VARIATIONS

Morphotype $A_2$

Pl. XIV Fig. 7

DESCRIPTION

The sculpture is reduced to strongly thickened and elevated sutures.

FIGURED SPECIMEN: Bh. A., 310'; P. C. Slide No. $31a_2$

Morphotype $B_1$

Pl. XIV Fig. 8

DESCRIPTION

The ridges do not follow a spiral pattern and can be even sinuous and meandriform or discontinuous and zig-zag.

FIGURED SPECIMEN: Bh. A., 310'; P. C. Slide No. 31c.

COMPARISON

All the Stensioina specimens from Zululand present some characters in common that attribute them all to one species.

1. Their tests are planoconvex with the convexity of the ventral side of approximately the same degree.

2. The ventral sutures are limbate, straight, slightly elevated or flush.

3. The umbilical characters - all the specimens have the umbilicus covered by a white, opaque, flat body of shelly material, that

has irregular edges.

4. Size - approximately the same.

They are very similar to <u>Stensioina altissima</u> Hofker 1956.

The extent of the dorsal sculpture is not a strong enough character to separate these specimens into subspecies. Most probably, if statistical studies were to be carried out, the various types would be found to belong to only one species.

PREVIOUSLY RECORDED STRATIGRAPHIC DISTRIBUTION

The holotype of <u>S. altissima</u> is from the Upper Cretaceous System, Maastrichtian Stage of Belgium (Hofker 1960).

FOR TABLE I

PLEASE SEE

35 MM FICHE

# STRATIGRAPHY

The stratigraphic subdivision of the top portion of Bh.A. was made by using Simpson's index No. 2 (Simpson, 1960). For explanation of how it was applied see under Techniques.

The top 525' of Bh.A. were subdivided into 21 sections of 25'. The choice of such thickness for the sections was due to the fact that it gives a clear enough picture of the fauna without going into extreme detail. A palaeontological assemblage was recorded from each section and each of the sections was submitted to the Simpson's index analysis to determine faunal resemblances. This was done by comparing each planktonic assemblage with all the others in the stratigraphic sequence studied. The same method was applied to the benthonic species but gave no clear result. It is a well known fact that the benthonic Foraminifera are not reliable stratigraphic markers, and can only in few cases be used for world-wide correlations.

The statistical results were plotted on the diagram given in Table I. The two parts of the diagram on opposite sides of the blank diagonal are unequal in actual numerical value because with this method each assemblage is in turn used as the standard, but the values of Simpson's index are disposed quite regularly on the two sides of the diagram, i.e. the highest values are near the diagonal. Curves could therefore be traced, contouring the areas of similar values of Simpson's index (Table II). Inflections in these curves are indicative of relative changes in the characteristics of the assemblages. If the curve approaches the diagonal the area of similarity diminishes, therefore there is a change in the constitution of the assemblage.

Likewise, if the curves are far from the diagonal, the area of similarity is large and there has been no change. In this way it was possible to determine that there are two major breaks, one between assemblages 1 and 2 and one between assemblages 19 and 20. Another break of less importance, extending only to the S.I. 95 areas and indicated by a flexure in the curves of lower values, occurs between assemblages 9 and 10. Sample 12 will be analysed in detail to clarify this method. Starting from the left-side of the diagram, assemblage number 12 is compared with assemblages 21 and 20 with which it shows small affinity (S.I. - 31 and 36 respectively). With sample 19 the affinity is suddenly much higher, which means that many more species are common than was the case with the other two assemblages. The affinity grows stronger and stronger until it is total with assemblages 13, 11 and 10 (S.I. - 100). Then the similarity decreases, but it is still very high. With assemblage 1, the affinity suddenly drops from 87 to 60.8. It is to be noted that the degree of affinity with assemblage 1 does not reach such low values as with assemblages 20 and 21.

In order to give a definite dating to the section under study and to verify the results obtained with Simpson's method, an examination of the microfaunal content of this section in terms of known international ranges was carried out. For this purpose only the globotruncanid fauna was examined as it is the most reliable, most widely studied and it can be used for wide-range correlations. Ranges are given for all the species recorded in Tables III and IV.

At the deeper end of the section under consideration such long-range globotruncanid forms as:

Globotruncana arca,

Globotruncana linneiana,

Globotruncana ventricosa,

Globotruncana marginata,

Globotruncana fornicata,

are present.

Globotruncana fornicata shows evidence of evolution towards Globotruncana contusa, a phenomenon which has been noted in the Upper Campanian in various parts of the world (Olsson, 1960). Globotruncana stuarti stuartiformis, which appears in the Campanian, is present, but there is no sign as yet of evolutionary change towards Globotruncana s. stuarti, which is known to happen in the Lower Maestrichtian (see taxonomic part). This lowermost part of the section was therefore attributed to the Upper Campanian. At sample 1463 (depth 772') Globotruncana gansseri, a typical Maestrichtian species, appears. On the other hand, the first G. s. stuarti appears a little higher (712'). From this evidence the beginning of the Maestrichtian is placed within the mentioned 50' interval. Many benthonic species appear in this interval, but the benthonic species are unreliable zone fossils, as already mentioned. The analysis of the planktonic fauna with Simpson's index yielded results which agree well with the above-mentioned findings, i.e. important faunal change between assemblages 19 (737') and 20 (772'). The lower limit of the Maestrichtian is thus established. Globotruncana marginata which ranges from the Turonian to the Lower Maestrichtian, was also recognised at depth 712'.

Globotruncana contusa starts at 618'. This species is considered restricted to the Upper Maestrichtian. Simpson's index data show a minor faunal change between depths 521' and 489'. This discrepancy could be due to an early appearance of G. contusa in Zululand. On the other hand the species which produce the discrepancy by starting between the mentioned depths are species which are usually considered long-range. Only further study on the Zululand Maestrichtian could clear the role played by these species, which in Bh.A. have a restricted range.

The final change remarked through the analysis of Simpson's index is between depths 292' and 310'. This is a major change, although not as importent as the first. Many Globotruncanid and other species disappear, and many new ones are recognised. However, the new ones are not generally considered as Tertiary, or even Danian, and many Globotruncanas survive until the end. A true Danian fauna is never developed. It is concluded that in the last assemblage of this section signs are present of the great evolutionary upheaval which occurred between the Cretaceous and the Tertiary, and which brought about the disappearance mainly of the genus Globotruncana, and its substitution by the genera Globorotalia and Globigerina, thus completely changing the character of the Foraminiferal fauna. A few considerations on the general characters of the fauna, as well as possible interpretations of its globotruncanid composition are given.

In the fauna under consideration the planktonic individuals greatly outnumber the benthonic ones. On the other hand, the benthonic species are by far the most numerous. A rich benthonic fauna is considered as indicative of clean, sandy bottom, with good oxygen circulation. (See Cita, 1960). The number of individuals in each species might have been kept low by limited food supply.

This is confirmed by the abundance of planktonic fauna, which indicates fairly deep and open sea. The scarcity of food at the bottom might then be due to low light penetration.

Amongst the planktonic species, the absence of Globotruncana calcarata is noted because this very important form is not only a guide fossil for the Upper Campanian, but is also a palaeoclimatic indicator. Reports from numerous localities in the northern hemisphere have led Bandy (1967) to regard this species as indicative of a tropical climate. From the absence of this species it might be inferred that the climate in Upper Campanian time was subtropical. On the other hand, during Maestrichtian time the climate must have been considerably warmer, as is proved from the presence of G. rosetta at least in the lower and middle Maestrichtian, and of G. linneiana throughout the Maestrichtian. (Bandy, loc. cit.).

It is not advisable, however, to regard such conclusions as final, as data on palaeoclimatology needs confirmation from various localities in order to give a true and complete picture of the climate of a region during a time of its geological history.

It is relevant to note that Spath (1924) found in the Campanian fauna from Umkwelane Hill elements of cooler habitat than in the Pondoland fauna.

In order to facilitate comprehension of the stratigraphic positions of the species described in the taxonomic part, a brief explanation of the relations of local stratigraphic names from various parts of the world with the standard European terminology is given.

UNITED STATES OF AMERICA.

Alabama. The Ripley formation is Upper Cretaceous in age. (Sandidge, 1932)

California. The upper part of the Guinda formation and the Forbes formation are considered contemporaneous with the Campanian (Takayanagi, 1965).

Delaware. Olsson (1964) regarded the Navesink and the Mt. Laurel formations as equivalent to the Campanian.

Gulf Coast. The Taylor Marl is to a greater or lesser extent compared in age to the Campanian. Bolli (1957) regards only the upper part of the Taylor as belonging to the Campanian, whereas Tappan (1962) regards the whole of the Taylor Marl, except the lowermost portion, as Campanian in age. The Navarro group is considered as corresponding to the Upper Campanian to Lower-Middle Maestrichtian in age. The Mendez Shale is regarded as Maestrichtian.

New Jersey. The Marshalltown formation is regarded as Campanian; the Wenonah, Mt. Laurel and Navesink as early Maestrichtian, the Redbank as late Maestrichtian (Olsson, 1964).

MEXICO.

Tampico area. According to White (1928) the Velasco formation is considered equivalent to the Navarro; the Mendez Shale is correspondent to the Taylor.

AUSTRALIA.

Northwestern Australia. The Korojon Calcarenite is regarded as corresponding to the Campanian-Lowermost Maestrichtian, and the Miria Marl as Maestrichtian in age by Edgell (1957).

Western Australia. The Gingin Chalk is regarded as mainly Santonian, the Toolonga Calcilutite as Santonian and Campanian. Both might have wider limits (Belford, 1960).

JAPAN.

Hokkaido. The Uppermost Urakawan corresponds to the Lower Campanian and the Lower Hetonaian to the Middle and Upper Campanian. The Upper Hetonaian corresponds to the Maestrichtian (from Takayanagi, 1960).

C O N C L U S I O N S.

The value of Foraminifera as stratigraphic and ecologic fossils has been known for many decades. The study of the foraminiferal fauna of Northern Zululand presented in this thesis has permitted a fine stratigraphic subdivision of the sediments. It was possible to subdivide 500' of sediments into Campanian, Lower Maestrichtian, Upper Maestrichtian and Transitional Zone. Simpson's Index No. 2 was proved highly reliable when an important change in the fauna takes place, but less so for minor changes. It is therefore advisable to use together with Simpson's Index some other means of stratigraphic subdivisions as a check. In this work the ranges of world-wide distributed and well established planktonic species have been used.

Observations of palaeoclimatic nature were possible and they agreed with analogous observations by Spath (1924) on a more southern Zululand fauna.

The Foraminifera seem therefore the most appropriate and rewarding of fossils to clarify the stratigraphy of the Cretaceous deposits of Zululand.

ACKNOWLEDGEMENTS

Thanks are due to Professor T.W.Gevers for allowing the present research to be carried out in the Geology Department.

The writer wishes,moreover,to express her deep gratitude to Anglo Transvaal Consolidated Investment Company for supplying the material of the present work and for financing it.Dr.M.G.Hearn and Dr.I.Schwellnus of Anglo-Transvaal were always most helpful and understanding.Thanks are also due to the late Dr.J.J.Marais and to Dr.G.F.Hart for initiating this research,and to Dr. G.F.Hart for his constructive criticism and help during many enlightening discussions in the course fo this research.

Mr.P.B.Truitt,of Moçambique Gulf Oil Company,was very kind in allowing the use of this Company's set of Ellis and Messina International Catalogue of Foraminifera,and he and Mr.G.Flores and Mr.G.Scorcelletti,of the Geology Department of Gulf were most helpful in evry way.

Dr.S.H.Haughton,who was the supevisor during the revision of the work contributed the invaluable assistance of his profound knowledge and experience,for which the writer is very grateful.

BIBLIOGRAPHY


ANDERSON, W., 1902. Report on a reconnaissance geological survey of the Eastern half of Zululand. Geol. Surv. Natal and Zululand, Rep. I.

-------, 1904. Further notes on the reconnaissance geological survey of Zululand. Geol. Surv. Natal and Zululand, Rep. II.

-------, 1907. The Upper Cretaceous rocks of Natal and Zululand. Geol. Surv. Natal and Zululand, Rep. III.

ASANO, K., 1950. Upper Cretaceous Foraminifera from Japan. Pacific Sci., Honolulu 4, (2), p. 158-163.

BANDY, O. L., 1951. Upper Cretaceous Foraminifera from the Carlsbad area, San Diego County, California. Jour. Pal., 25 (4), p. 488-513.

-------, 1967. Cretaceous planktonic foraminiferal zonation. Micropal. 13, 1, p. 1-31.

BARNARD, T. & BANNER, F. T., 1953. Arenaceous Foraminifera from the Upper Cretaceous of England (Pls. VII-IX). Q. J. G. S. L., Vol. 109, no. 434, pt. 2, p. 173-216.

BARR, F. T., 1962. Upper Cretaceous planktonic Foraminifera from the Isle of Wight, England. Palaeontology, Vol. 4, p. 4, 552-580.

------, 1966. Upper Cretaceous Foraminifera from the Bally deenloa Chalk, County Kerry, Ireland. Palaeontology, Vol. 9, pt. 3, p. 492-510.

BELFORD, D. J., 1960. Upper Cretaceous Foraminifera from the Toolonga Calcilutite and Gingin Chalk, Western Australia. Bur. Min. Res. Aust. Bull., 57.

BERGGREN, W. A., 1962. Some planktonic Foraminifera from Maestrichtian and type Danian stage of southern Scandinavia. Acta. Univ. Stock. IX, p. 1-106.

BOLLI, H. M., 1951. The genus Globotruncana in Trinidad, B.W.I. Jour. Pal. 25, p. 187-199.

------- 1957. The Genera Praeglobotruncana, Rotalipora Globotruncana, and Abathomphalus in the Upper Cretaceous of Trinidad, B.W.I. U.S. Nat. Mus. Bull., 215, p. 51-60.

BOLLI, H. M., LOEBLICH, A. R. jr. & TAPPAN, H., 1957. Planktonic foraminiferal families Hantkeninidae Orbulinidae, Globorotaliidae, and Globotruncanidae. U.S. Nat. Mus. Bull., 215, p. 3-50.

BRONNIMAN, P. & BROWN, N.K., 1956. Taxonomy of the Globotruncanidae. Ecl. Geol. Helv., 48, 2, (1955), p. 503-561.

BROTZEN, F., 1936. Foraminifera aus dem schwedischen untersten senon von Eriksdal in Schonen. Sver. Geol. Undersok, 30, (3, ser. C., no. 396), p. 1-206.

------- 1948. The Swedish Paleocene and its foraminiferal fauna. Sver. Geol. Undersok, 42, (2, C, 493), p. 1-140.

BULLARD, F. J., 1953. Polymorphinidae of the Cretaceous (Cenomanian) Del Rio Shale. Jour. Pal. Vol. 27 (3): p. 338-346.

CARSEY, D. O., 1926. Foraminifera of the Cretaceous of Central Texas. Texas Univ. Bull. no. 2612, p. 1-56.

CITA, B. M., 1960. Guida allo studio della micro-paleontologia. Ed. La Goliardica, Milano.