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Numerical distribution of Santonian to Danian corals (Scleractinia, Octocorallia) of Southern Limburg, the Netherlands

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Abstract

The stratigraphical occurrence of 35 known species from the Upper Cretaceous and Danian of Southern Limburg is presented based on existing collections and newly collected material. Corals are relatively rare, except in the Meerssen Member of the Maastricht Formation. Two faunas were recognised in the Meerssen Member: a fauna dominated by *Cyclolites cancellata* at the base of this member – which coincides with the sequence boundary of the third-order sequence cycle TA1.1 of Haq et al. (1988) – and a fauna dominated by mushroom-shaped and encrusting colonies at the top of the transgressive systems tract of the same sequence cycle.

Introduction

This contribution is the first in a series about corals from the Santonian to Danian of NW Europe, in which series the main goals will be the revision of the taxonomy of the Maastrichtian and Danian faunas and to get an impression of their development in the just mentioned time interval and areal extent. The aim of the present contribution is a review of the stratigraphical occurrence of corals in the Santonian to Danian deposits from the Maastrichtian type area, based on existing collections and newly collected material.

Fossil Scleractinia of the Cretaceous rocks in the neighbourhood of Maastricht (South Limburg, the Netherlands) have been collected for a long time. Walch (1771) and Faujas Saint Fond (1799) published atlases containing plates with the most common corals. Goldfuss (1826) coined most of the names still in use today. Umbgrove (1925) published the most thorough overview so far. He listed 38 scleractinians and one octocoral. The Octocorallia were published by Voigt (1958), who listed five species.

Until recently, fossil corals were seldom collected in the Maastrichtian type area for merely stratigraphical purposes. Two exceptions are Bosquet (1860) and Kruit (1954). Their lithostratigraphies are difficult to correlate, however, with modern ones such as the local, coded subunit division by Felder & Bosch (1998), and their identifications are hard to verify, since little of the original collections has survived.

Stratigraphy: a selected review

The Late Cretaceous and Danian deposits of Southern Limburg overlay Palaeozoic units and are covered with Tertiary sediments. They are assigned to five formations: the Aachen, Vaals, Gulpen, Maastricht and Houthem Formations (Albers & Felder 1979). The depositional environments of the Aachen, Vaals and Gulpen Formations are interpreted as a transgressive series containing basal terrestrial sediments grading into shallow-marine sediments. Maximal water depths were reached during the deposition of the Gulpen Formation, when the sea bottom was below the wave base. The Maastricht and Houthem Formations were deposited under shallow-marine conditions.

The upper part of the Maastricht Formation is subdivided into two members: the Nekum and Meerssen Members. The boundary between these two members is the Caster Horizon. The Meerssen Member consists of sedimentary cycles of coarse-grained fossil hashes with cross-bedded structures at the base overlain by finer-grained, bioturbated carbonate sandstones and

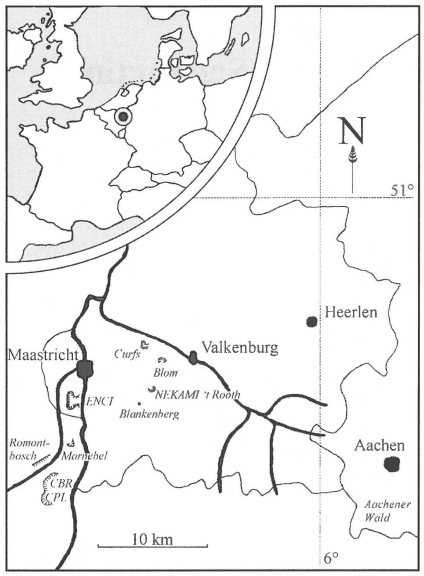

Figure 1. Geographic provenance of studied specimens (see also Table 1).

finished by burrowed hardgrounds. Zijlstra (1994) related these sedimentary cycles to precession-related storm deposits. Felder (see Felder & Bosch 1998) coded local lithological subunits of the Meerssen Member as IVf-1 to IVf-7. Correlation of these subunits between several localities is doubtful. The subunits contain one or more sedimentation cycles. The impact of the Yucatan Meteorite (65 Ma) occurred shortly after or during the formation of the hardground on top of IVf–6, the Berg en Terblijt Horizon (Brinkhuis & Smit 1996), thus defining the Cretaceous/Tertiary boundary within the Maastricht Formation. Herngreen et al. (1998) suggested for the Nekum, Meerssen and Geulhem Members in the Ankerpoort Quarry relative marginally marine, probably inner neritic conditions with most unconformities marking sea-level lowstands. They inferred a deepening trend during the deposition of the upper part of the Meerssen Member and the Geulhem Member. Superimposed on this deepening trend three third-order sea-level cycles were recognised.

Material

The 841 investigated coral specimens from the area (Figure 1) come from various localities (Table 1); part of them are stored in several collections, but the majority consists of newly collected material (Table 2). The taxonomy is based on Umbgrove (1925), with some

Table 1. Geographical co-ordinates of the most important localities from where the studied material originated

localities	latitude	longitude
ENCI quarry	50°49′25″ N	5°41′49″ E
Ankerpoort quarry (formerly Curfs quarry)	50°52′09″ N	5°46′32″ E
Blom quarry	50°51′26″ N	5°47′25″ E
't Rooth quarry	50°50′19″ N	5°47′11″ E
Marnebel quarry	50°47′23″ N	5°40′35″ E
Hallembaye quarry	50°45′ N	5°39′ E
Romont Bosch quarry	50°47′ N	5°38′ E
Vroenhoven bridge	50°50′07″ N	5°38′31″ E

Table 2. Collectors and current housing of the studied material.

collector	housed at	number of studied specimens
W.M. Felder	NHMM, Maastricht	92
R. Fraaije	De Groene Poort, Boxtel	22
P. Van Knippenbergen	private collection	19
M. Kuypers	private collection	58
J. Leloux	private collection	650

modifications after Wells (1956). The Umbgrove type collection, housed at the Nationaal Natuurhistorisch Museum – Naturalis – in Leiden and the Goldfuss type collection in the Goldfuss Museum of the Rheinische Friedrich Wilhelms Universität in Bonn served as reference collections. The taxonomy is subject of further research. New taxa were not considered.

Results and remarks on the preservation of the material

From the 841 specimens studied, 622 Scleractinia and 21 Octocorallia could be identified. A total of 35 taxa were recognised. Their stratigraphic occurrence is presented in Figure 2. The remainder of the studied specimens are either not identifiable or represent new species that will not be dealt with in the present contribution.

Corals occur in depositis from the Santonian to the Danian. However, they are rare in most sediments, except in the Meerssen Member. The middle part of the Meerssen Member (IVf-3 to IVf-5) is richest in species. The amount of corals decreases strongly above

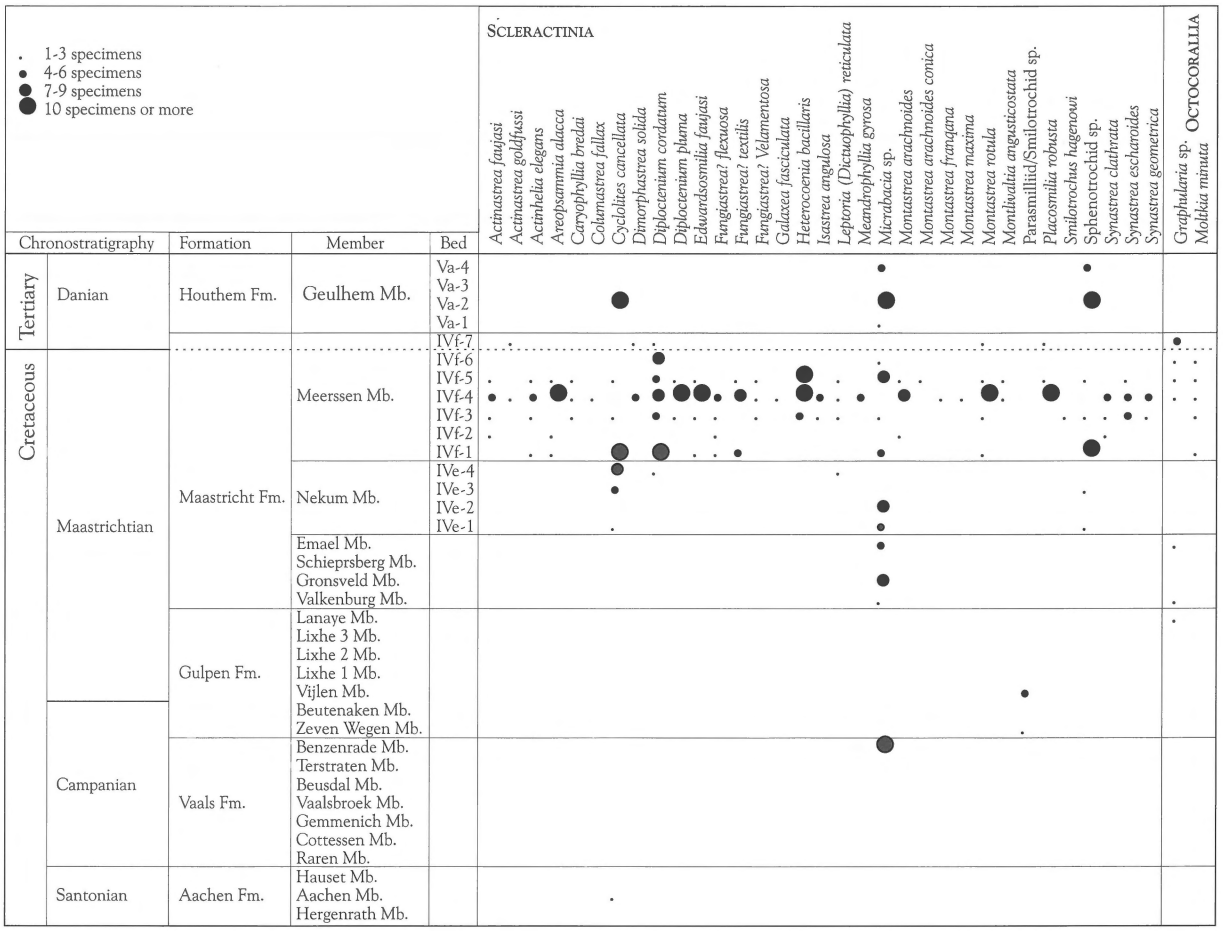

Figure 2. Distribution chart of encountered specimens of Octocorallia and Scleractinia from Southern Limburg. Lithostratigraphy is based on Albers & Felder (1979), Jagt et al. (1996), Felder & Bosch (1998) and Herngreen et al. (1998).

this interval. IVf-6 is poor in corals and only a few species cross the Cretaceous/Tertiary boundary.

Santonian

So far, only one specimen from the Aachen Formation has been studied. This specimen (Collection W.M. Felder A. Z 27, NHMM) is a corallite of *Cyclolites cancellata*, extending the range of this species back by more than 20 Ma.

Campanian

Micrabacia sp. has been found in considerable numbers in the Benzenrade Member near Heerlen. Their corallites are at least partially recrystallised with quartz.

The parasmiliids and smilotrochiids from the Upper Campanian to Lower Maastrichtian are very closely related, or belong to species found across large areas of NW and central Europe. They show only small, probably intraspecific, differences with specimens from Ciply (Hainaut, Belgium) and Denmark. These corallites show little recrystallisation. Further research is necessary.

Lower part of Maastrichtian: Valkenburg to Emael Members

Apart from the external moulds of micrabaciids, some probably epiphytic specimens of possibly new species were found. This fauna, which consists of both external moulds and silicified corallites, is a subject for further research.

Nekum and Meerssen Members (Upper Maastrichtian) and Geulhem Member (Danian)

Most specimens are preserved as external and internal moulds. When corallites are not preserved as moulds, they are recrystallised or form secondary calcitic fillings of moulds. Nonrecristallised specimens of *Caryophyllia bredai* were found in the top bed of the Meerssen Member in the Albert Canal outcrop. Specimens from Meerssen Member IVf-3 to IVf-5 from the ENCI Quarry clearly show calcitic recristallisation.

Most of the che coral fossils in the Nekum to Geulhem Members were transported before deposition. Most fossils were collected as fragments in the fossil hash. On top of the hardgrounds of IVf-3 to IVf-5, encrusting colonies in combination with sponges and algae were sometimes found 'in living position'. The hardgrounds have thin algal coverings. The encrusting and mushroom-shaped colony corallites co-occur with the highest occurrence of rudists in the area.

The numerous occurrences of *C. cancellata* moulds in a discontinuous layer of very hard calcareous rock at the base of the second bed of the Geulhem Member are noteworthy. The corallites in this layer are more often affected by burrowing than the specimens in the Meerssen Member.

The first strong peak of *C. cancellata* is at the top of the Nekum Member and the base of the Meerssen Member: this coincides with the bottom sequence boundary of the third-order sequence cycle TA1.1 of Haq et al. (1988) and Hardenbol (1994). The peak of the encrusting and mushroom-shaped colonial corals is at the top of the transgressive systems tract near the maximum flooding surface of this cycle, whereas the next peak of *C. cancellata* (base of Va-2) shows just below the maximum flooding surface of the next sequence cycle DA-1 of Hardenbol (1994).

Discussion

The author's observations point to a highest occurrence of, for instance, *Diploctenium cordatum* at the top of IVf-6, whereas specimens in the Felder collection are from the 'top Meerssen Member'. Since both IVf-6 and IVf-7 can occur as top beds of the Meerssen Member, the highest occurrence of scleractinian specimens as noted in IVf-7 (Figure 2) remains somewhat doubtful. Assigning codes to beds in the Nekum and Meerssen Members under field conditions is often difficult and can only be done in well exposed sites in which horizons, such as the Caster Horizon at the base of the Meerssen Member, are clearly visible.

The conditions during the Late Maastrichtian were favourable for coral growth until deposition of IVf-5. Fraaije (1996) concluded, based on crustacean content, a drop of water temperature during deposition of IVf-5 and IVf-6. Sporomorph results indicate a distinct cooling in this time interval (Herngreen et al. 1998).

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