

een krachtig hulpmiddel kan worden bij de bescherming van natuur en landschap. Bovenal echter sprak hij als contact-bioloog van het Natuurhistorisch Museum te Maastricht, omdat de hut het uitgangspunt zal kunnen worden voor het werk van de natuurgidsen, die zich willen bekwamen om de liefde voor de natuur, die zij zelf bezitten, door te gaan geven aan de vele belangstellenden, waardoor deze mensen in de bestudering der natuur een prachtige en goedkope vrije tijdsbesteding kunnen vinden, waaraan in onze dagen zo'n grote behoefte bestaat.

Talrijke bezoeken zijn reeds aan de hut gebracht, en vele excursie's zijn er al van uitgegaan, zodat hierdoor de hut zijn buitengewoon nut voor de opvoeding tot beleving der natuur reeds bewezen heeft.

#### FORAMINIFERA FROM THE CRETACEOUS OF SOUTH-LIMBURG, NETHERLANDS. LX.

##### THE EVOLUTION OF *DAVIESINA FLEURIAUSI* (D'ORBIGNY) IN THE MAESTRICHTIAN TUFF CHALK.

by J. HOFKER

#### Literature:

*Amphistegina fleuriausi* d'Orbigny, 1826, Ann. Sc. Nat., vol. 7, p. 304.

*Amphistegina fleuriausi* d'Orbigny, Reuss, 1862, Sitzber. Nat. Kl., Acad. Wiss. Wien, p. 308, pl. 1, fig. 12; also p. 391.

*Operculina cretacea* Reuss, 1862, ibid.

*Amphistegina fleuriausi* d'Orbigny, Hofker, 1926, Natuurhist. Maandbl., 15, p. 29-31, fig. 1-10; p. 80-82, fig. 1-14.

*Amphistegina fleuriausi* d'Orbigny, Raads-hoven, B. van, 1940, Natuurhist. Maandbl., 24, p. 12.

*Operculina complanata* (not DeFrance), Visser, W. A., 1937, Natuurhist. Maandbl., 26, p. 87.

*Operculina complanata* var. *granulosa* Leymerie, Brady, 1884, Challenger Report, p. 774.

*Operculina cretacea* Reuss, Bannink, 1948, Thesis Leiden, p. 59, 80.

*Operculina fleuriausi* (d'Orbigny), Visser, A. M., 1950, Leidse geol. Meded., vol. 16, p. 251-252, pl. 1, fig. 17; pl. 10, fig. 1 and 6.

*Operculina labanae* Visser, A. M., ibid. 1950, p. 253, pl. 1, fig. 18; pl. 10, fig. 2, 3.

*Camerina fleuriausi* (d'Orbigny), Hofker, 1951, Publ. Natuurhist. Genootsch., Limburg, ser. 4, p. 35-39, fig. 44-47.

This remarkable species first was believed to belong to *Amphistegina*; but the analysis of that genus with its secondary chamberlets clearly distinguishes it from the forms occurring in the Upper Cretaceous of Holland (see Hofker, Siboga Report IVa, pt. III, 1950, pp. 442-447). In 1926 the author distinguished three forms: a small one with lenticular shape, nearly radial sutures and involute chambers; a larger one with a lenticular part in the centre and a much flatter part later, always with distinct chalk-knobs in the central part and often along the sutures strongly bending backward near the margin; a third form, equally large, with numerous chambers and only slightly distinct sutures, smoothly finished. The small form, I found, had a large proloculus; the second with the knobs also a large proloculus, but generally somewhat larger than the small form; the large, smooth form always had a very small proloculus. We will distinguish these three forms respectively as A1, A2 and B.

The B form has been described by Reuss as *Operculina cretacea* 1862. The A1 form has been described by Visser as *Operculina labanae* 1950; she denied its specific identity with *Amphistegina fleuriausi* d'Orbigny, though she mentions that she only could find megalospheric specimens, though this form is the commoner one in all samples in which the species appears. The B-form was not found by her. The A2 form is the form which has been described by d'Orbigny, and thus bears, by priority, the name *fleuriausi*.

In a study on the group *Bolivina incrassata* Reuss, the author has shown that in that species of the Upper Cretaceous at first only two generations exist, B and A1; later, in the Lower-Middle Maestrichtian (in international sense) a third form appears, distinguished by Wicher as „*gigantea*“, but in reality the A2-form. When, in the uppermost Maestrichtian and in the lowest Danian *Bolivina incrassata* gets the form of *Bolivina basbeckensis* Hofker, it once again becomes dimorphic, may be even apogamic. (Hofker, 1957, Geol. Jahrb. Beih. 27, pp. 235-247; 1960, Meddel. Dansk Geol. Foren., 14, p. 241, fig. 16). Similar changes have been traced in several other fossil Foraminifera. When we



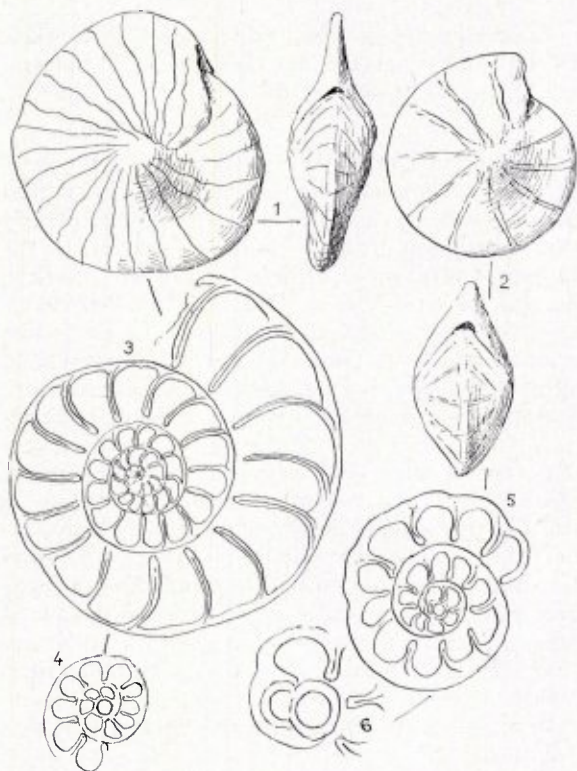


Fig. 1. *Daviesina fleuriausi* (d'Orbigny) *cretacea*-form, B-generation; x 15; ENCI-quarry series I Romein, 12,50 m above base of the series, Mc.

Fig. 2. *labanae*-form, A1-generation; x 25; ENCI-quarry, series I Romein, 18,50 m above base of the series, Mc.

Fig. 3. *cretacea*-form, B-generation, horizontal section, specimen of Fig. 1, x 28.

Fig. 4. *cretacea*-form, B-generation, section of Fig. 3, central part, x 160.

Fig. 5. *labanae*-form, A1-generation, horizontal section of specimen Fig. 2, x 28.

Fig. 6. *labanae*-form, A1-generation, central part of Fig. 5, x 160.

presume that the three forms of „*Amphistegina fleuriausi*” belong together, we find quite a similar change in the forming of generations. In the lower Mc of the Pietersberg and elsewhere, we only find specimens which belong to the form B, with rare A1; in the higher Mc the A1-form is commoner whereas the B-form is rare but never absent; suddenly, at the base of the Md, the form A2 appears, often in large quantities,

whereas B and A1 are relatively rare. It was found, that a sample, containing many specimens of A2, always is taken from lower Md; in the upper Md the A2 form gradually disappears, whereas a new form appears which shows the characters of the A1 form, but for the fact that the ornamentation is much more pronounced and reminds us of the A2-form, viz. inflate sutures, often with irregular chalk knobs. Together with this latest form which also can be found in the holes of the hard ground on top of the Md, we find the B-form.

Eventually we may distinguish these forms as follows:

- B: large, smooth; *cretacea*-form;
- A1: small, smooth; *labanae*-form;
- A2: large, with chalk knobs on centre, often also on sutures; *fleuriausi*-form;
- latest A-form: small, with ornamentation; *labanae ornamentata*-form.

Measurements of proloculi showed:

- labanae*-form, A1, 28-32  $\mu$ ;
- labanae ornamentata*-form, A, 16-18  $\mu$ ;
- fleuriausi*-form, A2, 45-52  $\mu$ ;
- cretacea*-form, B, always about 12  $\mu$ .

Visser, A. M., in 1950 brought this species in *Operculina*, according the flaring type of the later chambers in the *fleuriausi*-form, (the *labanae* form always is totally involute) and since she thought to distinguish canals in the septa as well at the margin (marginal chord system); Hofker (1951) believed to distinguish a very primitive single canal at the margin which he compared with the more complicated system of the Nummulitidae, and thus brought the species into the genus *Camerina*. The discovery of many very well preserved specimens in the holes of the hardgrounds at the base of the Md and at the top of the Md made it possible to study with much better result the inner structure of the different forms. These results are:

a; tests nearly always are asymmetrically built; at one side the alar prolongations of the chambers are much more overlapping than on the reverse side, especially in the B-form and the *fleuriausi*-form;

b; especially in the *fleuriausi*-form the chalk knobs at one side are much more pronounced than at the reverse side;



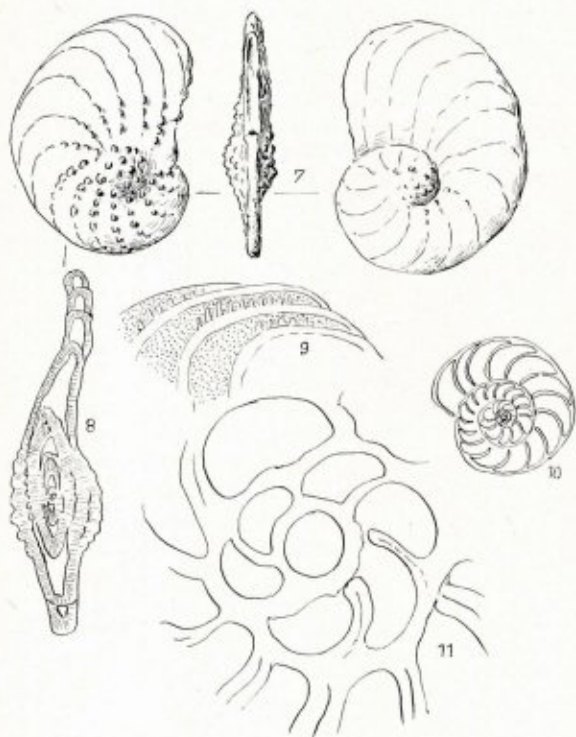


Fig. 7. *fleuriausi*-form, A2-generation, from three sides, x 7, holes of hard ground in the lower Md of the quarry Curfs, near Houthem.

Fig. 8. *fleuriausi*-form, A2-generation, section through specimen of Fig. 7, x 15.

Fig. 9. *fleuriausi*-form, A2-generation, specimen from sample T19, quarry van der Zwaan, Jekerdal, Pietersberg, Lower Md; surface of last formed chambers seen in clarifier, with pustules over the surface running from sutures, in older chambers giving rise to the pustules on the sutures; x 28.

Fig. 10. *fleuriausi*-form, A2-generation, horizontal section, x 7; specimen from same sample as mentioned in Fig. 9.

Fig. 11. *fleuriausi*-form, A2-generation; central part of Fig. 10, x 160.

c; the septa between the chambers are double, so that on horizontal sections the dark line between the two sheets looks like a canal; septa, however, seen in transverse section, never reveal canals; in the septa there are no canals;

d; well-preserved specimens on transverse section do not show any canal at the margin, nor a typical chord, sunken down into the lumen of the chamber, as is typical for *Operculina*;

some transverse sections show an opening in the marginal wall, but this opening is the end of the strongly overlapping next chamber at the margin, as is found in the *fleuriausi*-form. So, no canal system whatever exists.

All these characters strongly point, together with the fine and numerous pores, to the genus *Daviesina* Smout (Lower Tertiary Foraminifera of the Qatar Peninsula; British Museum, London, 1954, p. 66); specimens of the *fleuriausi*-form, sent to Smout, were considered by this author to stand very near his species *Daviesina langhami*, p. 68, pl. 11, figs. 1-11, from the Paleocene. On the other hand, the forma B, smooth, often with flaring later chambers,

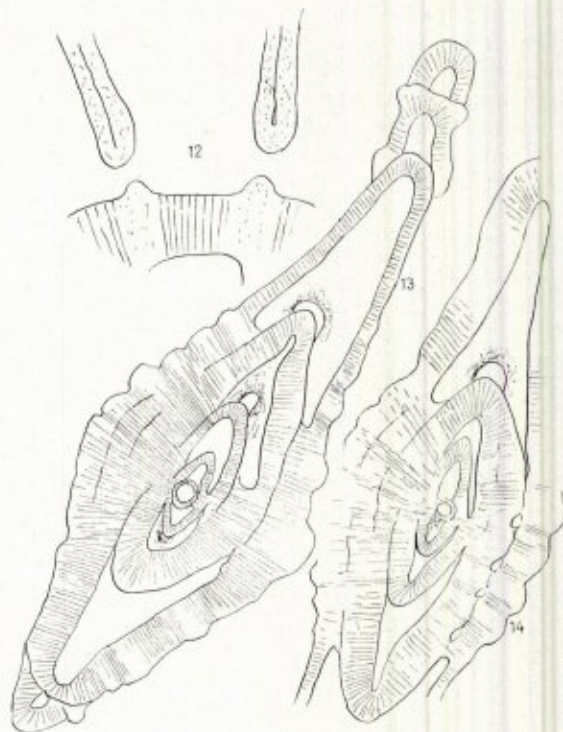


Fig. 12. *fleuriausi*-form, A2-generation; specimen from hard ground in lower Md, quarry Curfs, near Houthem; x 165; section showing double wall in septa, and the apertural openings between the chambers at spiral suture of former whorl.

Fig. 13. *fleuriausi*-form, A2-generation, from holes in hard ground lower Md, quarry Curfs, near Houthem; transverse section, x 50.

Fig. 14. *fleuriausi*-form, A2-generation, same locality as Fig. 13; transverse section, x 50.



strongly resembles the species which has been named by me *Daviesina primitiva* (Congr. Soc. sav., Dijon, 1959, p. 302, fig. 169-177) which is known to occur from the Santonian up into the Maestrichtian in the Aquitaine Basin, and also was found in the Upper Santonian of Folx-les-Caves in Middle Belgium. Since especially the B-generation of Foraminifera often shows the more primitive characters of the group to which they belong, it might be that our species, developing later than the levels in which *D. primitiva* is found in France, is an offspring of *Daviesina primitiva*, whereas *Daviesina langhami* might be the end of the evolution of this group.

In any case, our species is not an *Amphistegina*, an *Operculina* or a *Camerina*, but a true *Daviesina*; it appears with the beginning of the Mc, first dimorphic, gets at the base of the Md three generations (trimorphic) and, at the end of its appearance, it once again becomes dimorphic, but now the A-form has got the typical ornamentation of the former A2-generation.

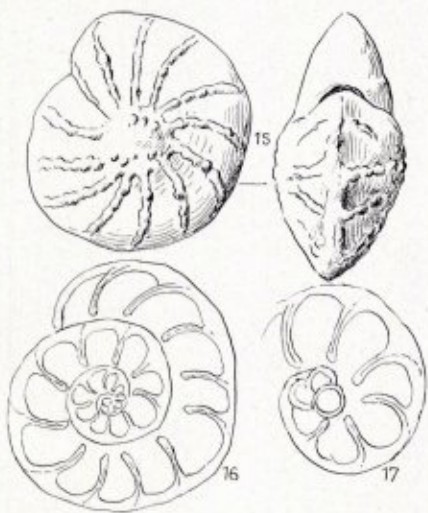


Fig. 15. *labanae ornamentata*-form, ENCI-quarry, series I Romein, 33,00 m above base of the series, upper Md; x 28.

Fig. 16. *labanae ornamentata*-form, horizontal section of specimen of Fig. 15; x 28.

Fig. 17. *labanae ornamentata*-form, central part of section Fig. 16, x 160.

In the Kunrade Chalk, we only find reworked specimens, often in large quantities, of our species.

In the lower levels of the Kunrade Chalk, there, where it rests on Upper Hervian sands (neighbourhood of Geleen, Putsberg, Benzenrade) or on Mb (Welterberg, Kunderberg) we invariably find the *fleuriausi*-form (A2); in higher levels (upper part of the Kunderberg-series, upper parts in the mining district) we mostly find the *labanae ornamentata* form (end form A). Together with many other data which have already been given by the author in former papers, we come to the conclusion that the Kunrade Chalk has been deposited after the lower Md.

*Daviesina* thus is a very fine guide-fossil for the finer stratigraphy of the Tuff Chalk and the Kunrade Chalk:

Upper Md: *labanae ornamentata* form and *cretacea* form; also reworked in upper Kunrade chalk;

Lower Md: *fleuriausi* form, *labanae* form and *cretacea* form; *fleuriausi* often reworked in lower Kunrade chalk;

Upper Mc: *labanae* form and *cretacea* form;

Lower Mc: *cretacea* form common, *labanae* form small and rare;

Mb: none of the forms of *Daviesina fleuriausi*.

Maestrichtian Tuff Chalk

Ma	Mb	Lower Mc	Upper Mc	Lower Md	Upper Md	
		X	X	X	X	<i>cretacea</i> (B)
		?	X	X		<i>labanae</i> (A <sub>1</sub> )
				X	?	<i>fleuriausi</i> (A <sub>2</sub> )
					X	<i>labanae ornamentata</i> (A)