters.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

Upper Campanian-Lower Maestrichtian, England.

FIGURED SPECIMEN: Bh. A., 282'; P.C. Slide No. 43b.

Subfamily VALVULININAE

Genus CLAVULINA d'Orbigny 1826

CLAVULINA FARAFRAENSIS (Le Roy) 1953

Pl. II Fig. 8

DESCRIPTION

The test is agglutinated and smooth to rough with very little cement. There are 2, 4 or 5 chambers in the uniserial stage, most commonly 5. The specimens with 4 chambers always have a distinct neck and this could perhaps indicate a different morphotype. The relative dimensions of the triserial stage vary but are always much smaller than the uniserial stage, except in juvenile specimens which only have one chamber in the uniserial stage. The triserial stage can be on the same axis as the uniserial stage or can be at an angle. The sutures of the triserial stage are usually indistinct. The three edges are usually rounded and only rarely sharp. The chambers of the uniserial stage are globular, or rarely they may be broad and low. The sutures of the uniserial stage are always very clear, straight and slightly constricted. Some specimens present anomalies in the last chamber, i.e. it can be smaller than the second last, or very big and flattened in a direction perpendicular to the axis. The most common aperture is rounded, with a little notch that could be a damaged valvular tooth. However, the shape of the aperture can vary from perfectly rounded to comma-shaped or be irregularly slit-like.

COMPARISON AND PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

The specimens attributed to this genus differ from the definition given by Loeblich and Tappan (1964) in their age, having been found in sediments of definite Cretaceous age. The apertural

characteristics also differ in that the valvular tooth is not always present. The aperture may be rounded with no indication of a tooth, or it may have a strongly reduced tooth, or it may be comma-shaped or slit-like with no indication of tooth, or a neck may be present. However, as all these different types of aperture may occur in chambers of the same specimen, they cannot be used for scientific subdivision. For this reason, and because transitional forms are frequent, all the specimens have been attributed to the same, highly variable species. The Zululand specimens are very similar to Le Roy's specimens from the basal Eocene of Sinai. Said and Kenawy found them in the Maestrichtian of Egypt. Kavary and Frizzell (1963) place their C. cf. farafraensis in the Maestrichtian of Turkey.

FIGURED SPECIMEN: Bh. A., 521'; P. C. Slide No. 6.

Family MILIOLIDAE

Subfamily QUINQUELOCULININAE

Genus QUINQUELOCULINA d'Orbigny 1826

QUINQUELOCULINA ROTUNDA Carsey 1926

Pl. II Fig. 9

DESCRIPTION

These specimens appear to be recrystallised internal casts. The test is rounded in outline and inflated. In apertural view the test is triangular to rounded, due to the last three chambers being inflated. The sutures are depressed and the chambers are generally inflated and rounded in cross-section. The wall is smooth, the aperture is rounded, and has a bifid tooth.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

The holotype of Q. rotunda is from the Upper Cretaceous System, Gulf Series, Navarro Formation, Texas.

FIGURED SPECIMEN: Bh. A., 425'; P. C. Slide No. 63a.

QUINQUELOCULINA cf. STOLLEYI Brotzen 1936

Pl. III Fig. 1

DESCRIPTION

The test is rather big, very elongated and subelliptical in outline. In apertural view it is subtriangular to rounded, and the third chamber is not strongly protruding. The first and oldest chamber is barely visible and occurs as a very fine rib between the third and the fourth chamber. The fifth chamber is strongly overlapping on the fourth at the aboral end. The chambers are angular-rounded in cross-section. The aperture is rounded with a small tooth (but this could be due to bad preservation). The sutures are thin and depressed. The chambers are flattened, and the wall is smooth.

COMPARISON

The Zululand specimens are very similar to Q. stolleyi except for the cross-section, which is like Q. substriata Bandy 1949.

Q. simplex Terquem emend. Le Calve 1947 is in all respects similar to these specimens except in the cross-section, which in the Zululand specimens is wider and sharper at the level of the 5th - 4th chamber and it is more domed at the level of the 3rd chamber.

They differ from the other Zululand species in their much more

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