THE GENERA *BROTZENIA* AND *VOORTHUYSENIA* (FORAMINIFERA) AND HOFKER'S CLASSIFICATION OF THE EPISTOMARIIDAE

by W. G. CORDEY

ABSTRACT. Perfectly preserved specimens of the Rotaliid species *Brotzenia mosquensis* Uhlig 1883 and *B. parastelligera* Hofker 1954 from the Oxford Clay of England, show dental plates of the *Voorthuysenia* type. These species were assigned by Hofker, on the basis of the dental plates, to *Brotzenia*. Hofker's (1954) classification is therefore invalid. The genus *Voorthuysenia* is considered synonymous with *Brotzenia* and the latter is emended. The genera *Höglandina* Brotzen 1948 and *Hiltermannia* Hofker 1954 are briefly discussed in relation to Hofker's classification.

Hofker's classification of the Epistomariidae. Hofker (1954) considered the genus *Epistomina* to be invalid, stating that the type species *E. regularis* (Terquem 1883) did not fit this group as it is understood at present, the type species showing neither the characteristic protoforaminal and deuteroforaminal apertures or dental plates (text-fig. 1*a–c*). Hofker (1954) suggested that Terquem (1883) may have described badly damaged specimens, or possibly that Terquem's specimens belonged to the genus *Conorboides* Hofker 1954. He therefore proposed a complete revision of the foraminifera with dental plates previously assigned to *Epistomina*, erecting three new genera, *Brotzenia* and *Voorthuysenia* (Jurassic–Lower Cretaceous), and *Hiltermannia* (upper Lower Cretaceous), and also including Brotzen's genus *Höglandina* (Cretaceous–Recent). The key to the recognition of these genera (and the basis of the classification) was the form of the dental-plate.

Hofker's classification has not been widely adopted by workers on Jurassic foraminifera, e.g. Lutze (1960), Bielecka (1960). However, Seibold and Seibold (1960), Gordon (1962), and Lloyd (1962) have used it, but with the exception of Lloyd make no reference to the use of thin sections. However, Lloyd's figures of *B. porcellanea* (Bruckmann), particularly text-fig. 7D, are of limited value since only part of the dental-plate is shown and the species could therefore belong either to *Brotzenia* or *Voorthuysenia*.

Briefly, the characteristics of the tooth-plates of the genera referred to are as follows:

Brotzenia. Tooth-plates in all chambers, narrow, smooth, partly attached to the proximal chamber wall, not reaching the marginal distal angle. Type species: *Epistomina spinulifera* Reuss.

Voorthuysenia. Plates in all chambers, large, smooth, attached entirely along the proximal chamber wall, reaching the marginal distal angle. Type species: *Epistomina tenuicostata* Bartenstein.

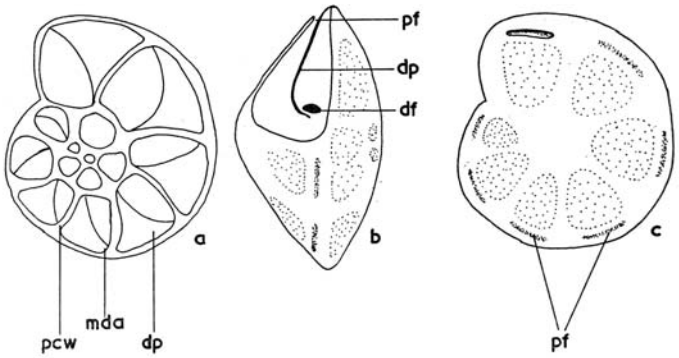
Hiltermannia. Plates as in *Brotzenia* but occurring in the final chamber only, resorbed in earlier chambers, plates frequently pustulose ('Höcken'). Type species: *Epistomina chapmani* Ten Dam.

Höglandina. Plates as in *Voorthuysenia*, occurring only in the final chamber, resorbed in earlier ones, plates frequently pustulose. Type species: *Epistomina elegans* d'Orbigny.

Foraminifera with dental plates from the Oxford Clay of England. The author's material

[Palaeontology, Vol. 6, Part 4, 1963, pp. 653–7, pl. 93.]

was obtained from two exposures, one at Stewartby (Bedfordshire) in the Lower Oxford Clay and the other at Purton (Wiltshire) in the Upper Oxford Clay (see Arkell 1941). Approximately 250 specimens of *Brotzenia mosquensis* were obtained in several samples from the Purton section, being exceptionally well preserved, particularly those obtained from Beds 4 and 5 (of Arkell 1941); and about 300 specimens of *B. parastelligera* in several samples from both the Purton and Stewartby sections. As most of the specimens were not infilled, a three-dimensional view of the plates could be obtained by embedding them in a resin, Lakeside 70, and removing the dorsal surface with a sharp needle. This contrasts with the frosted-glass method (van Morkhoven 1958) used by Hofker, where preservation did not permit the former technique.



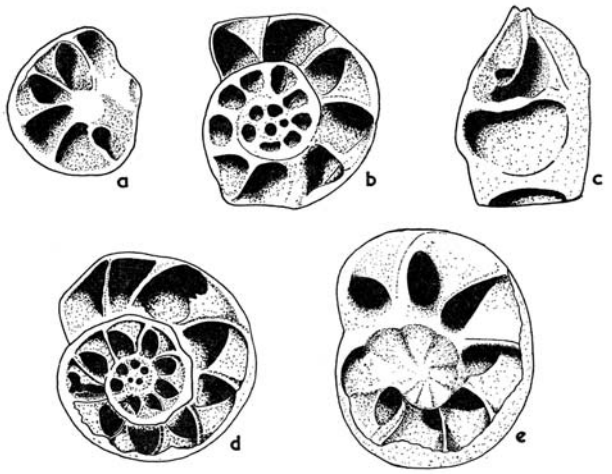
TEXT-FIG. 1. Diagram illustrating the morphology of *Brotzenia*. *a*, Parallel section; *b*, peripheral view with the terminal face of the final chambers removed; *c*, ventral view. *Abbreviations*: mda—marginal distal angle; dp—dental-plate; pcw—proximal chamber wall; pf—protoforamen; df—deuteroforamen.

The dental-plates in all the specimens of *B. mosquensis* and *B. parastelligera* occur in all chambers (except where damaged in preparation). They are always smooth and attached along the entire length of the proximal chamber wall (text-fig. 2*a–e*), and extend into the distal marginal angle of each chamber. The plates correspond exactly to the type described by Hofker (1954) for the genus *Voorthuysenia*. However, *B. mosquensis* and *B. parastelligera* were assigned by Hofker to the genus *Brotzenia*. It would thus appear that these two species, at least, are capable of possessing two distinct forms of dental plate, i.e. in the case of Hofker's 1954 material the *Brotzenia* type of plate, and in the present material the *Voorthuysenia* type.

These conclusions agree with those made by the author (1962) on material from the Oxford Clay of Skye. In view of the better preserved and more abundant material now available, the author considers that Hofker's genera *Brotzenia* and *Voorthuysenia* are not distinct and that his classification (1954) is invalid. It is therefore proposed that the genus *Voorthuysenia* be considered synonymous with *Brotzenia* and the latter emended to include it.

With regard to the author's ornamented forms (i.e. *B. mosquensis*), Hofker (*in litt.*) states that on the basis of the plates they should be assigned to *Voorthuysenia praeornata*

(Bartenstein and Brand 1951), the two species being identical externally. However, the author has examined paratypes of *V. praeornata* (Pl. 93, figs. 1–3) and the species can be distinguished from *B. mosquensis* (Pl. 93, fig. 4*a–c*) in having sharply convex dorsal sutures; distinct pustulose ornament on each chamber; and less intense sutural and intersutural ornament. Furthermore, the author has compared his specimens with some



TEXT-FIG. 2. *a*, *b*, *Brotzenia parastelligera* Hofker 1954. *a*, An eroded specimen showing dental plates of the '*Voorthuysenia* type' in two chambers, *coronatum* Zone, Oxford Clay, Stewartby, Bedfordshire, England. BMNH P45156, ×60. *b*, Parallel section showing plates in several chambers, *cordatum* Zone, Oxford Clay, Purton, Wiltshire, England. BMNH P45159, ×65.

c–e, *Brotzenia mosquensis* (Uhlig 1883). *Cordatum* Zone, Oxford Clay, Purton, Wiltshire, England *c*, Peripheral view showing the dental-plate, deuteroforamen situated on the dorsal side of the dental plate, BMNH P45157, ×55. *d*, Parallel section showing well-developed plates in the earliest chambers, BMNH P45158, ×57. *e*, Parallel section, earlier chambers removed in preparation, BMNH P45160, ×57.

of Hofker's (1954) material, which is identical. Specimens of this species loaned by Lutze are also identical, though preservation did not permit a study of the plates.

Specimens identified by Hofker and Lutze as *Brotzenia parastelligera* have also been examined, and are identical to the author's specimens. The Oxford Clay material also agrees closely with the figures and descriptions of this species by Seibold and Seibold (1960), Bielecka (1960), and Lutze (1960).

SYSTEMATIC DESCRIPTION

Genus BROTZENIA Hofker 1954

Type species. Brotzenia spinulifera (Reuss).

Emended diagnosis. Test calcareous, perforate, trochoid, dextrally or sinistrally coiled, smooth or ornamented, having latero-marginal apertures (protoforamen) (text-fig. 1) on

the ventral side of the test in each chamber, together with areal apertures (deutero-foramen or septal foramen) on the dorsal side of the dental plate. The dental plates are smooth, usually convex towards the ventral side, the plates being either attached along the entire length of the proximal chamber wall or only partly so; plates occurring in all chambers.

The following species are included in the genus *Brotzenia*:

Brotzenia mosquensis (Uhlig 1883)
Brotzenia parastelligera Hofker 1954
Brotzenia ornata (Roemer 1841)
Brotzenia spinulifera (Reuss 1862)
Voorthuysenia praeornata (Bartenstein 1951)
Voorthuysenia brandi Hofker 1954
Voorthuysenia parafavosoides Hofker 1954
Voorthuysenia suturalis (Ten Dam 1948)
Voorthuysenia tenuicostata (Bartenstein 1951)
Voorthuysenia pachyderma Hofker 1954

Remarks. In the Cretaceous species *caracolla* (*Epistomina* of earlier authors, *Höglandina* Hofker 1954) from the Speeton Clay of Lincolnshire, England, the author observed plates in chambers other than the final chamber. This throws doubt on Hofker's definition of *Höglandina*, and it is possible that species assigned to this genus should be referred to *Brotzenia* (here emended).

The distinction between *Höglandina* and *Hiltermannia* on the basis of dental plates is similar to that between *Brotzenia* and *Voorthuysenia*. The fact that the distinctions between the latter genera cannot be sustained casts some doubt on the validity of the genus *Hiltermannia*. However, the species assigned to this genus have not been studied.

Even if Hofker's tooth-plate groups were proved to be valid, his classification, being dependent on the study of the dental plates, is impracticable, since preservation often prevents the plates being exposed, making it impossible to assign specimens to a genus. Vella (1961) commented on the practical difficulties of such a classification with respect to uvigerinid foraminifera, where, however, it was possible (Vella 1961, p. 468) to use external morphology to recognize the dental plate groups. Unfortunately, this is of limited value only in the group considered here since many of the species have a similar external morphology, e.g. *Höglandina caracolla* (Roemer) and *Brotzenia parastelligera* Hofker.

Acknowledgements. The author is indebted to Dr. T. Barnard and Dr. C. G. Adams for criticism and for reading the manuscript; to Dr. J. Hofker for discussing the problem and examining some of the

EXPLANATION OF PLATE 93

Figs. 1–3. *Brotzenia praeornata* (Bartenstein and Brand 1951). 1, Dorsal view. 2, Peripheral view. 3, Ventral view. Three specimens, paratypes, Bohrung Düste 1, 510·8—516·3 m., Upper Valanginian, ×110. Dr. H. Bartenstein personal collection.

Fig. 4*a–c*. *B. mosquensis* (Uhlig 1883). *a*, Dorsal view; *b*, peripheral view; *c*, ventral view. *Cordatum* Zone, Oxford Clay, Purton, Wiltshire, England. BMNH P45161, ×67.

Fig. 5*a*, *b*. *B. parastelligera* Hofker 1954. *a*, Dorsal view; *b*, ventral view. *Mariae* Zone, Oxford Clay, Purton, Wiltshire, England. BMNH P45162, ×52.

Fig. 6*a–c*. *B. parastelligera* Hofker 1954. *a*, Dorsal view; *b*, peripheral view; *c*, ventral view. *Cordatum* Zone, Oxford Clay, Purton, Wiltshire, England. BMNH P45163, ×68.

author's material; to Dr. J. H. van Voorthuysen for the loan of some of Hofker's material; to Dr. H. Bartenstein for the loan of paratypes of *B. praeornata* and specimens of *B. mosquensis*; and to Dr. G. F. Lutze for many specimens of *B. parastelligera* and *B. mosquensis*.

Repository. All figured specimens, except those in Plate 93, figs. 1–3, are deposited in the British Museum (Natural History), London.

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Manuscript received 9 January 1963


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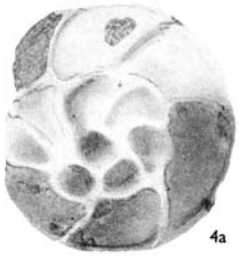
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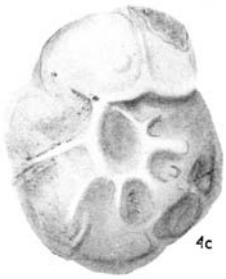
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CORDEY, *Brotzenia*