

Zitteliana	10	683-688	München, 1. Juli 1983	ISSN 0373 - 9627
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Project of an atlas of Late Cretaceous Globotruncanids (Results of the European Working-Group on planktonic foraminifera)

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With 3 text figures

ABSTRACT

After having revised the main species of the Middle Cretaceous, the European Working-Group on planktonic foraminifera has pursued its activities on the Late Cretaceous. Six meetings were needed to debate the status of about a hundred taxa belonging to the Globotruncanid family. Discussions led to the description and illustration of some thirty species chosen for their biostratigraphic value.

The vertical distribution of these species, for Tethyan and Boreal realms, is given in a range chart which takes into account phyletic relations and asserts an eight-part biozonation. Several genera will have to be created and some tens of forms will fall into synonymy.

RÉSUMÉ

Après la révision des principales espèces du Crétacé moyen, le Groupe de Travail Européen des foraminifères planctoniques a poursuivi ses activités en s'attachant aux formes du Crétacé supérieur. Six réunions furent nécessaires pour débattre du statut d'environ cent taxons appartenant à la famille des Globotruncanidés. Les discussions ont abouti à la description et à l'illustration d'une trentaine d'espèces retenues pour leur valeur biostratigraphique.

L'extension verticale de ces espèces, valable pour les domaines boréal et téthysien, est proposée dans une charte tenant compte des relations phylogénétiques et soutenant une biozonation en huit termes. Deux nouveaux genres devront être créés et plusieurs dizaines de formes seront mises en synonymie.

KURZFASSUNG

Nach der Revision der wichtigsten Arten der Mittel-Kreide hat sich die Europäische Arbeitsgruppe für planktonische Foraminiferen der Oberkreide zugewendet. Bei 6 Zusammenkünften wurden ca. 100 Taxa der Familie Globotruncanidae diskutiert und einheitlich beschrieben. Exemplare von 30 biostratigraphisch wertvollen Arten wurden für Abbildungen ausgewählt.

Die Reichweiten sowohl im Tethysbereich als im Boreal wurden in einer Tabelle mit 8 Biozonen vergleichend dargestellt, unter Berücksichtigung phylogenetischer Zusammenhänge. Zwei neue Gattungen müssen aufgestellt werden und mehr als 10 Arten fallen in die Synonymie.

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INTRODUCTION

After the publication in 1979 of the "Atlas of Middle Cretaceous Planktonic Foraminifera" by the "Special Section of the Middle Cretaceous Events Project" (I.G.C.P. no 58), the European Working Group on planktonic foraminifera decided to clarify and standardize the taxonomy of the main Late Cretaceous Globotruncanids.

Meetings and participants: Since 1980, six meetings of two or three days were organized at the universities of Bern, Amsterdam, Plymouth, Zürich and Rouen. The last one was arranged at Bordeaux by the Esso Company at the beginning of May 1982.

The Group gathers more than thirty specialists from universities and petroleum companies, representing ten European countries (Belgium: M. MEIJER, F. ROBASZYNSKI; Czechoslovakia: J. SALAJ; France: P. ANDREIEFF, J. P. BELLIER, M. BOURDON, L. BRUN, F. CALANDRA, P. A. DUPEUBLE, R. LEHMANN, M. NOIREAU-CONARD; Germany: D. HERM, W. WEISS; Holland: P. MARKS, J. POSTUMA, A. SCHROEDER, J. VAN HINTE, A. WONDERS; Italy: I. PREMOLI-SILVA; Poland: I. HELLER, D. PERYT; Spain: J. M. GONZALEZ DONOSO, M. LAMOLDA, D. LINARES RODRIGUEZ; Switzerland: F. ALLEMAN, H. BOLLI, M. CARON, R. HERB; United Kingdom: H. BAILEY, K. BALL, P. BIGG, M. B. HART, A. SWIECICKI); Z. EL NAGGAR, from Saudi Arabia, attended several meetings.

PROBLEMS AND DIFFICULTIES

As for paleozoologists, micropaleontologists are inevitably confronted with the concept of species and with taxonomic problems. Under the microscope, they observe populations connected in time by phylogenetic links, but to put the complex information perceived into words, they only dispose of the binominal linneian nomenclature. Other nomenclatural systems were suggested (for example by GANDOLFI 1955, BYKOVA 1960, SIGAL 1966, etc.) but they are often difficult to put into practice because of their relatively complicate transcription.

Although the binominal system has the startcoming of being rigid and rather typologic, even artificial and too restricted, it nevertheless offers the invaluable advantage of being concise (HUDSON & FOX 1962) especially when information is

directed to geologists, stratigraphers or to other general earth-science workers.

Micropaleontologists are generally aware of the intraspecific variability of planktonic foraminifera and in most cases, the holotype, sometimes defined a century ago or more, does not represent the "average species" or the "spectro-holotype" of SIGAL, 1966. Moreover, some recently named or well-described species are better chosen than senior ones. Yet, because of the rules of priority, the first named species has to be used, even if, morphologically, it is not exactly suitable.

Another question: in an anagenetic lineage, how many species should be chosen to show gradually evolving morphological characters?

METHODOLOGY FOLLOWED BY THE WORKING-GROUP

In order to stabilize the taxonomic position of one species, the most convenient is to refer to the holotype, even if this one does not represent the "average species".

During the sessions, the Group had at its disposal a lot of holotypes and paratypes, kindly lent by different institutions, examined in museum collections (P.R.I. Ithaca, U.S.N.M. Washington, Museums, Universities of Bâle, Paris, Stockholm, Strasbourg, Utrecht, Zürich, B.M.N.H. London, etc.), or borrowed from personal collections (coll. SIGAL, coll. of members of the Group). When holotypes were wanting, topotypes or geographically-close hypotypes were carefully investigated.

Having at disposal Tethyan and Boreal material, from outcrops and oceanic sections, the Group identified some phylo-

genetic lineages, which gave a logical frame to species retained mainly for their biostratigraphical value. In an anagenetic branch, species are chosen and given a name each time morphological changes, clearly seen under the microscope, are significant.

Each important species, that stands out as landmark along an evolutionary lineage, has been examined under the microscope, discussed at length by all the participants, and described integrally. Then, several specimens of the species and its variants, issued from diverse biogeographical provinces, were chosen to be photographed under the Scanning Electron Microscope.

The results will be published in an international journal as an Atlas comprising about sixty plates.

PHYLOGENETIC RESULTS

1. HIERARCHY IN MORPHOLOGICAL CHARACTERS

Thanks to the observations carried out for a century with the photonic microscope and more recently with the S.E.M., a hierarchy of evolutionary characters related to the test of planktonic foraminifera has been gradually defined. The first appearing characters are considered as the most primitive.

Arranged according to their importance, the following morphological criteria are used to individualize higher taxa in the Late Cretaceous Globotruncanids (details cf. CARON in BOLLI and al. ed., in press):

- position of the primary aperture (umbilical-extraumbilical nearly periumbilical; umbilical-extraumbilical; umbilical);
- morphology of expansions of the test around the umbilicus (lips, flaps, portici, tegilla);
- presence of keels (0, 1, 2) or of an imperforate peripheral band;
- type of ornamentation (rugose, costellae);
- bearing of umbilical sutures (raised, depressed...);

At the specific level, the following are determinant:

- shape and number of chambers (petaloid, crescentic...)
- aspect of the equatorial outline (circular, lobate...)
- shape of the sutures (radial, sigmoidal...)
- aspect of the lateral view (plano-convex, biconvex...)

2. THE MAIN PHYLETIC GROUPS

Using the characters listed above, several lineages were distinguished for the following taxa:

- genus *Globotruncana* : linneiana group, arca group, aegyptiaca group
- ? nov. gen. : fornicata group
- ? nov. gen. : gansseri group

The phylogenetic chart with genera and groups (fig. 1) is based on the successive appearance of evolved characters, for example: primary aperture nearly peripheric → aperture umbilical; lips → tegilla; no keel → two keels; two keels → one keel.

3. PHYLOGENY OF SPECIES IN THE ARCA GROUP

To give an example, we shall analyse the evolution of the species of the *arca* group belonging to the genus *Globotruncana* (fig. 2).

Among the characters defining the species *G. arca* (CUSHMAN), we shall retain: six to eight petaloid chambers in the last whorl, chambers increasing slowly in size on the spiral side, outline biconvex more or less symmetrical with two keels distinctly separated. The species appears near the base of the *elevata* zone (Lower Campanian) and continues with slight modifications till nearly the end of the Cretaceous.

In the *elevata* zone, rises a branch which begins with *G. orientalis* EL NAGGAR: petaloid chambers, increasing slowly in size on the last whorl of the spiral side, two closely spaced keels on the last ones. Through intermediate forms, the branch evolves towards *G. esnebensis* NAKKADY which also possesses petaloid chambers increasing slowly in size, but only one keel on all chambers of the last whorl. In the early Maastrichtian, another branch arises from the *arca* species. It begins with *G. falsostuarti* SIGAL, with numerous petaloid chambers, increasing slowly in size, two keels typically joining each other in the middle of each chamber; the umbilical keel may disappear on the last few chambers. Gradually, *falsostuarti* evolves to a form with petaloid chambers increasing slowly in size but single-keeled. *G. fareedi* EL NAGGAR could be a name for this evolutionary step although the specimen figured by DUPEUBLE 1969 ("*falsostuarti* emend." single-keeled, pl. III, fig. 10 = n. sp. ?) seems more significant.

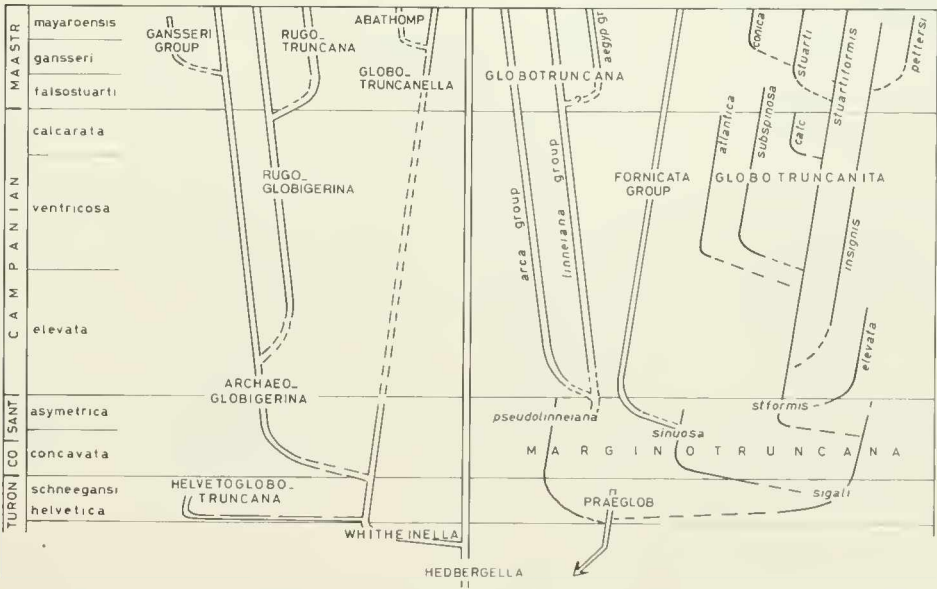


Fig. 1 Phylogeny of genera, groups and species of the "fornicata group" in the Late Cretaceous (branches tilted to the right: taxa with portici; to the left: with tegilla).

In the upper part of the Campanian, *G. rugosa* (MARIE), with very globular chambers on the umbilical side, can be distinguished from *G. arca*.

Parallel to the branches arisen from *arca*, maybe with a common ancestor, there is that of *G. mariei* BANNER & BLOW which has differing characters: crescentic chambers, increasingly rapidly in size; biconvex outline and two closely spaced-keels.

In *G. rosetta* (CARSEY), the first two characters are the same as for *G. mariei* but the test becomes umbilicoconvex with two keels on the first chambers and one keel on the last ones. It is possible that later on, *G. rosetta* becoming spiro-convex and single-keeled gave homeomorphs of *G. esnebensis*.

The gradualistic interpretation of the *arca* group is based on the analysis of a rich material (some tens, hundreds and sometimes thousands of specimens per sample), issued from closely spaced levels (time-steps of 50000 to 10000 years, sometimes even less) and sedimented on regularly subsiding areas (Tethys: Spain, France, Italy, Tunisia, Egypt, Carabbs, Atlantic D.S.D.P. cores, etc.; Boreal province: Northern Europe, from England to Poland).

The differentiation of new forms and new species would seem to be related to major eustatic variations of sea-level which modified ecological conditions and geographical extent of foraminifera (KAUFFMAN 1977, HART & BAILEY 1979).

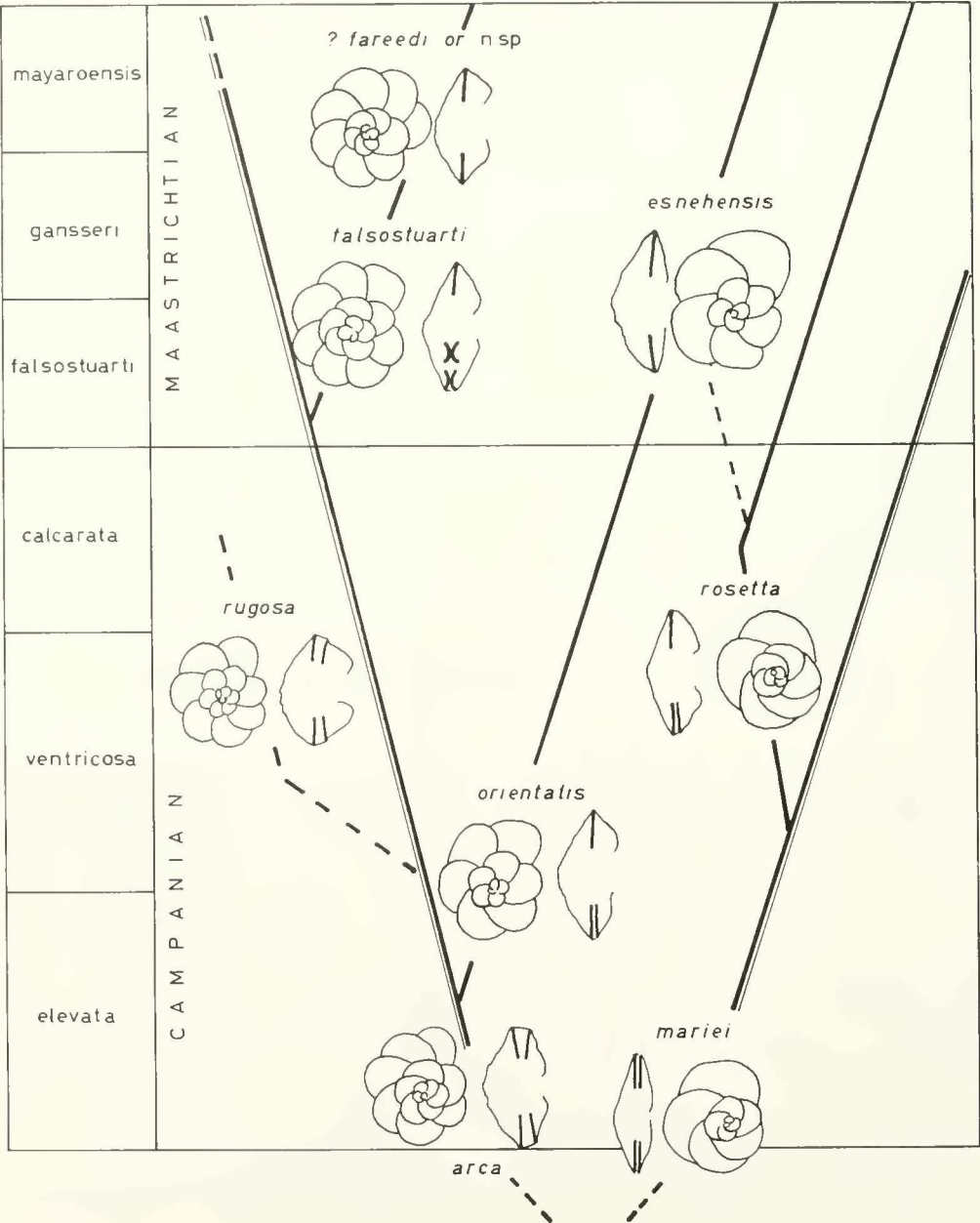


Fig. 2 Phylogeny of species of the "arca group".

TAXONOMIC CONSEQUENCES

If we agree with the opinion that species denominations are like reference-marks along an evolving branch, we have to choose "reference-species" with clear morphological characters. This way, numerous intermediate "species" (evolutionary links or ecological forms) fall into synonymy with the "reference-species". The advantage of this is that it lightens and simplifies the systematics, rendering the publication of biostratigraphical data more accessible to non-specialists. Among about a hundred "species" proposed in the literature, we retained some thirty species for the Late Cretaceous.

The list below indicates some of the synonymies proposed after numerous comparisons under the microscope and extended discussions during the sessions of the European Working Group.

Globotruncana linneiana (D'ORBIGNY, 1839), neotype by BRÖNNIMAN & BROWN, 1956

= *P. tricarinata* QUEREAU, 1893 (lectotype by PESSAGNO 1967)

= *G. obliqua* HERM, 1965

= *G. loeblichii* PESSAGNO, 1967

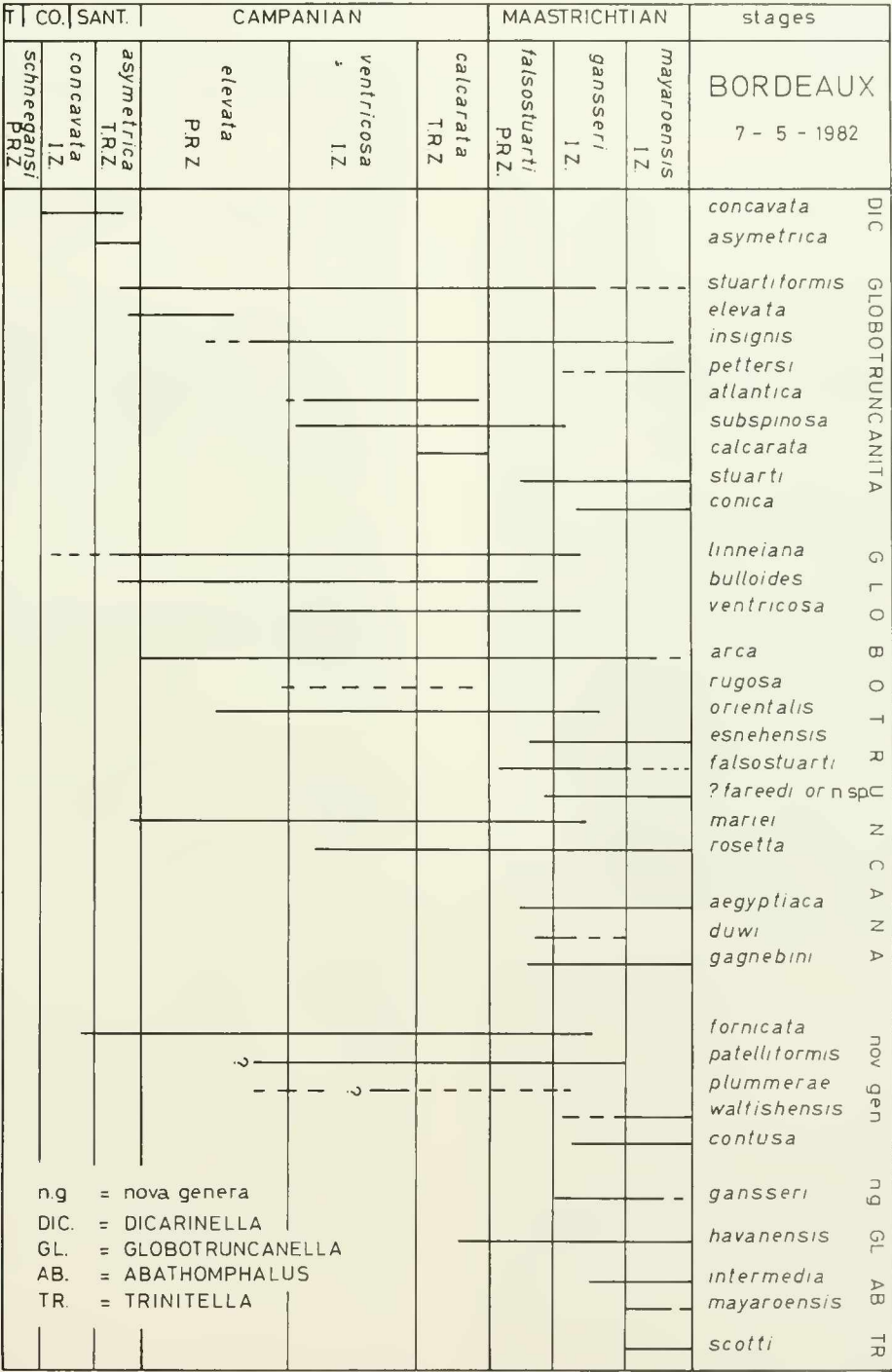


Fig. 3 Range-chart of the main Late Cretaceous species (Globotruncanids). Read "nova genera" for "novum genera".

- G. arca* (CUSHMAN, 1926)
 = *G. lapparenti* BROTZEN, 1936 (lectotype by PESSAGNO, 1967)
 = *G. leupoldi* BOLLI, 1945
G. orientalis EL NAGGAR, 1966
 = *G. stephensoni* PESSAGNO, 1967
G. mariei BANNER & BLOW, 1960
 = *G. cretacea* CUSHMAN, 1938
G. rosetta (CARSEY, 1926) lectotype by ESKER, 1968
 = *G. lamellosa* SIGAL, 1952
 = *G. caliciformis trinidadensis* GANDOLFI, 1955
 = *G. arca caribica* GANDOLFI, 1955
G. contusa (CUSHMAN, 1926)
 = *G. linnei caliciformis* VOGLER, 1941
 = *G. contusa galeoidis* HERM, 1962
 = *G. navarroensis* SMITH & PESSAGNO, 1973
Globotruncanita elevata (BROTZEN, 1934) lectotype by KUHRY, 1970

- = *G. andori* DE KLASZ, 1953
 = *G. putabensis* TAKAYANAGI, 1965.

References of the taxa cited will be given in the next future in the "Atlas of Late Cretaceous Globotruncanids" and are accessible in CARON (in press), EL NAGGAR 1966, LINARES 1977, MASTERS 1977, PESSAGNO 1967, WONDERS 1980.

ACKNOWLEDGEMENTS

This project was supported by grants from ESSO-France, S.N.E.A. (P.), N.A.T.O.-R.G. 1895 and Belgian F.N.R.S.

The financial support of these companies and institutions is gratefully acknowledged.

We thank M. GUILLAUME and I. PREMOLI SILVA for checking the English.

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Zeitschrift/Journal: [Zitteliana - Abhandlungen der Bayerischen Staatssammlung für Paläontologie und Histor. Geologie](#)

Jahr/Year: 1982

Band/Volume: [10](#)

Autor(en)/Author(s): Robaszynski Francis

Artikel/Article: [Project of an atlas of Late Cretaceous Globotruncanids \(Results of the European Working-Group on planktonic foraminifera\) 683-688](#)