

**Zeitschrift:** Eclogae Geologicae Helvetiae  
**Herausgeber:** Schweizerische Geologische Gesellschaft  
**Band:** 99 (2006)  
**Heft:** 3

**Artikel:** Dicarinella imbricata (Mornod 1949) : first SEM documentation of the lost holotype and foraminiferal assemblage from the type horizon (Upper Cretaceous, Switzerland)  
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**DOI:** <https://doi.org/10.5169/seals-169241>

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# *Dicarinella imbricata* (MORNOD 1949): First SEM documentation of the lost holotype and foraminiferal assemblage from the type horizon (Upper Cretaceous, Switzerland)

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**Key words:** Planktonic Foraminifera, Upper Cretaceous, Switzerland, type material, SEM

## ABSTRACT

The foraminifer species *Dicarinella imbricata*, from the Upper Cretaceous of Switzerland, was established in 1949 by L. Mornod. The holotype was figured only by Mornod's drawings and the specimen was never made available. As the holotype was missing since a long time, it was considered as lost and a neotype was established. However, the holotype was recently found.

We present here the first scanning electron microscope (SEM) documentation of the holotype. These data are compared with the original drawings of the holotype, the neotype and a paratype. In addition, we report a rich and diverse Tethyan planktonic foraminiferal assemblage from the type horizon, whose composition indicates a late Turonian age.

## RESUME

L'espèce de foraminifère *Dicarinella imbricata*, du Crétacé supérieur de Suisse, a été décrite par L. Mornod en 1949. L'holotype a été figuré seulement par des dessins de l'auteur, et l'holotype n'a jamais été déposé dans le domaine public. Comme l'holotype manquait depuis longtemps, il a été considéré comme perdu et un néotype a été créé. Cependant, l'holotype a été récemment découvert.

Nous présentons la première documentation de l'holotype au microscope électronique à balayage (MEB). Ces données sont comparées avec les dessins originaux de l'holotype, le néotype et un paratype. De plus, nous présentons l'assemblage de foraminifères planctoniques téthysiens provenant de l'horizon type, dont la composition indique un âge Turonien supérieur.

## 1. Introduction

When the foraminifer species *Dicarinella imbricata* was established (Mornod 1949), the author provided only drawings of the holotype, because the scanning electron microscope (SEM) was not in use at that time. Successively, many scientists attempted to obtain access to the holotype (e.g. Caron 1976), however, the specimen was never made publicly available as the author turned down any request of it.

In the absence of a detailed SEM documentation of the holotype, and with the increasing phylogenetic and stratigraphic importance of the species, it appeared necessary to designate a neotype. Caron (1976) provided SEM images of the type material (paratypes of the neotype) from the type locality of Montsalvens area (western Switzerland), but only drawings of the established neotype because at that time there was no guarantee for the safety of the specimen after SEM photography.

When Mornod passed away, his wife donated his library

and his samples to the Department of Geosciences, Geology and Paleontology of the University of Fribourg (Switzerland), where Mornod had been a former student. These samples included a box with the collection of foraminifera from the Montsalvens area and the holotype of *Dicarinella imbricata* in the original slide.

Currently, the Mesozoic Planktonic Foraminifera Working Group (of which the 2 authors are members and which is chaired by B. Huber of the Smithsonian Institution), is engaged in the compilation of the on-line dictionary of Mesozoic planktonic foraminifera in the framework of the Chronos initiative (US-NSF Project). This dictionary also includes the photographic documentation of type specimens, their availability being an essential requirement for comparison.

In this way, we present here the first SEM photographs of the *Dicarinella imbricata* holotype and neotype. We compare them with the original drawings by Mornod (1949) and with the neotype drawings by Caron (1976).

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## 2. Geological setting

The species was described from a site located along the stream “Rio des Covayes” in the Massif du Montsalvens, in the Fribourg Prealpes (western Switzerland). The “Rio des Covayes” is a stream and unfortunately it is not marked on the geologic map (1:25000) of Gruyères (Pasquier 2004). The type locality of this species is in a gully running below the Montferrand farm, about 1 km North of Cerniat village as it is described in detail in Mornod (1949).

The site is composed of three successive outcrops: Outcrop I at about 1075 m, Outcrop II at about 1000 m and Outcrop III between 975 and 985 m of altitude. The type level of *Dicarinella imbricata*, as given in Mornod (1949: 577, fig. 2), is Outcrop III level 43.

The type horizon is dated as Turonian of the Upper Cretaceous sedimentary succession, representing the uppermost part of the Jurassic-Cretaceous series of the Ultrahelvetetic Nappe in the Montsalvens area (Mornod 1949). Cenomanian sediments consist of dark grey clayey chalks with greenish-blackish intercalations. Turonian sediments consist of whitish and massive chalks with clay intercalations (Caron 1976).

## 3. Material and methods

The type material of *Dicarinella imbricata* used in the present study is housed at the Naturhistorisches Museum Basel (NMB). The SEM documentation of the *Dicarinella imbricata* holotype (Pl. I, 2a–c) was obtained using the standard techniques for SEM sample preparation.

The neotype was deposited at the NMB and since we did not obtain the permission to coat it with gold, we have applied an alternative methodology to obtain the SEM images. The following procedure was applied: the specimen was placed on the standard glue tape on a SEM sample holder, which was coated on its external part with an annular layer of silver paint to ensure enough conductivity. The neotype was then placed into an electronic microscope (FEI XL30 Sirion FEG), and studied with a 3 KV beam and a Spot 2, which are the minimum values that yield quite good quality images without damaging the samples (because of the electron flux). The SEM pictures are shown in Plate I (4a–c).

Furthermore, the sample from the type horizon (level 43 of Profile III in Mornod 1949), from which the neotype was chosen, was analysed for its planktonic foraminiferal content. It was washed with a 10% H<sub>2</sub>O<sub>2</sub> and sieved through 500, 250, 125 and 63 mm meshes. This material is housed at the Department of Geosciences, University of Fribourg.

## 4. Systematic palaeontology

Class Foraminifera EICHWALD 1830  
Order Globigerinidae ORBIGNY 1826  
Family Globotruncanidae BROTZEN 1942  
Genus *Dicarinella* PORTHAULT 1970

## *Dicarinella imbricata* (MORNOD 1949

(Pl. I)

### Holotype:

1949 *Globotruncana imbricata* MORNOD – Mornod: 581, figs. 5, III, a–d; present study: Pl. I, 1a–c, 2a–c.

### Neotype:

1976 *Dicarinella imbricata* (MORNOD 1949) – Caron: 32, fig. 3a–c; d; present study: Pl. I, 3a–c, 4a–c.

### Paratype:

1949 *Dicarinella imbricata* (MORNOD 1949) – Mornod: figs. 5, II, a–c; present study: Pl. I, 5a–c.

### Selected references:

- 1976 *Dicarinella imbricata* (MORNOD 1949) – Caron: Pl. 3, figs. 1–6, Pl. 4, figs. 1–6, Pl. 5, figs. 1–6.  
1979 *Dicarinella imbricata* (MORNOD 1949) – Robaszynski et al.: Pl. 58, figs. 1, 2; Pl. 59, figs. 12.  
1990 *Dicarinella imbricata* (MORNOD 1949) – Robaszynski et al.: Pl. 35, figs. 4, 5.  
2004 *Dicarinella imbricata* (MORNOD 1949) – Premoli Silva & Verga: Pl. 17, fig. 4.

*Type material.* – Holotype by Mornod (1949: 581, fig. 3a–c); Neotype designated by Caron (1976: 332, figs. 3a–c); Paratype by Mornod (1949: 581, figs. 5, II, a–c); collection Naturhistorisches Museum Basel (NMB).

*Type horizon and type locality.* – Turonian, Massif du Montsalvens (Fribourg Prealpes), Switzerland (Mornod 1949; Caron 1976).

*Material.* – Holotype (NMB-C39015); neotype (NMB-C33317); paratype (unnumbered).

*Description.* – According to the descriptions of Mornod (1949) and Caron (1976), this species has a trochospiral test with 5 to 6 chambers in the last whorl. Chamber sizes grow gradually as added. The test is generally large (the holotype has a diameter of 0.53 mm and the neotype has a diameter of 0.51 mm). The spiral side is distinctly convex with curved and raised sutures. The umbilical side is concave with radial and depressed sutures; the umbilicus is narrow and the primary aperture in umbilical–extraumbilical position, bordered by a lip especially well developed in the last two chambers. Portici are rarely preserved and can be observed only in the specimen illustrated by Caron (1976: Pl. 3, figs. 4–5).

The diagnostic feature of the species is the keel band, which is composed by two keels close to each other that are generally missing in the last chamber. An imperforate band separates the two keels. This band seems to originate near the contact with the previous chamber and gives the test a typical imbricated aspect. The portici are visible on the umbilical side.

The comparison between the SEM photos (Pl. I, 2a–c) and the original drawings (Pl. I, 1a–c) of the holotype shows that the preservation of the specimen is very poor, it was better preserved at the time of the first description. Consequently,

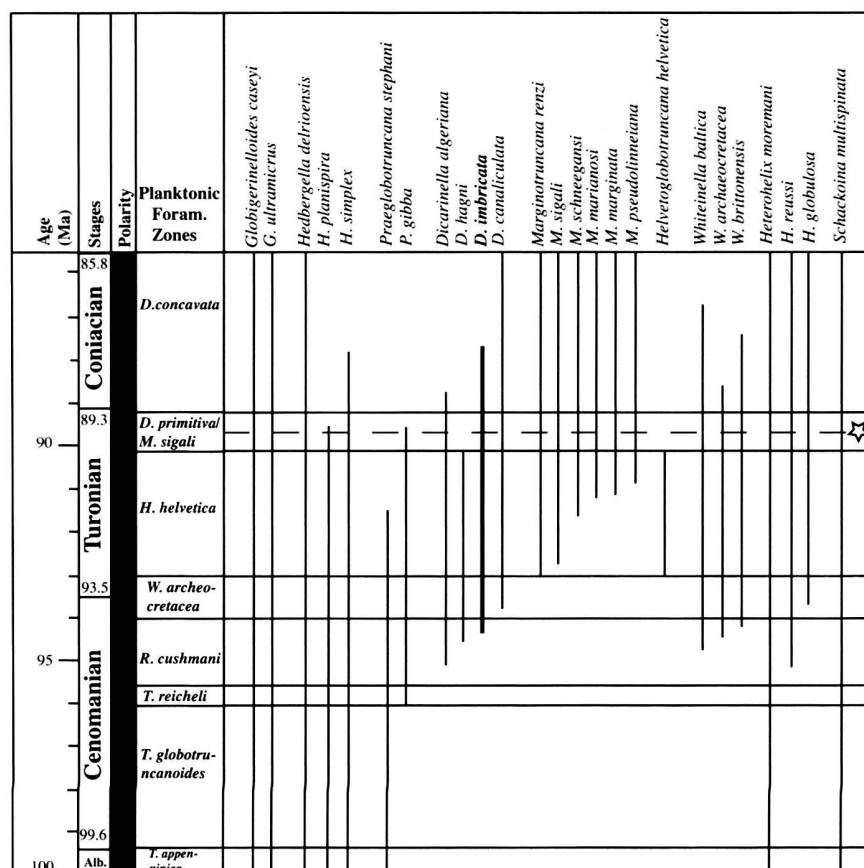


Fig. 1. Stratigraphic distribution of Upper Cretaceous genera and species of planktonic foraminifera from the type horizon of *Dicarinella imbricata* (MORNOD 1949). The star marks the suggested position of the type level of *Dicarinella imbricata*, according to the faunal analysis (see text: 5. Accompanying assemblage). Time scale from Ogg et al. (2004).

although the SEM photos are partly consistent with the drawings, they illustrate only the outline of the form. The last chamber is partially broken as also shown in the drawing; the upper keel can hardly be seen on the spiral side in the SEM photos, although this feature is well marked in the drawings of Mornod (1949). The morphology of the chambers and the radial, depressed sutures on the umbilical side are consistent in the SEM photos and the drawings.

The comparison of the holotype (Pl. I, 1a–c; 2a–c) with the neotype (Pl. I, 3a–c; 4a–c) shows that the two specimens have a biconvex morphology with a distinct double keel on the peripheral margin. The keels are close to each other and absent on the last chamber. The holotype displays five chambers in the last whorl whereas the neotype has six chambers. On the umbilical side the sutures are radial and depressed. Portici are not preserved in either specimen. The neotype remains an interesting specimen to illustrate the diagnostic features of this species.

Finally, the various paratypes from Mornod's foraminiferal collection (e.g. Pl. I, 5a–c) show a strong alteration of the wall texture. This alteration is possibly related to their exposure to open air since the paper microslides in which they were preserved for over fifty years were not hermetically closed.

## 5. Accompanying assemblage

A sample in the type horizon yielded a very rich and diverse Tethyan planktonic foraminifer fauna. The two smallest fractions (see 3. Material and methods) contain abundant *Heterohelix*, *Globigerinelloides*, *Hedbergella* and very small *Schackoina*. *Dicarinella*, *Praeglobotruncana* and large *Marginotruncana* generally characterize the two largest fractions. The different species of this assemblage are mentioned in Figure 1.

The known range of *Dicarinella imbricata* extends from the late Cenomanian to the basal Coniacian (Mornod 1949; Caron 1976; Robaszynski et al. 1979, 1990; Premoli Silva & Verga 2004). The reported assemblage spans a distinct stratigraphic position (Fig. 1), it follows the last occurrence (LO) of *Helvetoglobotruncana helvetica* and precedes the first occurrence (FO) of *Dicarinella concavata*. Consequently, it is interpreted as belonging to the *M. sigali* / *D. primitiva* Partial Range Zone (PRZ) of late Turonian age (Fig. 1).

## 6. Conclusions

The finding of the *Dicarinella imbricata* (MORNOD 1949) holotype is significant considering that only the original drawings were available since more than fifty years.

It allowed us to give the first SEM documentation of this specimen. Unfortunately it appears that, due to the very poor preservation of the holotype (better preserved at the time of the original description), the SEM photos did not give further information than the drawings.

The composition of the accompanying Tethyan planktonic foraminiferal assemblage, found in the type horizon, led to date this latter to the late Turonian.

# Acknowledgements

We warmly thank Jean-Pierre Berger (University of Fribourg), who first realized that the brown and half broken box, which was about to be thrown away, contained the Mornod's Cretaceous foraminiferal collection. Thanks to Christoph Neururer (University of Fribourg) for his help in SEM documentation and for the procedures to photograph the neotype without gold coating. Thanks to Isabella Premoli Silva and Hans Thierstein for their reviews.

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Manuscript received November 13, 2005

Revision accepted November 7, 2006

Published Online First January 12, 2007

# Plate I.

Type material of *Dicarinella imbricata* (MORNOD 1949). 1) Drawings of the holotype (NMB-C39015) in spiral (1a), side (1b) and umbilical (1c) views (from Mornod 1949); 2) SEM photographs of the holotype (NMB-C39015) in spiral (2a), side (2b) and umbilical (2c) views; 3) Drawings of the neotype (NMB-C33317) in spiral (3a), side (3b) and umbilical (3c) views (from Caron 1976); 4) SEM photographs of the neotype (NMB-C33317) in spiral (4a), side (4b) and umbilical (4c) views; 5) SEM photographs of the paratype (unnumbered, illustrated in Mornod 1949) in spiral (5a), side (5b) and umbilical (5c) views. Scale bars: 1, 2 & 5 (200 mm); 3, 4 (500 mm).

