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CAMPANIAN-MAASTRICHTIAN SERPULIDS FROM THERMAE 2000 BOREHOLE (VALKENBURG A/D GEUL, THE NETHERLANDS)

by

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(1 figure, 2 plates)

1. INTRODUCTION

This report deals with a preliminar result of a more extensive study on the serpulids of the Upper Cretaceous of South-Limburg (the Netherlands) and adjacent regions. It is promoted by a «Sachmittelbeihilfe» of the «Deutsche Forschungsgemeinschaft» (DFG ; project Ja 385/2-1). The serpulid associations from Thermae 2000 must be correlated with those from other sections before general conclusions can be made. In this paper only few comparisons with other associations are discussed. Although the borehole has yielded some new serpulid species, no new taxonomic names are introduced.

The Thermae 2000 borehole is a very important one, since it is an almost complete section through the marine Upper Cretaceous (only Upper Campanian and Lower Maastrichtian are missing) in an area in between typical «Kunrade facies» and typical «Maastricht facies». Because of the careful sampling there is practically no contamination from higher levels.

2. VAALS FORMATION

The sandy to clayey, glauconitic sediments of the Vaals Formation have yielded only few serpulids. This matches the data from other comparable deposits and from recent soft, sandy sea bottoms. In the lower half of the Vaals Formation in Thermae 2000 (186-193 m) rare specimens occur of a probably new species very similar to *Sclerostyla macropus* (pl. 1, fig. 1). They are relatively small and presumably have only a small part of the tube fixed to the substrate. This may be an adaptation to a soft bottom with relatively rare, large and hard objects for fixation. The presence of *S.* cf. *macropus* in Thermae 2000 can be correlated with the Gruitrode borehole (BGD 169) in NE Belgium (some 30 km to the WNW) where the same species occurs in the lower half of the Vaals Formation. *S. macropus* sensu stricto is a common species in boreal Cretaceous shallow water sediments. The absence of *Glomerula gordialis* in the Vaals deposits of Thermae 2000 is remarkable, since this species occurs in the Vaals Formation at Gruitrode and in the Aachen area.

3. GULPEN FORMATION

The lower portion of the Gulpen Formation (Upper Campanian Zeven Wegen Member and Lower Maastrichtian Beutenaken Member) is missing in this borehole. The Vijlen to Lanaye Members have been studied.

The lower, glauconitic part of the Vijlen Member frequently bears a rich and diverse serpulid association (o.a. Nieuwe Weg Zeven Wegen outcrop in eastern South-Limburg, Kastanjelaan-2 borehole in Maastricht, Halembaye Quarry in Belgium). Although there are distinct local changes in the frequency of individual serpulid species, it seems that a basal transgression can be distinguished which is relatively rich in *Glomerula gordialis* (pl. 1, fig. 17). This basal layer is succeeded gradually by sediments with high numbers of *Pentaditrupa subtorquata* (pl. 1, fig. 2-3) and *Filogranula cincta* (pl. 1, fig. 11-12).
The same succession is found in Thermae 2000, although the total number of specimens in the Vijlen Member is low compared with that in the other localities. In Thermae 2000 there is a clear change in lithology at 160.3 m where glauconite becomes rare. Only the first sample above this level contains a few serpulids (?*Pentaditrupa subtorquata* and ?*Filogranula cincta*). Also in Halembaye these species occur in the poorly glauconitic part of the Vijlen Member. The serpulid succession of the Vijlen Member matches the paleoecology of the same species in boreal Cretaceous of Northern Germany, where *G. gordialis* is adapted to the high-energy transgressive environment and *P. subtorquata* seems to have preferred rather quiet water, although specimens of the latter species may have been washed into adjacent facies. *Filogranula cincta* and *Parsimonia wegneri* (pl. 1, fig. 21-22) are euryecological.

Higher up in the Vijlen Member an oxygen reduction may have occurred locally (Albers & Felder 1979). At least no autochthonous serpulids have been recognized in Thermae 2000 or in some other localities. The presence of *Sclerostyla mosae* at 157.0-157.3 m and 160.75-161.35 m is interpreted as contamination from higher levels.

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PLATE 1

Serpulid from the boring Thermae 2000 near Valkenburg. Scale = 1 mm.

1 *Sclerostyla* cf. *macropus* (SOWERBY 1829). 192-193 m.

2-3 *Pentaditrupa subtorquata* (MÜNSTER in GOLDFUSS 1831). 2 : 161.35-161.75 m, 3 : 160.75-161.35 m.

4-10 *Sclerostyla regia* (REGENHARDT 1961), synonym : *Sclerostyla? fragilis* JÄGER 1983. 4-8 : outer layer, 9-10 : inner layer. 4-5 : 111.5-112.5 m, 6, 8, 10 : 112.5-113.5 m, 7 : 114.5-115.5 m, 9 : 118.5-119.5 m.

11-16 *Filogranula cincta* (GOLDFUSS 1831). 12 may also be *Vermiliopsis fluctuata*. 11 : 163.0-163.5 m, 12 : 158.75-160.3 m, 13, 15 : 108.5-109.5 m, 14 : 100.5-101.5 m, 16 : 105.5-106.5 m.

17-20 *Glomerula gordialis* (SCHLOTHEIM 1820). 17 : 166.3-167 m, 18 : 55-56 m, 19 : 50-51 m, 20 : 37-38 m.

21-22 *Parsimonia wegneri* JÄGER 1983. 21-22 : 161.35-161.75 m.

23-25 *Parsimonia* cf. *wegneri* JÄGER 1983. 23 : 65-66 m, 24 : 66-66.5 m, 25 : 84.5-85.5 m.

26 *Sclerostyla regia* (REGENHARDT 1961). 105.5-106.5 m.

27-30 *Janita?* sp. 27 : 84.5-85.5 m, 28 : 60-61 m, 29 : 71.5-72.5 m, 30 : 67.5-68.5 m.

31 Spirorbidae indet. 43-44 m.

32 *Bipygmaeus pygmaeus* (HAGENOW 1840). 51-52 m.

The Lixhe Member is generally very poor in macrofossils and also in serpulids. An exception is the *Echinocorys* level of the Lixhe-1 Member in Halembaye Quarry, where serpulids are fixed on some of the many *Echinocorys* tests. These tests may have formed the only suitable substrate for serpulids. The absence of the same in Thermae 2000 and Kastanjelaan-2 suggests that virtually no serpulids lived in the intervals between these tests or in areas where echinoids are rare or absent.

In the Lanaye Member the water seems to have been warmer and somewhat shallower. Here serpulids appear again. In Thermae 2000 at first a single *Eoplacostegus* sp. or *Conorca* sp. (pl. 2, fig. 30) is found at 120.5-121.5 m ; and subsequently some specimens of *Sclerostyla regia* (pl. 1, fig. 4-10), which becomes more frequent from 119.5 to 111.5 m. *S. regia* is considered to be a characteristic species for the Lanaye Member. Like other fossil groups it marks the beginning of warm water influence from the Tethys. Later on, *S. regia* succeeded in reaching Northern Germany (Hemmoor near Hamburg), where is was described erroneously as *S.? fragilis* Jäger 1983, which is conspecific with *S. regia* or at most a subspecies of it. Further investigations must show how the change from boreal to warm water environment influenced the serpulid assemblages in detail. Several serpulid species occurring in the Lanaye Member of the quarries of Halembaye and Lanaye (Belgium) and ENCI near Maastricht (*Glomerula gordialis, Filogranula cincta, Parsimonia* cf. *wegneri,* etc.) are missing in Thermae 2000 in this interval.

4. MAASTRICHT FORMATION

The base of the Maastricht Formation has been recognized at 110.5 m in Thermae 2000. This level coincides with the appearance of few specimens of *Sclerostyla mosae* (pl. 2, fig. 1-12), the characteristic species of the Maastricht Formation and a close relative of *S. regia*. With few exceptions which need further investigation *S. mosae* does not occur in the boreal Cretaceous. In contrast to Jäger (1983) it is now clear that Cupedo's (1980) determination of the fixed parts of *S. mosae* in South-Limburg was correct and that Jäger's determination of the same as *S.? ignota* and *S.? basisculpta* was wrong. Otherwise it seems difficult to distinguish between *S. mosae* and *S. ciplyana* when only fragments are preserved. Perhaps it is practical to consider *S. cypliana* as a subspecies of *S. mosae*, but this needs further study.

A few silicified specimens of *S. regia* occur at 105.5-106.5 m (pl. 1, fig. 26). Some findings of the inner tube layer of *Sclerostyla* between 106.5 and 104.5 m may either belong to *S. mosae* or *S. regia*. Also in the ENCI *S. regia* is still present in the lowest part of the Maastricht Formation.

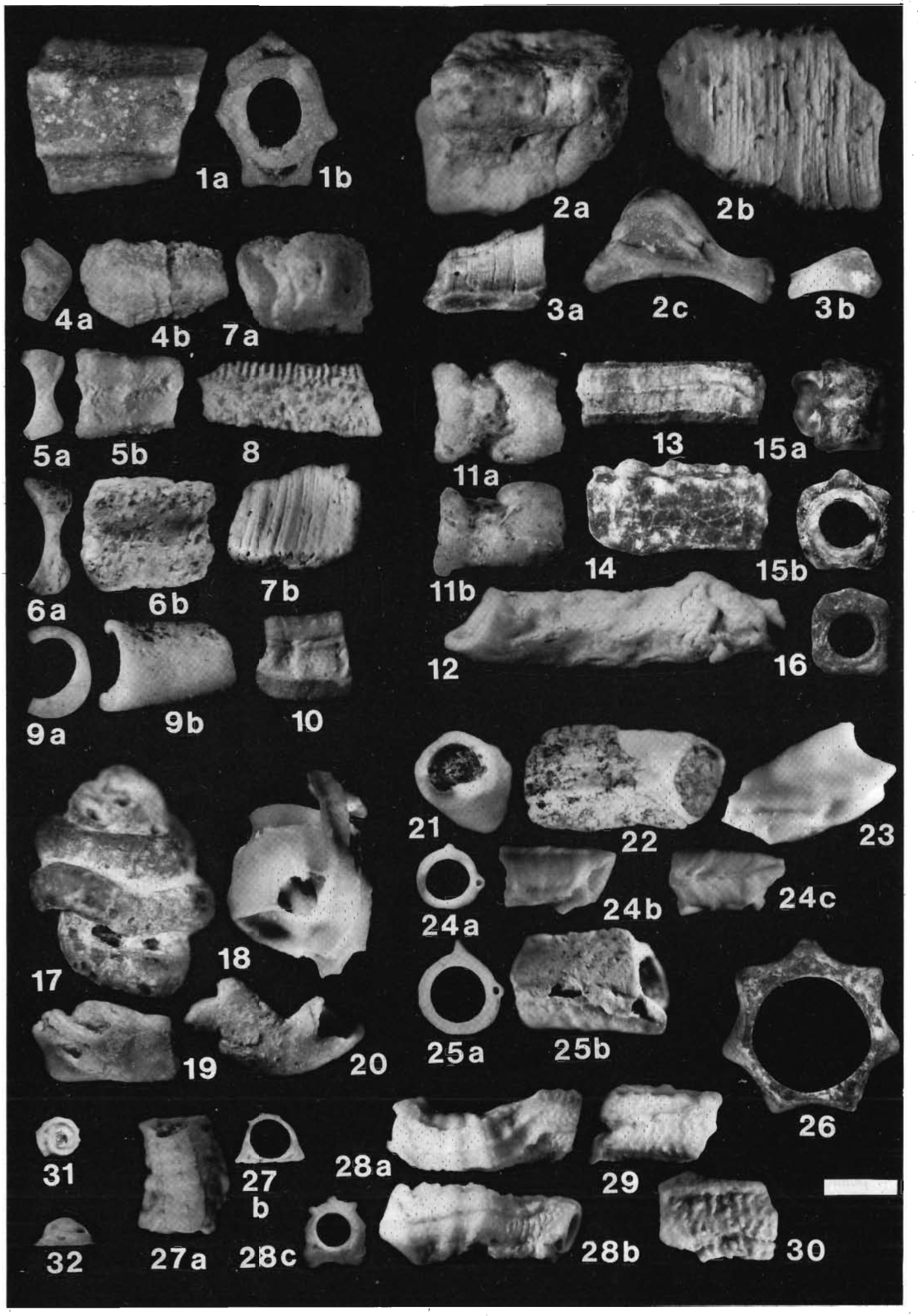
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PLATE 2

Serpulids from the boring Thermae 2000 near Valkenburg. Scale = 1 mm.

1-12 *Sclerostyla mosae* (BRONN 1837). 1-9 : outer layer, 10-12 : inner layer. 1-3, 8, 10, 12 : 52-53 m, 4-6 : 39-40 m, 7 : 55-56 m, 9 : 83.5-84.5 m, 11 : 65-66 m.

13-17 *Sclerostyla* sp. 13 : 50-51 m, 14 : 35-36 m, 15-17 : 36-37 m.

18-19 *Proliserpula?* sp. 18 : 66-66.5 m, 19 : 65-66 m.

20-22 *Vermiliopsis fluctuata* (SOWERBY 1829). 20 : 46-46.7 m, 21 : 37-38 m, 22 : 35-36 m.

23-25 *Proliserpula ampullacea* (SOWERBY 1829). 23 : 65-66 m, 24 : 69.5-70.5 m, 25 : 63-64 m.

26-30 *Eoplacostegus* sp. 30 may also be *Conorca* sp. 26-27 : 51-52 m, 28-29 : 37-38 m, 30 : 120.5-121.5 m.

31-32 *Cementula* sp. 31 : 50-51 m, 32 : 51-52 m.

33-35 *Sclerostyla* cf. *erecta* (GOLDFUSS 1831). 33 : 48-49 m, 34 : 38-39 m, 35 : 43-44 m.

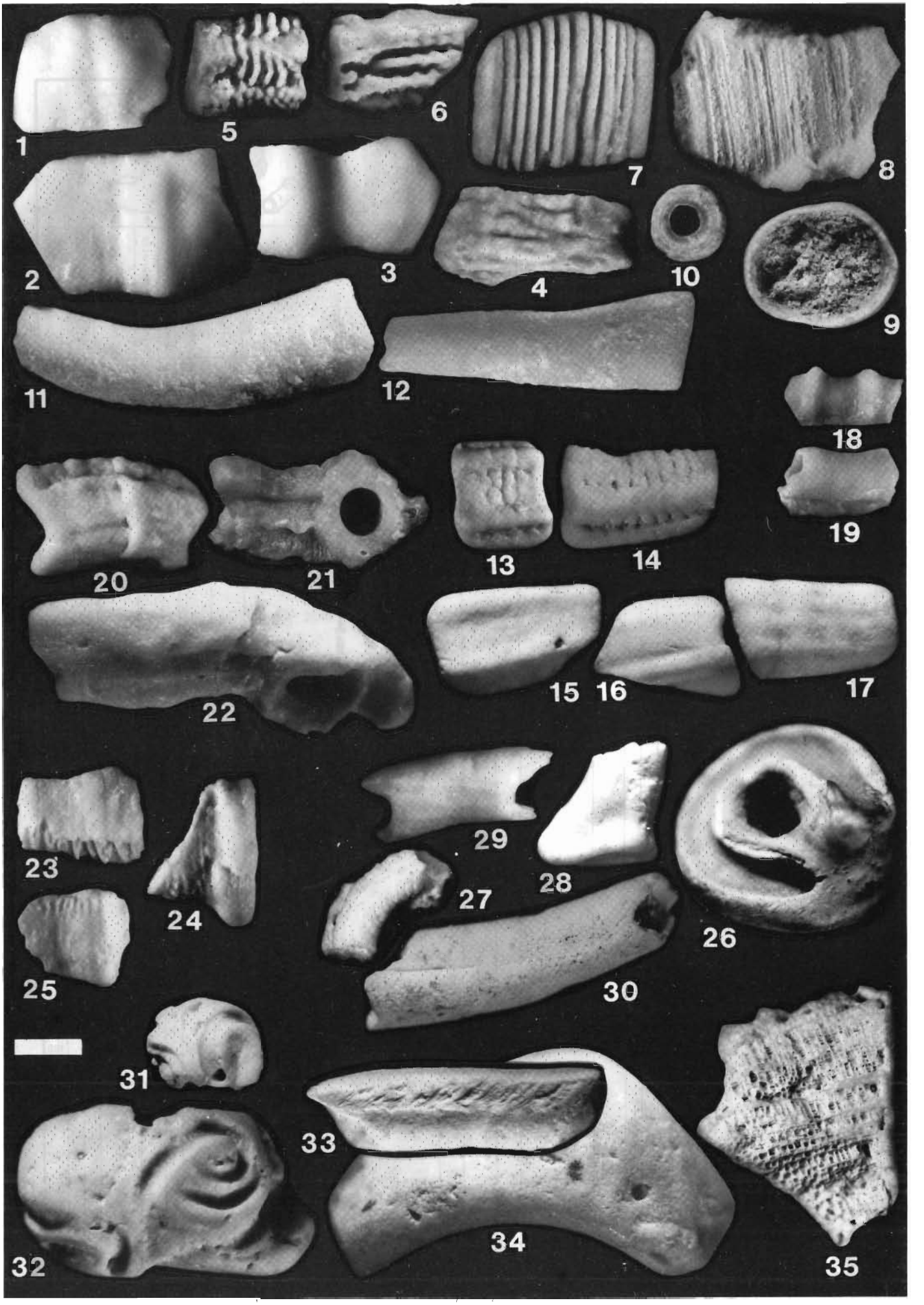
From 110.5 to 100.5 m *Filogranula cincta* (pl. 1, fig. 13-16) is relatively frequent in Thermae 2000, whereas in the ENCI this species seems to be absent in the more or less equivalent Valkenburg Member. The specimens from Thermae 2000 are fixed with a wide base ; peristomes are frequent. This shape closely resembles specimens from shallow water deposits in the boreal Cretaceous of North Germany. This agrees with the paleogeographical position of Valkenburg which was more nearshore than the ENCI.

The higher samples are rather poor. The small double maximum of serpulid specimens between 71.5 and 67.5 m correlates with the « rest group » maxima R1a and R1b in the uppermost Gronsveld Member and in the Schiepersberg Member of the ENCI (cf. P.J. Felder et al. 1985). *S. mosae* becomes the predominant species, although it does not reach its enormous number of specimens as later in the Emael and Nekum Members. There are also fragments of silicified tubes between 70.5 and 95.5 m which may be serpulids. Their main occurrence between 95.5 and 85.5 m matches the occurrence of silicified fossils in the Gronsveld Member of the ENCI (cf. P.J. Felder in Bless et al. 1982). Between 85.5 and 67.5 m the diversity of serpulid species increases with *Parsimonia* cf. *wegneri* (pl. 1, fig. 23-25), *Proliserpula ampullacea* (pl. 2, fig. 23-25) and *Janita?* sp. (pl. 1, fig. 27-30). In other more nearshore localities (Kunrade, Benzenrade) the diversity is much higher in the shallow water deposits of the Kunrade limestone which presumably correlate with the Lanaye to Emael Members of the ENCI.

Above 66,5 m - slightly above the base of the Emael Member - serpulids become more frequent, and the mass occurrence of *S. mosae* begins. In virtually all samples between 66.5 and 48 m fragments of *S. mosae* make up 90 to 100 % of the serpulid assemblages. Obviously *S. mosae* preferred relatively quiet water conditions in comparison to other serpulid species. This means that the water energy in the Emael and part of the Nekum Members was lower than in the overlying Meerssen Member. But especially in the Nekum Member transitory periods of high water energy broke off the tubes and washed these together. It has been noticed that in Thermae 2000 low percentages of ornamented ostracode specimens (indicative of shallow water) correlate with maxima in serpulids (*S. mosae* ; Bless et al. 1986).

In accordance with Bless et al. (1986) the serpulid maximum at 65.0-66.5 m in Thermae 2000 is considered to be the equivalent of the R1c peak of the « rest group » in the ENCI, whereas the maximum at 61-64 m might be the R2 peak and the maximum above 59 m the R3 peak around the boundary between Emael and Nekum Members (Laumont Horizon).

Some other serpulid species occur at these three maxima. First of all *Proliserpula?* sp. (pl. 2, fig. 18-19) and *Sclerostyla* sp. (pl. 2, fig. 13-17) appear. *Proliserpula?* sp. is restricted to the Emael Member in Thermae 2000. At the lower maximum the increase in serpulid diversity is less obvious than the increase in overall faunal diversity. At the second maximum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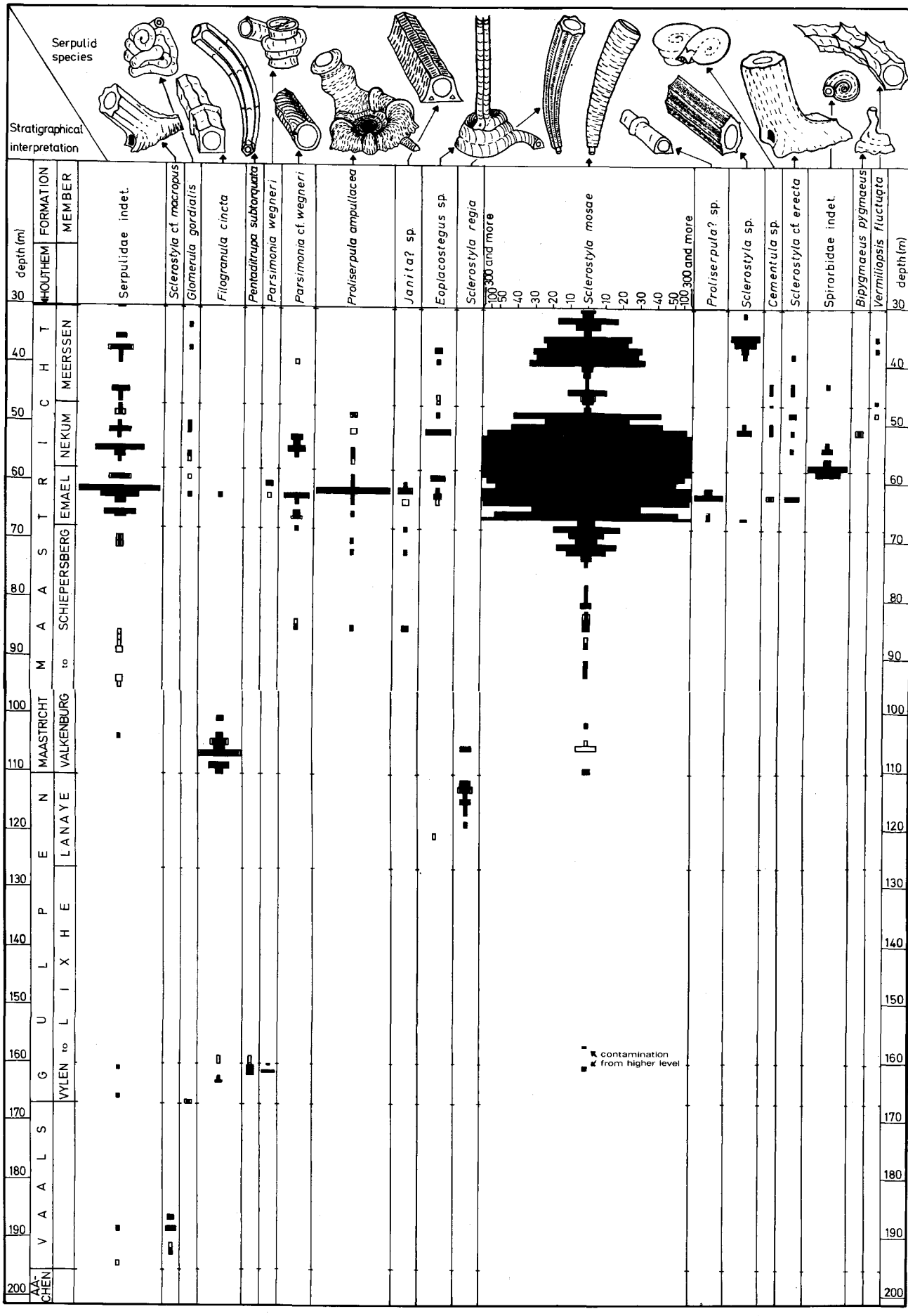
Serpulid species
Stratigraphical interpretation
depth (m)
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MEMBER
HOUTHEM
MAASTRICHT
VALKENBURG
LANAYE
GULPHEN
VYLEN to LIXHE
VAALS
AACHEN
MAASTRICHT to SCHIEPERSBERG
MEERSSEN
NEKUM
EMAEL
Serpulidae indet.
Sclerostyla cf. macropus
Glomerula gordialis
Filogranula cincta
Pentaditrupa subtorquata
Parsimonia wegneri
Parsimonia cf. wegneri
Proliserpula ampullacea
Janita? sp.
Eoplacostegus sp.
Sclerostyla regia
Sclerostyla mosae
Proliserpula? sp.
Sclerostyla sp.
Cementula sp.
Sclerostyla cf. erecta
Spirorbidae indet.
Bipygmaeus pygmaeus
Vermiliopsis fluctuata
100 300 and more
contamination
from higher level

G. gordialis (pl. 1, fig. 18-20), *Filogranula cincta, Parsimonia wegneri* and *Eoplacostegus* sp. (pl. 2, fig. 16-29) re-appear. These are already known from lower horizons. *Cementula* sp. (pl. 2, fig. 31-32) and the very large *Sclerostyla* cf. *erecta* (pl. 1, fig. 33-35) obviously appear for the first time in South-Limburg. Usually, the genus *Cementula* prefers warm, shallow water. This is also true for most *Sclerostyla* species. The three recent species of *Sclerostyla* live today in the Caribbean in water depths between 13 to 100 m (Hove 1973). In the Emael Member of Thermae 2000 *Cementula* sp. and *S.* cf. *erecta* only occur in one sample (62-63 m), but these are more common in the Nekum and Meerssen Members. This shows that life conditions were not always suitable for these species in the Emael Member. But anyhow it also reveals that there was a further gradual change to a more favourable warm water environment.

The third maximum around the Laumont Horizon may be called an oyster layer. Along with numerous specimens of *S. mosae* very small spiral spirorbids (pl. 1, fig. 31), coiled in the right direction in the biological sense, become common. These preferred the oysters as substrate. It has been observed for recent spirorbids that the larvae of some species are capable to select their favourite substrate. Perhaps these benefit from water currents produced by the oysters. Or did they simply choose large objects to protect themselves against sedimentation? In this interval the diversity of serpulids decreases because *P. wegneri, Janita?* sp. and *F. cincta* have disappeared. However, *F. cincta* may occur at the base of the Nekum Member in South-Limburg because it was collected in large numbers at the St. Pieter sports ground in Maastricht by Prof. Voigt (correlation ot those samples needs to be checked as yet). *Hamulus sexcarinatus* occurring as external moulds above the Laumont Horizon in South-Limburg has not been recognized in Thermae 2000.

The lower and middle portion of the Nekum Member in Thermae 2000 still bear large amounts of *S. mosae*, which becomes less frequent in the upper third above 52 m. This agrees with the locations Nekami (P. J. Felder et al. 1985), Kastanjelaan-2 (P. J. Felder 1981) and Blom (Elsen 1985), whereas in the ENCI (P. J. Felder 1981) the lower and upper thirds are rich and the middle part is poor in serpulids. In the upper third of the Nekum Member two more serpulids occur in Thermae 2000 : *Bipygmaeus pygmaeus* (pl. 1, fig. 32) and *Vermiliopsis fluctuata* (pl. 2, fig. 20-22). Both are know already in the Gulpen Formation at other localities in South-Limburg.

At the boundary between Nekum and Meerssen Member (Caster Horizon) *S. mosae* becomes much rarer, whereas the frequency of other serpulids remains more or less constant. Obviously *Sclerostyla* did not like the increasing water energy. There is also a change in morphology of *S. mosae*, because now strongly sculptured specimens are more common than in the underlying maxima. The same is true in the specimens collected from the Meerssen Member at Vroenhoven (Belgium).

Compared with the highly diverse serpulid assemblages collected from borings in the hardground of the Caster Horizon of the ENCI by Prof. Voigt, the serpulid fauna at the boundary between Nekum and Meerssen Members in Thermae 2000 is less diverse. This may be due to the differences in sampling techniques. In the Meerssen Member of Thermae 2000 the three species associated with *S. mosae* below the Emael Member have disappeared almost completely.

Three intervals can be distinguished in the Meerssen Member of Thermae 2000. A lower interval poor in *S. mosae* but with a relatively diverse serpulid fauna 48 and 40 m. A second interval with high numbers of *S. mosae* and still showing a relatively high diversity of serpulids between 40 and 35 m. And an upper interval with a medium frequency of *S. mosae* and a very low diversity between 35 and 30.35 m. Until now this development of the Meerssen Member cannot be correlated with other localities. Maybe the special ecological conditions in the very shallow water of the Meerssen Member changed very quickly from one location to another.

5. HOUTHEM FORMATION

The only sample from the Tertiary Houthem Formation in Thermae 2000 at 30.35-30.25 m contains only two unidentified doubtful serpulid fragments.

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Figure 1. - Occurrence and frequency of different serpulid species in the boring Thermae 2000. A white sign means that the determination is not sure, and in the column « Serpulidae indet. » a white sign means that it is not sure if this specimen belongs to the serpulids at all. The scale of number of specimens in Sclerostyla mosae is also valid for the other species.
Note that the boundary horizons between the Members are interpretations only.
The drawings of the serpulids are schematic only. They show a characteristic view of the species, not individual characters of the specimens found in Thermae 2000.

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