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Notes on Foraminifera of the Genus *Hedbergella*

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With 1 Plate

INTRODUCTION

Until about thirty years ago, all Lower Cretaceous planktonic foraminifera were placed in the species *Globigerina cretacea* D'ORBIGNY, 1840. Examination of material from strata older than the Late Cretaceous from which D'ORBIGNY's species came, convinced me in 1937 that this was incorrect. I described then *G. infracretacea* as a new species. About ten years earlier, CARSEY (1926) had named a *G. cretacea* var. *delrioensis* from the Cenomanian of Texas. Since that time all pre-Maestrichtian *Globigerina*-like foraminifera have been removed to new genera and families. Some authors have requested a re-description and re-examination of the status of *G. infracretacea* in the light of new views on classification. 24 topotype specimens are now available from my original collection and drawings of 3 of these, which have been placed in the collection of the U.S. National Museum, were made by Mr. L. B. ISHAM by arrangement with Dr. R. CIFELLI. I am grateful to them for their cooperation. This study was carried out during a visit to the Geology Department of Florida State University. I wish to express thanks to the Department for their invitation and permission to use their facilities, and to the U.S. National Science Foundation for a Senior Fellowship award.

Re-description of "*Globigerina*" *infracretacea*

Hedbergella infracretacea (GLAESSNER), 1937

(Pl. I, Figs. 1–3)

1937 *Globigerina infracretacea* GLAESSNER. Studies in Micropal. 1 (1), p. 28, Textfig. 1.
1950 *Globigerina infracretacea* GLAESSNER, TEN DAM, Soc. Géol. France Mém., n.s. *29* (4), No. 63, p. 54.
1953 *Globigerina infracretacea* GLAESSNER, SUBBOTINA, Trudy VNIGRI, n.s. *76*, p. 51, pl. 1, fig. 5–10.
1954 *Globigerina infracretacea* GLAESSNER, BARTENSTEIN, Senckenb. Leth. *35*, (1–2), p. 49.
1959 *Praeglobotruncana infracretacea* (GLAESSNER), BOLLI, Bull. Amer. Pal. *39* (179), p. 266, pl. 21, fig. 9–10 (non pl. 22, fig. 1).
1961 *Globigerina infracretacea* GLAESSNER, HOFKER, Micropaleont. *7* (1), p. 96.
1961 *Globigerina infracretacea* GLAESSNER, LOEBLICH & TAPPAN, Micropaleont. *7* (3), p. 275.
1961 *Hedbergella infracretacea* (GLAESSNER), LOEBLICH & TAPPAN, Micropaleont. *7* (3), p. 276.
1962 *Globigerina infracretacea* GLAESSNER, Leitfoss. d. Mikropal., p. 280 ,Tab. 18, pl. 39, fig. 15(?).
1963 *Hedbergella delrioensis* (CARSEY), part, MASLAKOVA, Paleont. Zhurnal (*1963*), No. 4, p. 114.
1963 *Hedbergella infracretacea* (GLAESSNER), RENZ, LUTERBACHER & SCHNEIDER, Eclogae geol. Helv., *56* (2), p. 1083.
1965 *Globigerina infracretacea* GLAESSNER, NEAGU, Micropaleont. *11* (1), p. 36, pl. 10, fig. 10–12.

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Type locality and age: R. Ubin, Ilskaya, Northwest Caucasus. Dark calcareous clay, Albian.

Distribution and range: Caucasus, South Kazakhstan, Carpathians, Alps, France, Germany, England, Holland, Trinidad. Cretaceous. Reported from Barremian to Lower Cenomanian. It appears, however, from charts and synonymies given by MASLAKOVA (1963) that reported occurrences in pre-Upper Albian strata may represent *H. aptica* (AGALAROVA) or *H. trocoidea* (GANDOLFI). Similar doubts concerning reported earlier occurrences of *H. infracretacea* have been expressed by other authors. The range of the species requires revision.

Material described: 24 specimens from topotype material collected by M. F. GLAESSNER in June 1935.

Description: Test flatly trochospiral in the mature stage, consisting of about 15–16 chambers in about $2^1/_2$ whorls. The earlier whorl is gently convex, usually slightly raised above the upper surface of the last whorl, but occasionally slightly depressed. Last whorl consisting of 5 or fractionally more chambers in 14 tests, $4^1/_2$ in 4 tests, $5^1/_2$ in 2 tests, and 6 in 1 test. The coiling is random (dextral in 11, sinistral in 13). The chambers are inflated, subspherical to slightly elongate, the elongation being mostly in the direction of coiling rather than radial, as seen from the spiral side. There is a significant variation in the growth of chambers. They increase in size generally slowly and regularly, but the last chamber may be smaller than the penultimate, or it may be large and projecting radially and vertically. In a few of the observed specimens the coiling is irregular in that the growth axis of the second whorl does not continue the regular downward spiral of the first but is inclined, so that chambers are lower or higher than in normal growth. This results, firstly, in the initial whorl appearing depressed rather than raised in some specimens, and secondly, in the last chamber "slipping" down toward the umbilicus, out of its normal position, or "rising" up to a position almost astride the periphery of the preceding whorl. The sculpture of the walls is finely granulate to papillate, some papillae becoming elongate through fusion; the sculpture first increases and then in most tests decreases during growth of additional chambers. There is no marginal keel. The umbilicus is depressed and small. No projecting umbilical structures are known but the umbilicus is often obscured. Projections shown in figs. 1c and 2c are apparently due to accidents in fossilisation. The aperture is an arcuate opening on the umbilical side, generally interiomarginal and extraumbilical. In connection with the described variation in the position of the last chamber its position can vary from almost peripheral to almost reaching the umbilicus, but it is not normally visible from the umbilical side when the test is resting on its spiral side. The shape of the foramen of the penultimate chamber closely resembles that of the terminal aperture. No projecting apertural lips have been observed. There is, however, a very thin rim around the edge of the aperture.

The maximum diameter of the test ranges from 0.14 to about 0.23 mm, the height from 0.07 to 0.13 in normal specimens. The tests are well preserved, fragile, and only partly in-filled with sediment, pyrite, or calcite.

Remarks: The re-description establishes, on a small sample of a population from a small amount of sediment, some aspects of the variability of the taxon. The

modal form has a small test with about 5 chambers, slowly and regularly increasing in size, with a small umbilicus and an arcuate aperture between the periphery and the umbilicus. It has a faint apertural rim. In close connection with the variability of chamber growth (size increase rate and placement or coiling) the test may be flatter or higher than the modal shape with a slightly convex to slightly depressed centre of the spiral side, and with the aperture varying in position from almost peripheral to almost reaching the umbilicus. This statement determines the limits of variability of the topotype population as presently known. There is continuity between the rare extremes. There is no grading into biumbilicate, keeled, large (over 0.25 mm), or spinose forms. There is no grading into forms with apertural lips or with such structures protruding from foramina into the umbilicus, or with secondary apertures. This means that there exists a taxon as defined above. The possibility of the existence, at other times and places, of links by transitions with taxa which have characters not observed in the topotype population has to be considered in future studies. This is a problem of phylogeny rather than taxonomy. LOEBLICH & TAPPAN (1961) remarked: «Although similar in general appearance to *Globigerina infracretacea* GLAESSNER, 1937, the present species [*Hedbergella delrioensis* (CARSEY)] is about twice as large. A study of type material would be necessary to determine whether it should be included as a junior synonym of *Hedbergella delrioensis*». This study has now been carried out and its results suggest to me that *infracretacea* is distinguishable by small size, moderately elevated rather than depressed early coil, and absence of a "large spatulate lip which flares slightly at its umbilical end". HOFKER's studies (1960, 1961) suggest the possibility of evolutionary trends which could link *H. infracretacea* with younger and more advanced forms, some of which may possess the characters of *H. delrioensis*. In future *H. infracretacea* (GLAESSNER), 1937, may therefore be given the status of a chronosubspecies of *H. delrioensis* (CARSEY), 1926, rather than that of a species. As I have no material from younger strata in the Caucasus which may have a bearing on the evolution of the taxon *infracretacea*, and no material of *H. delrioensis*, I am unable to test this hypothesis. The placing of *infracretacea* in the synonymy of *delrioensis*, which was done by MASLAKOVA (1963) without qualifications or stated reasons, cannot be accepted.

H. infracretacea differs clearly from *H. planispira* (TAPPAN). This species has more chambers (5–7 in the last whorl) which increase in size more gradually and are less inflated. MASLAKOVA (1963) considers *Globigerina globigerinelloides* SUBBOTINA a synonym of *H. planispira*.

Evolutionary trends in *Hedbergella*

"*Globigerina*" *infracretacea* is considered a morphologically primitive species of the genus *Hedbergella*. It possesses all its diagnostic characters. The genus is now recognised by most authors. It differs from *Globigerina* in its extraumbilical rather than umbilical aperture, and from *Praeglobotruncana* in the lack of a marginal keel (LOEBLICH & TAPPAN, 1964, p. C659). The type species, *H. trocoidea* (GANDOLFI), 1942, is larger than the species here described, with 6–7 chambers in the last whorl, the early whorls not elevated, and weaker surface sculpture.

MASLAKOVA (1963) discussed phylogenetic and biostratigraphic relations of Albian to Cenomanian species of *Hedbergella*. Her first conclusion is that *Hedbergella* should be considered a separate genus because this group of forms represents *a distinct stage in the evolution of Cretaceous planktonic foraminifera;* it should also include some species with a narrow umbilicus which were considered by earlier authors as its globigerinid ancestors. With this conclusion and its implied criticism of HOFKER's views I am in agreement. HOFKER (1960, 1961), to whom we are indebted for statistical demonstration of lineages involving phylogenetic size increase, has repeatedly insisted on extensions of generic concepts to cover entire lineages rather than their morphologically distinguishable successive portions or stages. This is based on his belief in orthogenesis and requires relegation of the origination of genera to the mythical realm of macroevolution as a distinct process. The origination of *Hedbergella* is not well known. It is claimed that the genus can be traced back to the Hauterivian. Earlier *Globigerinacea* are known as far back as the Middle Jurassic where much more high-spired trochospiral forms occur. The implied trend from high to low spire has not yet been demonstrated. When *Globigerinacea* become common in about mid-Neocomian time, they conform to the generic concept of *Hedbergella*. Much evolutionary diversification, size and frequency increase occurs in Aptian-Albian time, but the genus *Hedbergella* persists to the end of the Upper Cretaceous.

According to MASLAKOVA, the aperture evolves in this genus from an inframarginal position in Aptian-Albian species to an umbilical-inframarginal position in Upper Albian-Cenomanian species. This appears to conflict with LOEBLICH & TAPPAN's (1961, p. 277) description of the aperture of *H. trocoidea* as "interiomarginal, extraumbilical-umbilical" but it is just possible that the phylo-morphogenetic assumption is correct and that the discrepancy is a matter of terminology and choice of specimens of a certain geological age for description. The postulated trend should be tested by an analysis of variability throughout the range of *H. trocoidea*, taking into consideration the extension of its range from Albian to Turonian (KLAUS, 1959), and the concurrent trend towards widening the umbilicus into which the umbilical portion of the aperture finally opens (MASLAKOVA, 1963).

Although MASLAKOVA deplores the absence of data on the variability and of diagnoses of *Hedbergella*-species, she proceeds to the construction of a phylogenetic diagram according to which early Aptian *H. trocoidea* evolves into *H. aptica* (AGALAROVA), the possible ancestor of *H. planispira* (TAPPAN) and of a *H. delrioensis-H. simplicissima* lineage in the Albian; *H. portsdownensis* (WILLIAMS-MITCHELL) and two other species arise from *H. aptica* in the Late Albian.

MASLAKOVA considers *Hedbergella* as the ancestor of *Ticinella* REICHEL and *Praeglobotruncana* BERMUDEZ. By inference, through the inclusion of these genera in the family Globotruncanidae, *Hedbergella* becomes its ancestor. This is basically the phylogeny proposed by BRÖNNIMANN & BROWN (1956), if we make in it the necessary and simplifying correction that there is no «*Globigerina*» in the Albian but only *Hedbergella*.

MASLAKOVA's final conclusion that species of *Hedbergella* can be used to subdivide the middle part of the Cretaceous into Middle and Upper Albian and Lower and Upper Cenomanian seems a justified *expectation* but requires for its future

practical application investigations of shifts in the variability of morphological characters with time, which will justify the formulation of differential diagnoses of species. In these studies the linking of seemingly discrete characters, to which attention was drawn in the description of *H. infracretacea*, must be taken into consideration. The position of the aperture, length-width-height ratios of the test, apparent elevation of the later over the earlier whorls, and shape of last chamber, may be controlled by a single and simple growth factor, i.e. the irregularity of coiling which can produce either "slipping" down or "rising" up of the last chambers. Experience with other pelagic foraminifera has convinced me that lack of understanding of this structural principle has contributed much to current confusion in the taxonomy of many pelagic foraminifera.

In the study of evolutionary trends in pelagic foraminifera, the question of the recognition of repeated origination of similar broad morphological characters by parallel, convergent, or iterative evolution, becomes increasingly important. HOFKER's (1960) data raise the question of repeated origination of planispiral, *Globigerinellina*-like forms. Others have pointed out that there may be repeated trends towards radial elongation of chambers. If, as stated above, *Hedbergella* is the ancestor of *Globotruncana*, and *Rugoglobigerina* is its descendant (OLSSON, 1964) rather than its ancestor, then we are postulating a partly retrogressive trend. After an early *Globigerina*-like stage which is now known as *Hedbergella*, there is a keeled stage, which then through loss of keels evolves again into a *Globigerina*-like final stage. This trend can be recognised because it is coupled with a progressive trend in the apertural characters. HOFKER's data (1961), however, raise the question whether the keeled stage is a *necessary* part of a lineage from *Hedbergella* to *Rugoglobigerina*. This requires further investigation. It may be noted that the first indication of phylogenetic trends in Cretaceous *Globigerinacea* stems from the recognition of differences between the progressive *Globotruncana cretacea* (D'ORBIGNY) and its remote ancestors *Hedbergella delrioensis* (CARSEY) and *H. infracretacea* (GLAESSNER) which had been considered identical with D'ORBIGNY's species.

SUMMARY

The species described as *Globigerina infracretacea* GLAESSNER, 1937 is reexamined on the basis of topotypes and their variability is discussed. It is placed in the genus *Hedbergella*. Views on the place of this genus in the evolution of *Globigerinacea* are critically reviewed.

ZUSAMMENFASSUNG

Die Art *Globigerina infracretacea* GLAESSNER, 1937 wird auf Grund von Topotypen neu beschrieben, mit Hinweisen auf ihre Variabilität. Sie gehört zu der Gattung *Hedbergella*. Die phylogenetischen Beziehungen dieser Gattung zu anderen Gattungen der *Globigerinacea* werden kritisch besprochen.

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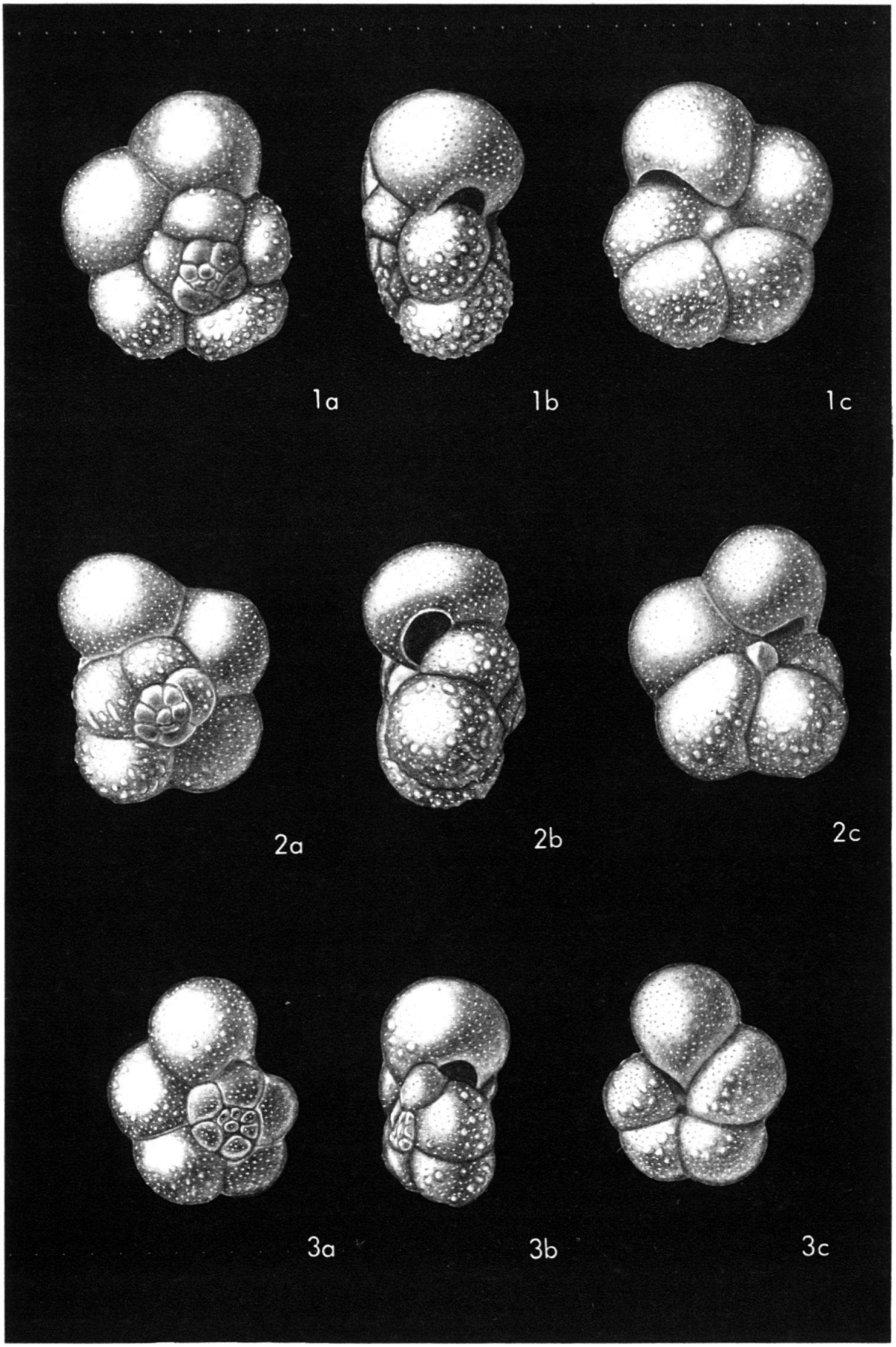
Plate I

Hedbergella infracretacea (GLAESSNER)

Topotype specimens in U.S. National Museum, Washington D.C., Foraminifera Catalog No. 130, numbers 642370 to 642372.

Fig. 1–3. a – spiral views, b – lateral views, c – umbilical views. All figures × 214. Drawings by L. B. ISHAM.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