

FORAMINIFERA FROM THE CRETACEOUS OF SOUTHERN LIMBURG, NETHERLANDS, IV.

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THE GENUS *BOLIVINOIDES* IN THE CRETACEOUS OF SOUTH LIMBURG.

This genus has been, since the investigation by Hiltermann and Koch (Taxonomie und Vertikalverbreitung von *Bolivinoides*-Arten in Senon Nordwestdeutschlands, Geol. Jahrb. 64, p. 595—632, 1950) given attention by several authors, since the species seem to have a wide range and are relatively short living. In Holland *B. delicatula* has been found in the Hervian, but always rare, and in the layers above the Hervian only some of the species mentioned by Hiltermann and Koch have been found, viz. *Bol. strigillata* (Chapman), *Bol. decorata* (Jones), *Bol. gigantea* Hiltermann et Koch, and a species, intermediate between *B. decorata* and *B. gigantea* which seems to be identical with *B. australis* Edgell, and has not been mentioned by Hiltermann and Koch. The group of small *Bolivinoides*-species to *Bol. delicatula*, never has been found in the samples from localities younger than the Hervian; it seems that this group is confined to more neritic sediments and not to the coastal ones occurring in South Limburg.

Since the authors investigations on *Bolivinoides* prove, that each of the types, described by Hiltermann and Koch form groups of specific range, and have to be considered as species and not as sub-species, here they have been treated as species also.

Bolivinoides strigillata (Chapman) was found in the lowest samples of the locality "Onderste Bos" near Epen. It is found abundantly in the lowest part in Hallambaye, Belgium. It occurs in samples with *Globorotalites multisexta* and *Neoflatellina leptodisca* and these layers have to be considered as lower Upper Campanian. I refer for description to Hiltermann and Koch, p. 610—612, and to my paper on the genus *Bolivinoides* (1952) and on the Upper Cretaceous of North western Germany and Holland. Specimens from Onderste Bos, at the base of the quarry, have a length of about 500 μ , Index Length/Breadth about 2, 1, Breadth/thickth 1, 8, Index E. 100/L

27. These indices agree with those, given by Hiltermann and Koch for this species.

In the upper layers of "Onderste Bos", at locality Vijlerbos, New Way, at Wahlwylre in the Cr 3 gamma, in Orps le Grand, Hanniques and Cuesmes in Belgium, typical *Bolivinoides decorata* (Jones) occurs. I refer to the description by Hiltermann and Koch.

At locality Onderste Bos, upper part, this species has following indices, in agreement with those, given by Hiltermann and Koch: Length about 600 μ ; Length/Breadth 1,5; Breadth/thickness 1, 9; E. 100/L 34.

In the locality Bovenste Bos, in the quarry at Vijlen in the layers below about 6 m from the top, and at Moerslag and Mesch, a species occurs which shows all indices of *Bol. decorata*, and also its ornamentation, but for a stronger development of the knobs, whereas the length of the specimens is much larger then that of typical *B. decorata*. These characters are found in *Bolivinoides australis* Edgell (The stratigraphic value of *Bolivinoides* in the Upper Cretaceous of Northwest Australia; Contr. Cushman Found., V, p. 2, 1954, p. 71, pl. 13 figs. 5, 6; pl. 14, figs. 5, 6.). So, since *B. draco draco* and *B. gigantea* also are occurring in Australia, together with *B. strigillata*, it seems adequate to give this large species with characters of *B. decorata* the name *Bolivinoides australis* Edgell. Following Indices for this species were found:

Locality	Length in μ	E. 100		
		L	B	D
		B	D	L
Mesch J. V. 188	864	1,7	1,5	41
Vijlen 86	750	1,6	1,6	48
Vijlen 88	768	1,7	1,65	33
Vijlen 89	624	1,55	1,8	32
Vijlen 91	780	1,8	1,9	38
Vijlen 92	798	1,6	1,7	32
Vijlen 608	630	1,6	1,45	35
Bov. Bos, Upper	918	1,9	1,6	37

Description of the species:

Test large, length 0,63—0,92 mm, breadth about 0,45 mm, thickness about 0,24 mm. Largest breadth at about 1/3 of the total length measured from the apertural end. Ornamentation consisting of rows of chalk buds, strongly developed, each bud about three times as long as broad, those of the last formed chambers

somewhat longer, not melting together into single ridges, directed towards the axis, about 6 buds at the last formed chamber. Initial part rounded and smooth in surface. Margin rounded.

The species forms the link between true *Bol. decorata* and *Bol. gigantea*, shows all characters of *B. decorata* but for its length and the very strongly built ornaments, and never shows the narrow ridges found in *B. gigantea*.

The species *Bol. australis* Edgell is found in the samples from the upper part of the Upper Campanian and the Lower Maestrichtian (Cr 3b and Cr 3c). In the Cr 3c it is mingled with typical *Bol. gigantea*.

Bolivinoides gigantea, distinguishable by the long and narrow ridges which in most specimens

Bolivinoides gigantea is typical for the Maestrichtian. It has been found in North-western Germany from the lower to the uppermost Maestrichtian (*Pseudotextularia*-zone). In Holland it is found in the Cr 3c (Hoogcruts, Mesch, uppermost part of quarry at Vijlen) and in the lower part of the Cr 4; reworked it is found in the Ma and the Prae-Mb, together with the Prae-K. So it is obvious, that Cr 3c and Cr 4 are Maestrichtian. In the Cr 3c it is found together with *Neoflabellina reticulata* and *N. postreticulata*, in the Lower Cr 4 with *Neoflabellina postreticulata*. *Bolivinoides australis* is found together with *Neoflabellina praereticulata* and with *N. reticulata*.

The stratigraphic development of *Bolivinoides* in Holland can be given as follows:

Species	Prae Mb Prae K	Ma	Upper Cr 4	Lower Cr 4	Cr 3c	Cr 3b	Cr 3a
<i>B. strigillata</i>	...	...	...	...	...	...	...
<i>B. decorata</i>	...	...	...	...	...	×	×
<i>B. australis</i>	...	...	...	...	×	×
<i>B. gigantea</i>	×	×	...	...	×	...
	reworked	reworked					

show an irregular periphery, and the strongly built test, occurs from the Cr 3c upward, into the lower part of the Cr 4. It is also found, reworked, in the Ma and, rarely, reworked in the Prae-Mb and the Prae-K.

The species is easily distinguishable by the fine, typical ridges covering the surface, arisen by coalescence of the alar prolongations of the chambers, running towards the axis obliquely and showing irregular knobs and an irregular outline. Between the ridges are deep furrows. Following data on indices were got:

Locality	Length in μ	E. 100		
		B	D	L
Maasbühl I, 542 m	780	1,8	1,6	41
Hallambaye south, top	900	1,66	1,8	50
Eben Emael 171	864	1,9	1,7	39
Eben Emael 170	792	1,6	1,9	37
Mesch J. V. 188	696	1,8	1,4	39
Vijlen 84	744	1,55	1,9	42

Interesting is the occurrence of *Bolivinoides* in Wahlwylre. Here, a layer of about 10 m thickness in maximum consists of a basal conglomerate containing ground quartz stones, pieces of carbon, chalk particles, etc. In a drilling West from Wahlwylre 10 m of this conglomerate were drilled. Several of these samples contained typical *Bolivina australis*. The whole other fauna also pointed to upper Cr 3b. Above this conglomerate white chalk is found, which contains *Bolivina gigantea* in abundance; here the fauna points to Cr 4. (Lower part).

So it is obvious, that the Cr 3c is missing here, and that in the beginning of the Cr 4 period the underlying sediments were reworked into the conglomerate. This conglomerate is known as the Cr 3 gamma, a name given by Uhlenbroek (Uhlenbroek, G. D., Het krijt van Zuid-Limburg. Jaarverslag Rijksopsp. Delfstoffen, 1912). Uhlenbroek considered this conglomerate Cr 3 gamma as situated between Cr 3b and Cr 3c, which must be questionable,

as none of the faunae, characteristic of the Cr 3c have been found; this would have been, in the case that the conglomerate had been formed in the Cr 3c time; however, as it may have been formed in the lower Cr 4 time, it is, consequently, the basal conglomerate of the Cr 4, which is found in a thick packet above the conglomerate.

But there may be the possibility, that the Cr 3c has been removed by the Cr 4-sea. So it will be better to describe the conglomerate as reworked Cr 3b, and not to lay much stress on the time in which it was reworked.

Review of literature on the species of *Bolivinoides* occurring in the Upper Cretaceous of South Limburg, Holland.

Hiltermann and Koch (1950) found, that *Bolivinoides strigillata* in North western Germany occurs in the Lower Campanian as well as in the Santonian. In the Upper Campanian the species is missing. So the lowest part of the Cr 3a must belong to the uppermost Lower Campanian; in reality it is the boundary Lower-Upper Campanian. The specimens of the Cr 3a have already the tendency towards *B. decorata*, found also in the Phosphatic clay of Taplow (England) and the boundary Lower-Upper Campanian of several drillings in Holland. Edgell found the species in Australia in the Santonian, whereas it has been found (under the name of *Bolivinoides austiniiana* Cushman) in the Austin Chalk of Texas.

Bolivinoides decorata (mostly mentioned as *B. decorata decorata* (Jones)) has been traced by Hiltermann and Koch in North western Germany rarely in the Upper part of the Lower Campanian, commonly in the Upper Campanian, whereas it extinguishes in the Lower Maestrichtian. Reiss (Upper Cretaceous and Lower Tertiary *Bolivinoides* from Israel; Contr. Cushman Found. 1954, p. 155) found it frequently in the Campanian and Lower Maestrichtian of Israel. Reiss mentions a form resembling somewhat *B. decorata* in the Maestrichtian; may be this is *B. australis* Edgell. *B. decorata* has not been found in the Australian region by Edgell.

Interesting is the rarity of *Bolivinoides draco* Marsson, otherwise typical for the Maestrichtian. It may be, that this species is a form from deeper water. It was found at the top of the Gulperberg.

Bolivinoides australis has been described by Edgell from the Upper Campanian of Australia. In Holland it is found in those samples which have to be considered as belonging to the Upper Campanian. It has not been mentioned by Hiltermann and Koch, though it may be that they found it as intermediate forms between *B. decorata* and *B. gigantea*. It may be a typical form for shallow coastal water.

B. gigantea has been described and figured already by Wicher (On the age of the higher upper Cretaceous of the Tampico Embayment Area in Mexico, etc.; Bull. Mus. Hist. Nat. du Pays Serbe, Belgrado, 1949, Ser. A, 2.). Hiltermann and Koch found it in Germany in the uppermost Campanian and the Maestrichtian. Wicher (Mikropaläontologische Beobachtungen in der höheren borealen Oberkreide, besonders im Maastricht; Geol. Jahrb., 68, Hannover 1953) stresses its occurrence throughout the Maestrichtian, even into the *Pseudotextularia*-zone, where it is abundant. Together with *B. draco* he mentions in the *Pseudotextularia*-zone a peculiar form, which is reticulate. This form has been described lately by Reiss from Israel (1954, p. 155) as *Bolivinoides draco dorreeni* Finlay, from New Zealand. It was found in the Upper Maestrichtian of Israel. Specimens which show the reticulate ornamentation occur also in the highest layers of the Cr 4 near Eben Emael, Belgium, but have not yet been found in the more coastal sediments of the upper Cr 4 of Holland. Since, however, just above these layers in the quarry Bonne Espérance the lowest Mb has been traced, it may be that the Upper Cr 4 is in reality identical with Wicher's *Pseudotextularia*-zone.

Since in Holland *B. gigantea* is found in the upper Cr 3, the Cr 4, and, reworked, in the Ma and Prae-Mb and Prae K, these layers must be of Maestrichtian age.

Edgell found *B. gigantea* (p. 72) in Australia in the Maestrichtian only.

- a—a. *Bolivinoides stringillata*, $\times 140$; Onderste Bos, lowest part of the quarry, Cr 3a. Sample 103.
- b—b. *Bolivinoides decorata*, $\times 140$; Bovenste Bos, lowest part of the quarry, Cr 3b. Coll. Kruit, 606.
- c—c. *Bolivinoides australis*, $\times 140$; quarry at Vijlen, sample 92, Cr 3b, upper part. Sample 92.
- d—d. *Bolivinoides gigantea*, $\times 140$; Eben Emael Belgium, lower part of Cr 4, sample 170.

