Annales de la Société Géologique de Belgique, T. 115 (fascicule 1) - 1992, pp. 145-157 Juin 1992

CONODONTS AND MEGAFAUNA FROM TWO SECTIONS AT NISMES AND MARIEMBOURG (FRASNIAN OF THE SOUTHERN FLANK OF THE DINANT SYNCLINORIUM, BELGIUM)[1]

by

HELSEN, Stefan[2] & BULTYNCK, Pierre[3]

(7 figures, 5 tables and 3 plates)

ABSTRACT.- Both conodonts and megafaunal associations have been examined from two Frasnian sections at Nismes and Mariembourg (Dinant Synclinorium, Belgium). The recognition of the Late *hassi*?, the *jamieae,* and the Early *rhenana* Conodont Zones (= *Ancyrognathus triangularis* (Ziegler, 1962) and Lower *Palmatolepis gigas* Zones (Ziegler, 1971)) makes it possible to situate both sections in the middle and upper part of the Frasnian. From the base towards the top of the Nismes section there is a deepening of the environment. This can be documented by the conodont biofacies, the megafaunal associations and some lithological characteristics.

RESUME.- Conodontes et associations macrofauniques de deux coupes frasniennes, une à Nismes et une autre à Mariembourg (Synclinorium de Dinant, Belgique) sont étudiés. Les zones à conodontes reconnues, ?la Zone Supérieure à *Palmatolepis hassi*, la Zone à *P. jamieae,* et la Zone Inférieure à *P. rhenana* (= *Zone à Ancyrognathus triangularis* de Ziegler, 1962 et Zone Inférieure à *Palmatolepis gigas* de Ziegler, 1971), permettent de situer les deux coupes dans la partie moyenne et supérieure du Frasnien. Dans la coupe de Nismes l'environnement devient plus profond de la base au sommet. Cet approfondissement est documenté par la succession des biofacies à conodontes, des associations macrofauniques et par quelques caractères lithologiques.

INTRODUCTION

The middle and upper part of the Frasnes Group (Upper Devonian, Frasnian) on the Southern Flank of the Dinant Synclinorium can be subdivided into several lithostratigraphical units, namely the Bieumont Member, followed by the Boussu-en-Fagne Member and its limestone mounds from the Lion Member, then the Neuville Formation and its small bioherms and finally the Matagne Formation (Tsien, 1974).

In the Frasnes type area the characteristic nodular shales from the Neuville Formation are quite different from the older Boussu-en-Fagne Member and the younger Matagne Formation. However, towards the east in the Nismes area, the nodular aspect is disappearing progressively, resulting in a calcareous shale - clayey limestone alternation. Consequently, lithological correlations from sections around Nismes with the type area are often difficult. Conodonts and some megafossils have been used to solve these problems.

GEOGRAPHICAL SITUATION AND LITHOSTRATIGRAPHY

The sections at Nismes and Mariembourg are located approximately 6 km northeast of Couvin.

1.- Manuscrit reçu le 20 mars 1991.

2.- Instituut voor Aardwetenschappen, Redingenstraat 16, B-3000 Leuven.

3.- Koninklijk Belgisch Instituut voor Natuurwetenschappen, Vautierstraat 29, B-1040 Brussels.

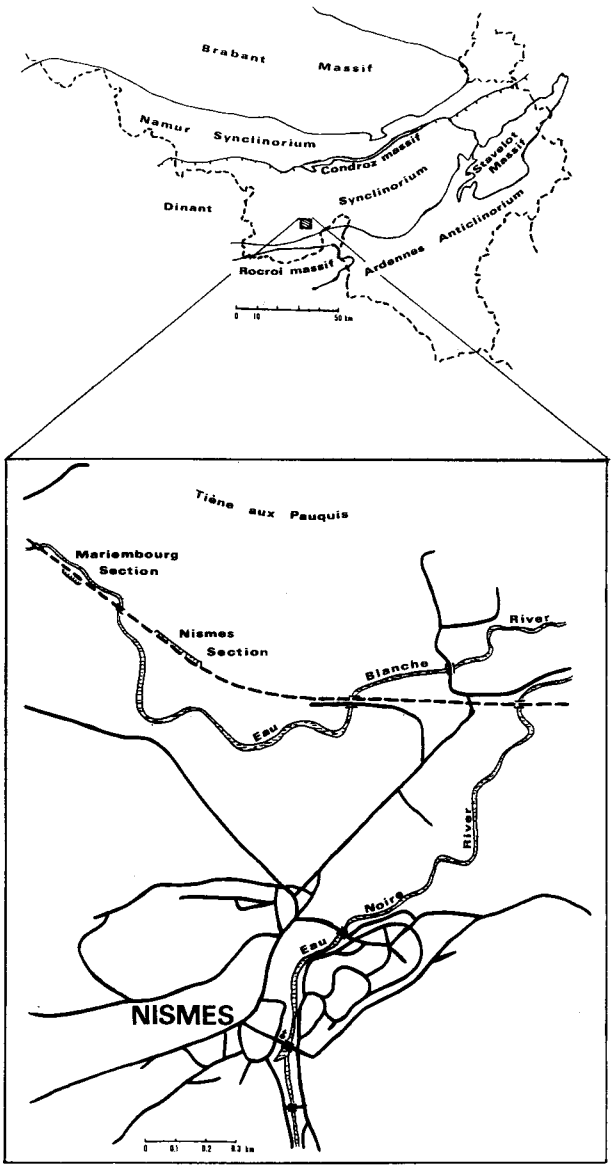


Fig. 1.- Location of the studied area

Both sections are exposed along the railway from Mariembourg to Olloy-sur-Viroin (Figs. 1-4). They have already been described by Mailleux (1913) and Mouravieff (1970). In the lowest part of the Nismes section, we recognized an alternation of limestones and calcareous shales. It has been assigned in the present study to the Neuville Formation although with some doubt, as there are no important nodular shaley lithologies apparent. Within this formation three members have been recognized. Member A consists of an alternation of limestones and shales. Member B is a bedded limestone sequence with a massive limestone lens in its middle part. Member C is characterized by limestone beds with some shaley interlayering. The succession is completed by dark and fine shales, interrupted by a few dark thin bedded or nodular limestone horizons. The base of the Matagne Formation has been taken at the first important appearance of the fine shales (Fig. 5). The Mariembourg section shows nodular shales in outcrop, a lithology which corresponds very well to the Neuville Formation in the Frasnes area (Fig. 6).

CONODONT ZONATION

In the present paper the most recent Frasnian conodont zonation of Ziegler and Sandberg (1990) has been used (Fig. 5). The lowest part of the succession at Nismes (bed 1-8), may correspond to the Late *hassi* Zone by its stratigraphical position below the earliest occurrence of *Palmatolepis jamieae* and according to the occurrence of *Palmatolepis hassi* in conodont sample C2 and of *Palmatolepis plana* in sample C1. The first *Palmatolepis jamieae* specimens, characteristic for the *jamieae* Conodont Zone, were recovered from bed 9 (C2B-3A). The first appearance of

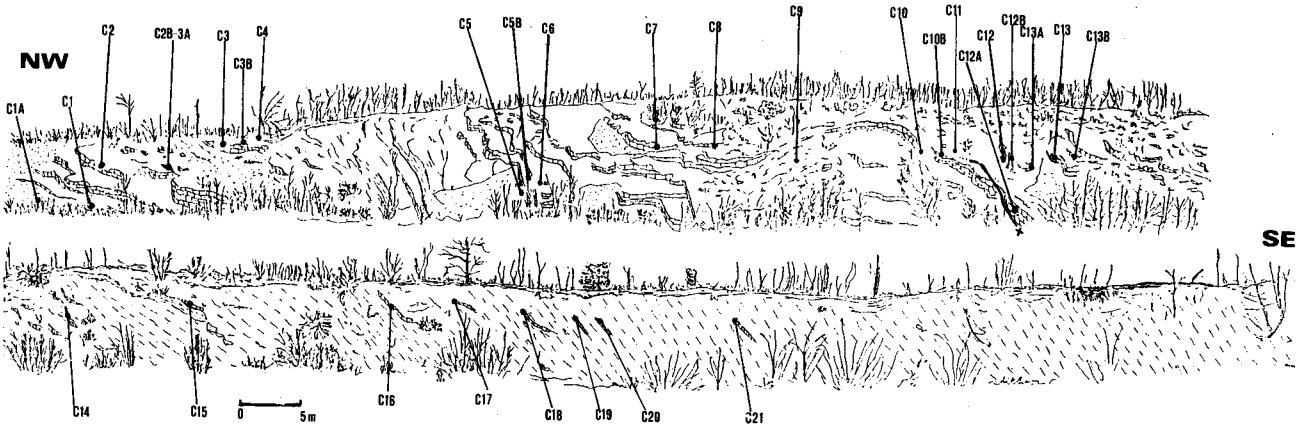


Fig. 2.- Sketch of the Nismes section

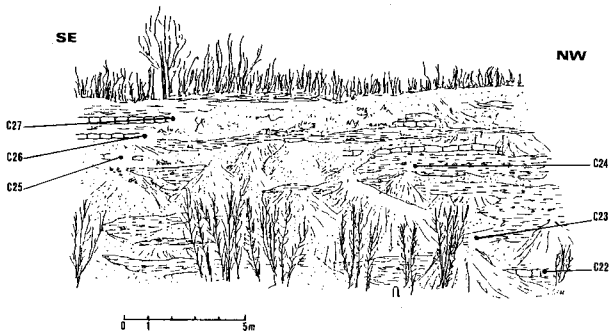


Fig. 3.- Sketch of the Mariembourg section

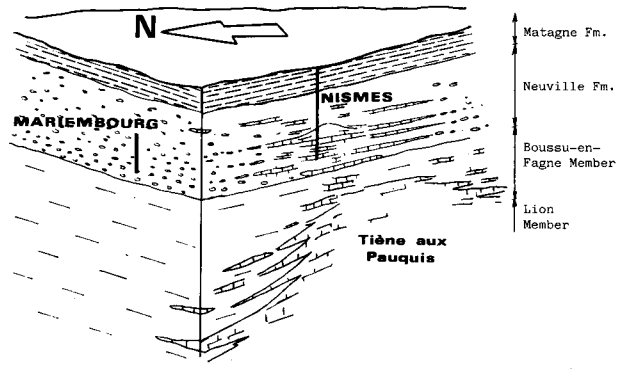


Fig. 4.- Middle and Upper Frasnian lithostratigraphical units in the Nismes-Mariembourg area

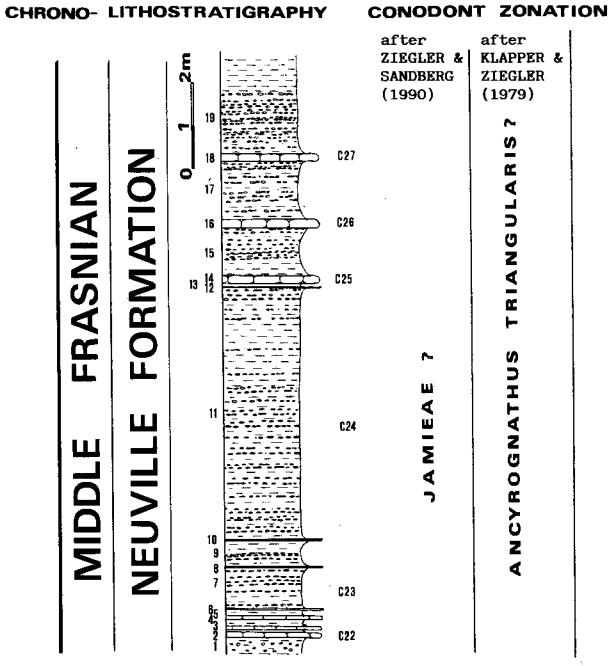


Fig. 6.- Chrono-, litho- and conodont biostratigraphy of the Mariembourg section

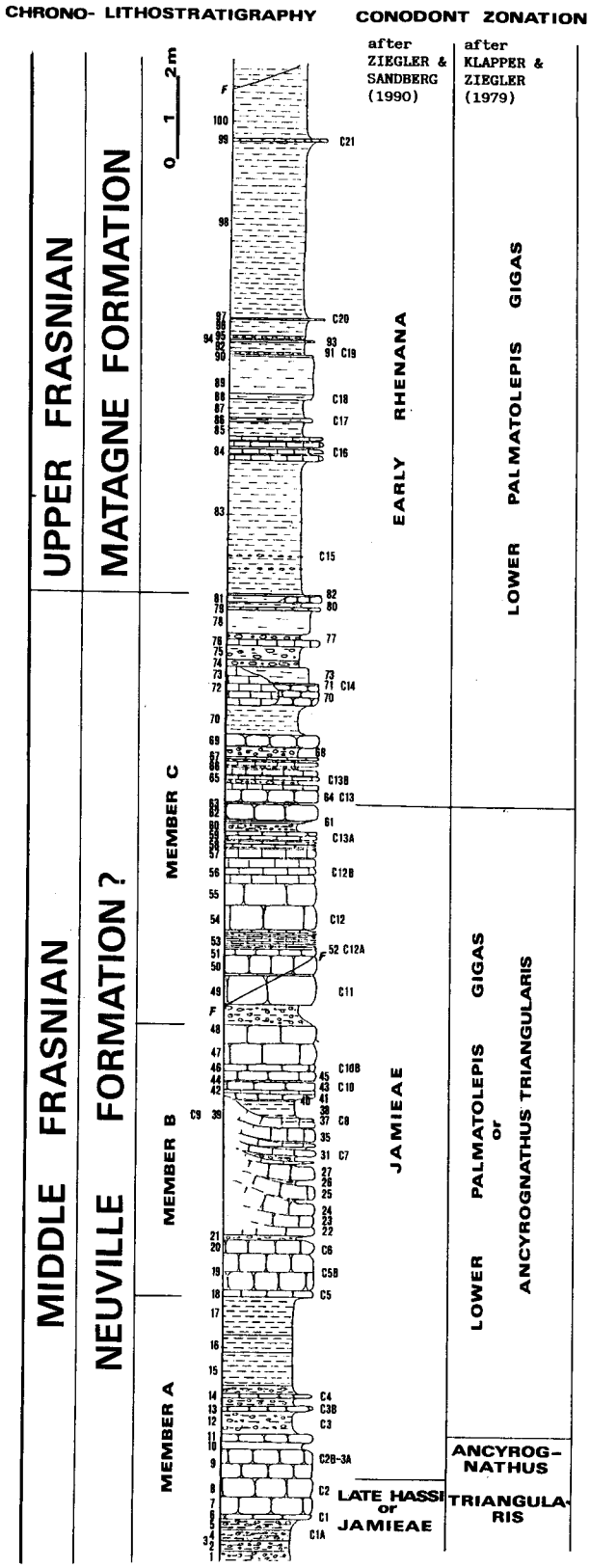
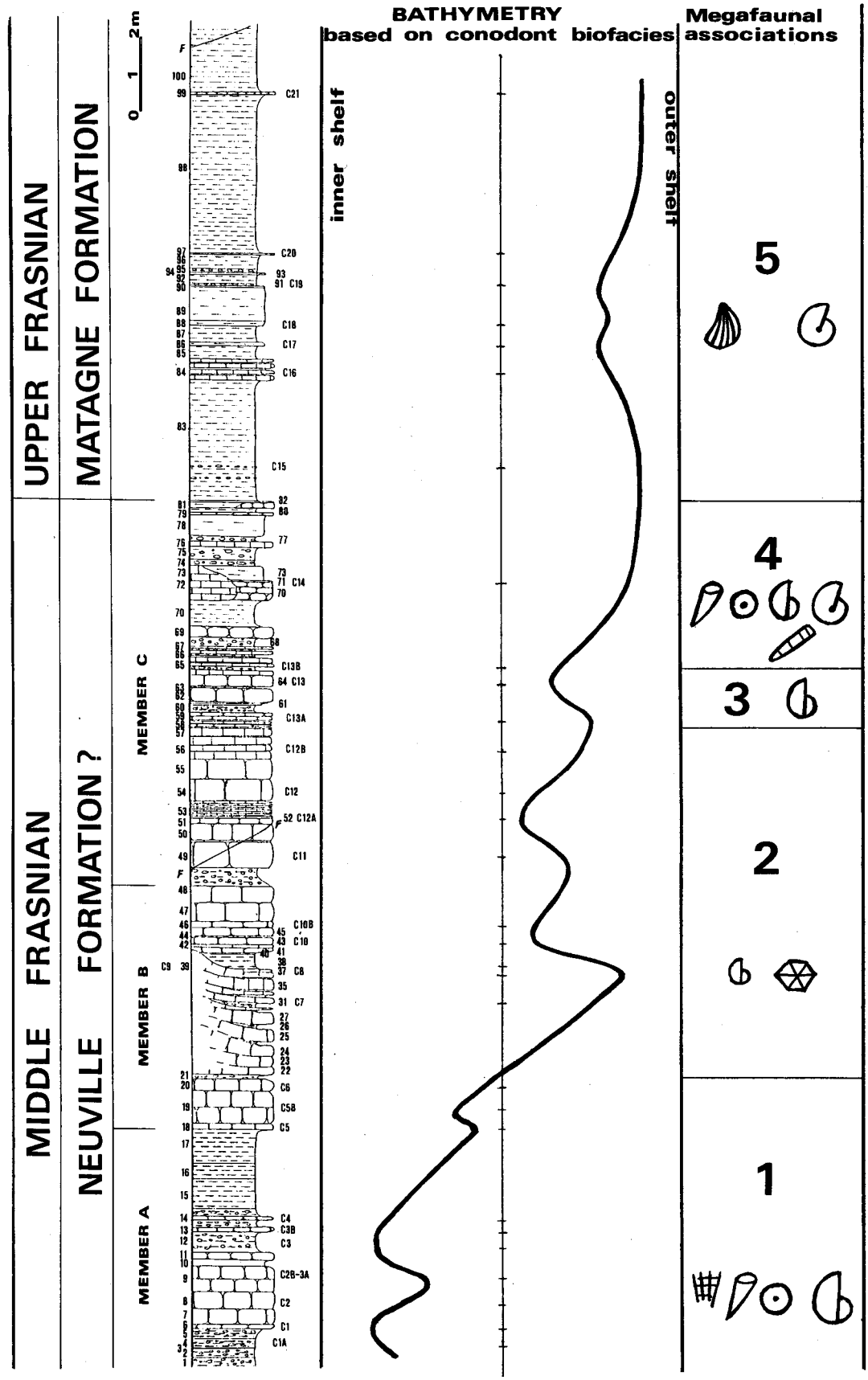


Fig. 5.- Chrono-, litho- and conodont biostratigraphy of the Nismes section



Buchiola – Goniatites – Orthocones – Crinoids – Solitary Rugosa – Colonial Rugosa – Bryozoa – Brachiopods.

Fig. 7

	C1A	C1	C2	C2B-3A	C3	C3B	C4	C5	C5B	C6	C7	C8	C9	C10	C10B	C11	C12A	C12	C12B	C13A	C13	C13B	C14	C15	C16	C17	C18	C19	C20	C21
Ancyrodella (Pa)	0	0	2	3	5	0	0	0	4	3	0	3	1	0	6	0	1	2	4	0	3	7	41	0	127	72	2	13	5	0
curvata	0	0	1	3	0	0	0	0	1	0	0	2	1	0	2	0	1	0	2	0	1	4	5	0	80	26	0	7	4	0
gigas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	10	10	0	0	0	0
ioides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0
lobata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	10	0	1	0	0	0
nodosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	24	0	1	8	0	5	0	0
sp.A	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
sp.	0	0	1	0	4	0	0	0	3	2	0	1	0	0	3	0	0	0	1	0	0	1	11	0	26	27	1	1	1	0
Ancyrognathus (Pa)	3	1	3	49	4	0	3	0	2	0	0	0	0	0	2	2	4	4	33	0	36	11	144	3	145	12	1	2	0	0
seddoni	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
irregularis	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
triangularis	0	0	0	27	0	0	0	0	1	0	0	0	0	0	1	2	3	1	19	0	24	6	112	3	83	2	0	2	0	0
tsiensi	2	1	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	0	0	0	0
sp.	1	0	2	22	0	0	2	0	1	0	0	0	0	0	1	0	1	3	14	0	12	5	42	0	58	4	1	0	0	0
Palmatolepis (Pa)	8	11	2	174	0	0	1	7	4	14	0	145	2	21	31	13	14	29	97	0	69	27	615	15	455	235	6	34	32	0
foliacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	11	0	0	0	0	0
gigas gigas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
gigas paragigas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0
gigas ssp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
hassi	0	0	1	32	0	0	1	3	0	5	0	10	1	8	8	4	5	5	28	0	29	7	155	1	5	51	3	14	7	0
jamieae	0	0	0	10	0	0	0	0	0	2	0	11	0	0	4	2	0	1	6	0	1	3	25	2	10	7	0	0	0	0
plana	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
proversa	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
punctata	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
rhenana nasuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0	0
cf. *rhenana*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
simpla	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
sp. + juvenile	3	7	1	132	0	0	0	4	4	6	0	122	1	12	17	7	9	23	56	0	38	17	434	11	422	172	3	20	25	0

Table 1 -- Conodont distribution in the Nismes section (Pa-elements of the genera *Ancyrodella*, *Ancyrognathus* and *Palmatolepis*). The distribution of the Pa-elements of the genera *Polygnathus* and *Icriodus* and the M- and S-elements is shown in Table 2.

	C1A	C1	C2	C2B-3A	C3	C3B	C4	C5	C5B	C6	C7	C8	C9	C10	C10B	C11	C12A	C12	C12B	C13A	C13	C13B	C14	C15	C16	C17	C18	C19	C20	C21
Polygnathus (Pa)	35	12	85	63	4	9	3	5	34	16	0	14	12	13	15	6	12	23	28	0	89	3	52	0	1278	287	11	144	32	1
aequalis	6	1	3	12	0	1	0	0	3	2	0	0	0	1	1	0	0	1	2	0	7	0	3	0	65	6	0	2	0	0
alatus	0	1	7	5	0	0	1	0	0	2	0	0	0	0	0	0	0	2	0	0	1	0	0	0	2	2	0	1	0	0
angustidiscus	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	1	0	0	0	0	0
brevis	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
aff. *brevis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
independensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
webbi	8	3	11	6	0	0	0	0	1	1	0	2	3	2	1	1	1	2	5	0	8	0	6	0	69	5	0	10	0	0
xylus group	8	2	7	19	2	0	0	1	17	5	0	5	3	4	5	0	4	11	6	0	22	1	8	0	828	201	6	98	30	0
sp. A	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
sp. B	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
sp. + juvenile	13	5	57	20	2	4	2	4	11	6	0	7	6	6	8	5	7	7	12	0	28	2	35	0	306	72	5	3	2	1
Icriodus (Pa)	1	1	2	20	0	1	0	1	1	8	1	3	1	15	9	0	6	2	14	0	192	4	12	0	4223	181	1	22	1	0
alternatus	0	0	0	6	0	0	0	0	0	1	0	0	1	1	1	0	4	0	7	0	70	2	1	0	101	120	0	0	0	0
expansus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
aff.*expansus*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
symetricus	1	0	2	4	0	1	0	1	0	0	0	2	0	0	0	0	0	0	1	0	10	1	0	0	778	125	1	12	0	0
sp. A	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	1225	4	0	0	0	0
sp. B	0	0	0	9	0	0	0	0	1	0	1	1	0	13	8	0	2	2	2	0	53	1	4	0	557	7	0	0	1	0
sp.	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	51	0	7	0	1563	33	0	10	0	0
M-elements	0	0	1	3	0	0	0	1	5	5	0	4	13	15	58	0	14	6	18	0	14	7	38	0	309	14	0	7	4	0
Pb- and S-elements	30	35	114	207	19	3	10	13	43	15	3	53	27	57	84	25	33	61	178	0	354	62	419	7	3268	782	28	197	72	5
Sample weight, kg	1.4	1.3	2.0	4.0	1.5	1.6	1.7	2.0	1.9	2.0	2.0	1.5	2.3	2.5	2.2	2.5	2.2	2.4	2.3	2.2	2.3	2.2	2.4	1.2	2.5	3.8	2.8	2.2	2.3	1.5

Table 2 -- Conodont distribution in the Nismes section (Pa-elements of the genera *Polygnathus* and *Icriodus*, M- and S-elements).

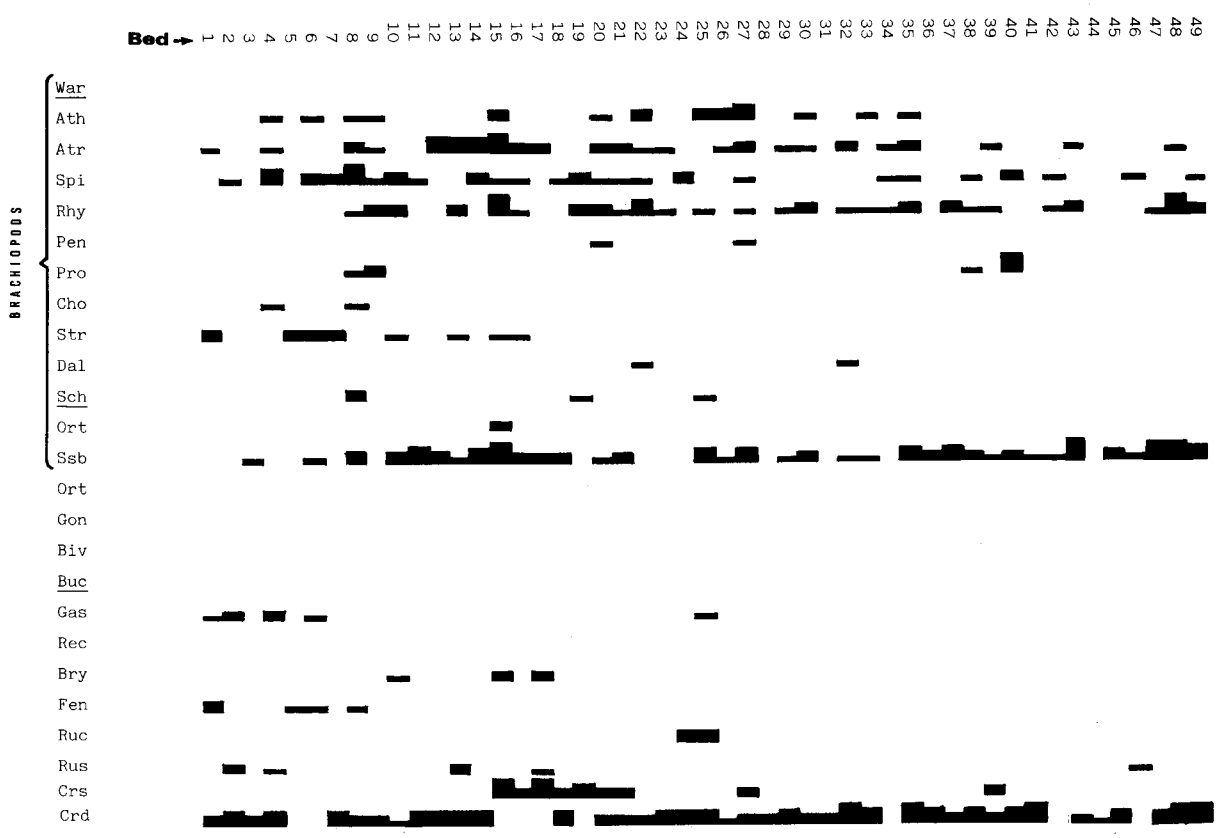


Table 3a -- Megafaunal distribution in the Nismes section, bed 1-49.

War: Warrenella - Ath: Athyridacea - Atr: Atrypacea - Spi: Spiriferidina - Rhy: Rhynchonellida - Pen: Pentamerida - Pro: Productidae - Cho: Chonetidae Str: Strophéodontidae - Dal: Dalmanellidae - Sch: Schizophoria - Ort: Orthidina - Ssb: Small smooth shelled brachiopods - Ort: Orthocones - Gon: Goniatites - Biv: Bivalves - Buc: Buchiola - Gas: Gastropods - Rec: Receptaculites - Bry: Bryozoa - Fen: Fenestellids - Ruc: Colonial rugose corals - Rus: Solitary rugose corals - Crs: Crinoid stems - Crd: Crinoid debris. dominant or very frequent; frequent; present; scarce

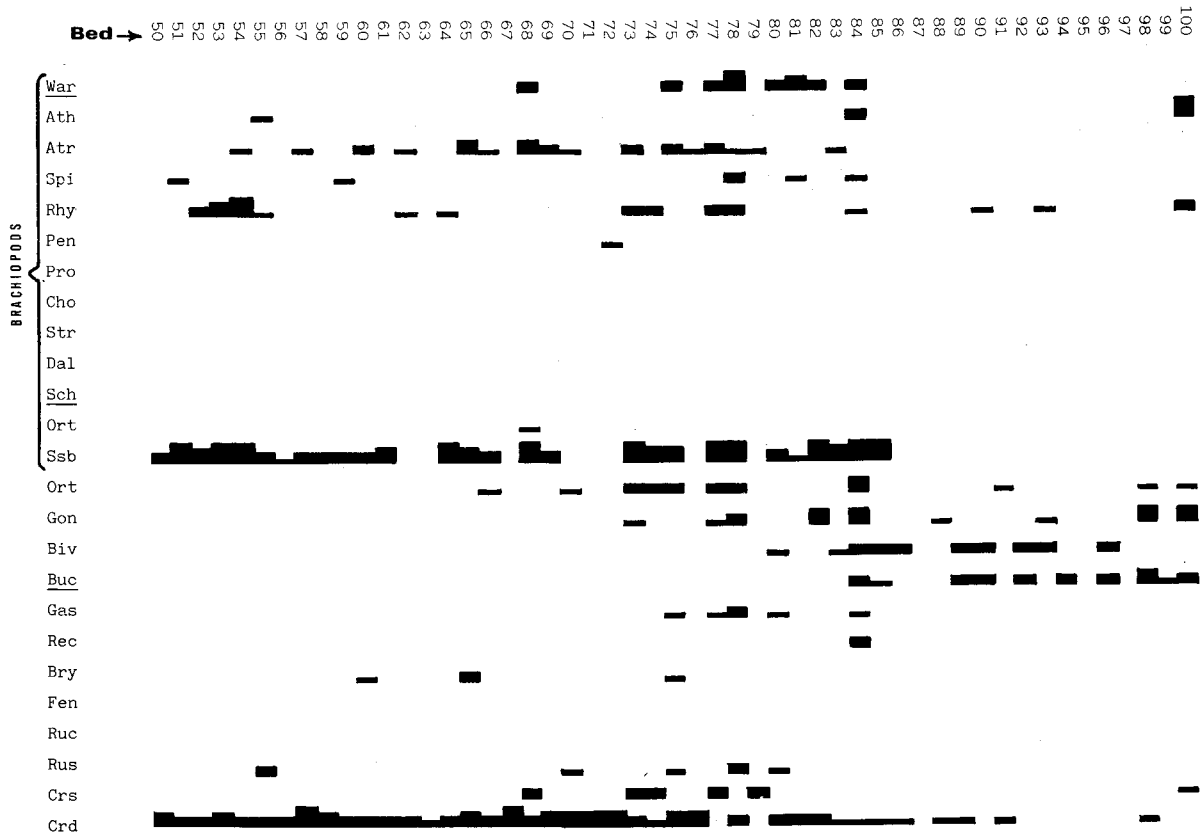


Table 3b -- Megafaunal distribution in the Nismes section, bed 50-100.

War: Warrenella - Ath: Athyridacea - Atr: Atrypacea - Spi: Spiriferidina - Rhy: Rhynchonellida - Pen: Pentamerida - Pro: Productidae - Cho: Chonetidae Str: Strophéodontidae - Dal: Dalmanellidae - Sch: Schizophoria - Ort: Orthidina - Ssb: Small smooth shelled brachiopods - Ort: Orthocones - Gon: Goniatites - Biv: Bivalves - Buc: Buchiola - Gas: Gastropods - Rec: Receptaculites - Bry: Bryozoa - Fen: Fenestellids - Ruc: Colonial rugose corals - Rus: Solitary rugose corals - Crs: Crinoid stems - Crd: Crinoid debris. dominant or very frequent; frequent; present; scarce

	C22	C23	C24	C25	C26	C27
Ancyrodella (Pa)	0	0	0	0	1	0
sp.	0	0	0	0	1	0
Ancyrognathus (Pa)	0	1	0	0	0	0
triangularis	0	1	0	0	0	0
Palmatolepis (Pa)	0	0	0	0	0	3
hassi	0	0	0	0	0	1
sp.	0	0	0	0	0	2
Polygnathus (Pa)	1	0	0	4	14	14
aequalis	0	0	0	0	0	1
webbi	0	0	0	1	0	2
xylus group	0	0	0	0	9	0
sp.	1	0	0	3	5	11
Icriodus (Pa)	0	1	0	1	4	2
aff.*expansus*	0	0	0	0	0	1
symmetricus	0	0	0	1	4	0
sp. A	0	0	0	0	0	1
sp. B	0	1	0	0	0	0
M-elements	0	0	0	0	1	1
Pb- and S-elements	5	0	0	9	57	18
sample weight, kg	1.3	1.0	0.6	2.1	2.2	2.2

Table 4 -- Conodont distribution in the Mariembourg section.

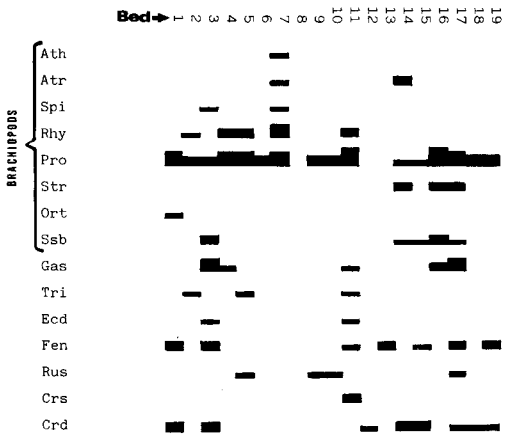


Table 5 -- Megafaunal distribution in the Mariembourg section.

Ath: Athyridae - Atr: Atrypacea - Spi: Spiriferidina - Rhy: Rhynchonellida - Pro: Productidae - Str: Strophodontidae - Ort: Orthidina - Ssb: Small smooth shelled brachiopods - Gas: Gastropods - Tri: Trilobites - Ecd: Echinoid debris - Fen: Fenestellids - Rus: Solitary rugose corals - Crs: Crinoid stems - Crd: Crinoid debris.

dominant or very frequent — frequent — present — scarce

Palmatolepis rhenana nasuta in bed 64 (C13) indicates the lower boundary of the Early *rhenana* Conodont Zone. The base of the Early *rhenana* Zone is within the Neuville Formation and does not conform to the Matagne Formation boundary. Samples from the railway cut at Mariembourg are scarce in Palmatolepids, which implies some uncertainties about their position in the Standard Conodont Zonation (*jamieae* Zone?, Fig. 6). Besides the recent conodont succession (Ziegler & Sandberg, 1990), figure 5 also shows the former zonation, which is not only based on Palmatolepid conodonts (Klapper & Ziegler, 1979). Using those two conodont zonations in the Nismes section completely independant from each other, we found similar correlation results.

CONODONT BIOFACIES AND MEGAFAUNAL ASSOCIATIONS

In this study the facies dependence of conodonts throughout the Nismes section has also been examined. In the Mariembourg section conodonts are not frequent enough to be used for biofacies analyses. By means of conodont genera ratios we recognized at Nismes two biofacies which conform to the deeper marine *Palmatolepis* and the relatively shallow *Polygnathus-Icriodus* biofacies. According to Druce (1976) and Klapper and Lane (1985) *Icriodus symmetricus* belongs to the deeper *Palmatolepis* instead of the *Icriodus* biofacies. As shown in Fig. 7 all the different conodont biofacies were interpreted as an alternation of deeper and more shallow marine deposits. In addition, a similar alternation may be seen in the megafaunal distribution. It was possible to recognize five different associations. In the interval C1-C6 we mainly found bryozoans, rugose corals (both colonial and solitary forms), brachiopods and long crinoid stems (up to 25 cm), reflecting a calm marine environment.

The second interval corresponds to the massive limestone core and its lateral facies. According to the *Palmatolepis* conodont biofacies, this mound developed in a relatively deep environment. Megafossils are represented by some small brachiopods, rugose corals and crinoid debris.

The next interval from which a poor brachiopod fauna was recovered, is relatively thin and considered to represent a shallow environment, according to the abundance of *Icriodus* in sample C13.

The fourth interval with the conodont sample C14 is the start towards a general deepening of the basin. In here, a lot of brachiopods, crinoids and some solitary rugose corals were found. New in this interval are the cephalopods (goniatites and orthocones) and bivalves. The scarcity of rugose

corals in interval 1-4 may be controlled by depositional factors. The open marine side of a carbonate build-up is always scarce in Rugosa (similar to biotope 7, Copper, 1966). Finally, the fifth megafaunal association has been found in the Matagne Shales. Tentaculites, cephalopods and especially the bivalves are very abundant, while brachiopods and crinoids become less important. Fish scales and fish teeth fragments common in the heavy fraction in interval 1-4 are of no significance in interval 5. This interval conforms to the conodont samples C15-C21 and the top of the upwards deepening curve. The four dark limestone beds, grouped together in unit nr.84 are very rich in *Icriodus* (C16). They may be an equivalent of the German Lower Kellwasser Limestone as besides their age the fossils and lithologies correspond quite well.

In the Mariembourg section megafossils are mainly represented by brachiopods, bryozoans and some rugose corals. Less important are gastropods, trilobites, crinoid and echinoid debris. We did not recognize any analogue association from the nearby Nismes section.

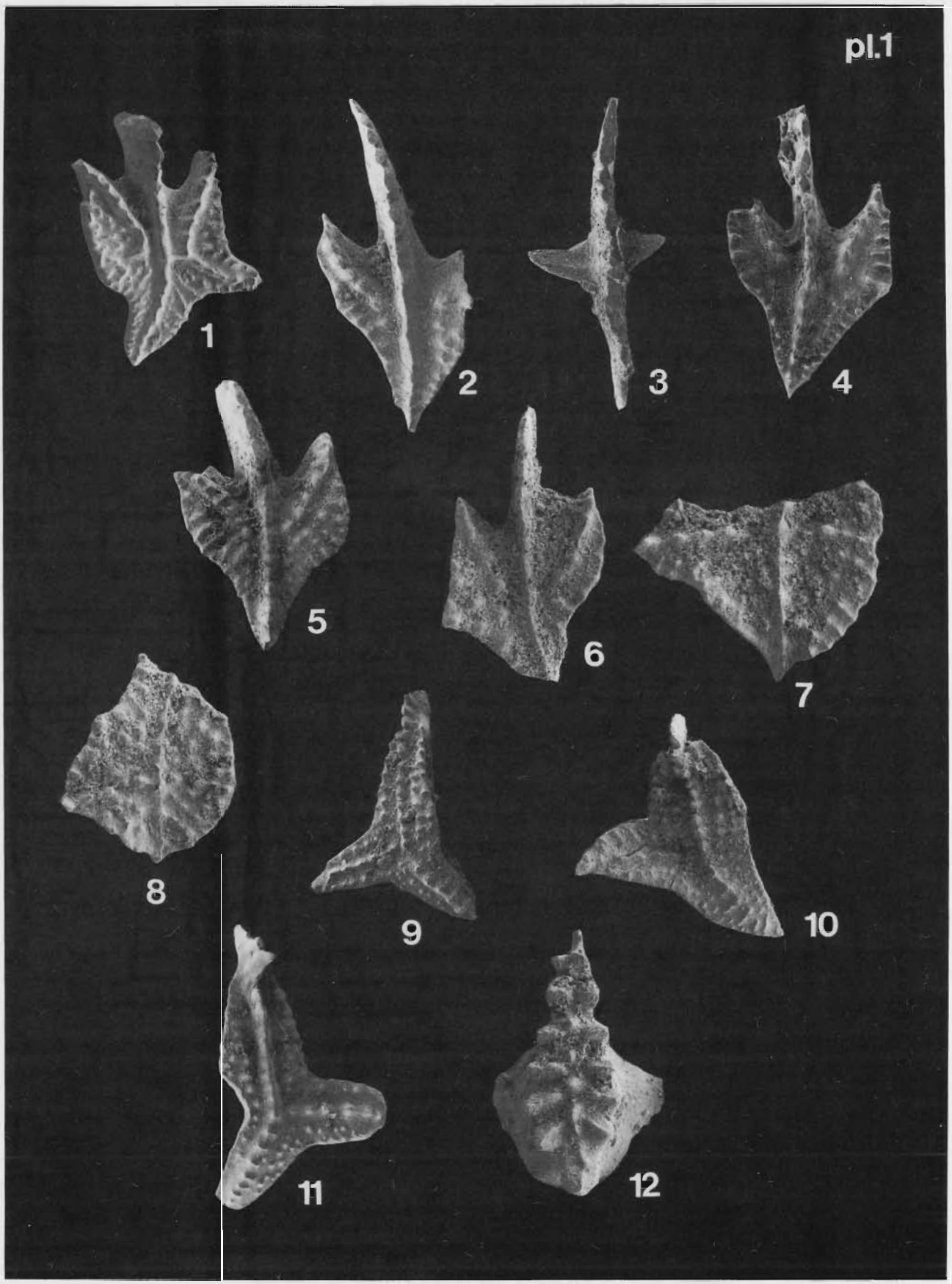
CONCLUSIONS

The lower part of the succession in the Nismes section was probably deposited in a relatively shallow open marine environment. Later, starting from bed 20 on, there has been a deepening of the basin, in which a small mound could develop. In the upper part of the section (starting from bed 83) we recognized a change into an anoxyc environment (dark shales, presence of pyrite, etc.) where almost no benthonic organisms could survive. This

PLATE 1

All original specimens, figured on Plates 1-3, are reposited at the Department of Paleontology of the Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels, Belgium, under catalogue numbers b2426-b2464.

1. *Ancyrodella curvata* Branson & Mehl, 1933; b2426; upper view, x 36; Early *rhenana* Zone; C16, Nismes.
2. *Ancyrodella gigas* Youngquist, 1947; b2427; upper view, x 41; Early *rhenana* Zone; C16, Nismes.
3. *Ancyrodella ioides* Ziegler, 1958; b2428; upper view, x 82; *jamieae* Zone; C12, Nismes.
4. *Ancyrodella lobata* Branson & Mehl, 1934; b2429; upper view, x 53; Early *rhenana* Zone; C16, Nismes.
5. *Ancyrodella nodosa* Ulrich & Bassler, 1926; b2430; upper view, x 30; Early *rhenana* Zone; C17, Nismes.
6. *Ancyrodella* sp. A.; b2431; upper view, x 52; *jamieae* Zone; C6, Nismes.
7. *Ancyrognathus seddoni* Ziegler & Sandberg, 1990; b2432; upper view, x 52; *jamieae* Zone; C3, Nismes.
8. *Ancyrognathus irregularis* Branson & Mehl, 1934; b2433; upper view, x 46; *jamieae* Zone; C3, Nismes.
9. *Ancyrognathus triangularis* Youngquist, 1945; b2434; upper view, x 42; Early *rhenana* Zone; C16, Nismes.
10. *Ancyrognathus triangularis* Youngquist, 1945; b2435; upper view, x 41; Early *rhenana* Zone; C16, Nismes.
11. *Ancyrognathus tsiensi* Mouravieff, 1982; b2436; upper view, x 39; Early *rhenana* Zone; C16, Nismes.
12. *Icriodus expansus* Branson & Mehl, 1938; b2437; upper view, x 59; Late *hassi* or *jamieae* Zone; C1, Nismes.


pl.1
1
2
3
4
5
6
7
8
9
10
11
12

may have been the result of a continuous deepening of the basin. The succession in the Mariembourg section is considered to represent a more shallow depositional environment, as we only found benthonic elements. As the deeper water *Palmatolepis* biofacies is not continuously represented in the section at Nismes and not represented at Mariembourg, precise correlations with the Upper Devonian Conodont Standard Zonation are not always possible. In fact, the Upper Devonian Conodont Standard Zonation we discussed above, has been established mainly in Nevada and Germany where deeper marine facies occur. Consequently, for the studied area the new zonation of Ziegler and Sandberg (1990), only based on Palmatolepids, does not provide significantly better biostratigraphical results than the former zonation.

BIBLIOGRAPHY

COPPER, P., 1966.- Ecological distribution of Devonian Atrypid Brachiopods - *Palaeogeography, Palaeoclimatology, Palaeoecology,* Kingston, 3 : 363-379.

DRUCE, E.C., 1973.- Upper Paleozoic and Triassic Conodont Distribution and the Recognition of Biofacies - *Geological Society of America special paper,* Boulder, 141 : 191-237.

KLAPPER, G. & LANE, H.R., 1985.- Upper Devonian (Frasnian) conodonts of the *Polygnathus* biofacies, N.W.T., Canada - *Jour. of Paleont.,* Tulsa, 59, 4 : 904-951.

KLAPPER, G. & ZIEGLER, W., 1979.- Devonian conodont biostratigraphy - *in Devonian System: special papers in Paleontology,* the Paleontological Association, London, 23 : 199-224.

MAILLEUX, E., 1913.- Quelques mots sur les récifs frasniens de la plaine des Fagnes, entre Nismes et Chimay - *Bull. Soc. belge Géol.,* Bruxelles, 27 : 113-126.

MOURAVIEFF, A.N., 1970.- Conodontes du Frasnien de la Belgique. Biostratigraphie et aspects écologiques - Université Catholique de Louvain, unpubl. Ph.D. dissertation; Leuven.

TSIEN, H.-H., 1974.- Paleoecology of Middle Devonian and Frasnian in Belgium - *International Symposium on Belgian Micropaleontological Limits,* Brussels, 12 : 53 p.

ZIEGLER, W., 1962.- Taxionomie und Phylogenie Oberdevonischer Conodonten und ihre stratigraphische Bedeutung - *Hessisches Landesamt Bodenforschung Abhandlungen,* Wiesbaden, 38 : 166 p.

ZIEGLER, W., 1971.- Conodont stratigraphy of the European Devonian, *in:* Sweet, W.C., and Bergström, S.M., (eds.), Symposium on conodont biostratigraphy - *Geological Society of America Memoir,* Boulder, 127 : 227-284.

ZIEGLER, W. & SANDBERG, C.A., 1990.- The Late Devonian Standard Conodont Zonation - *Courier Forsch.-Inst. Senckenberg,* Frankfurt a.M. 121 : 115 p.

PLATE 2

1. *Icriodus alternatus* Branson & Mehl, 1934; b2438; upper view, x 110; Early *rhenana* Zone; C16, Nismes.
2. *Icriodus* sp. A; b2439; upper view, x 89; Early *rhenana* Zone; C16, Nismes.
3. *Icriodus* sp. B; b2440; upper view, x 107; Early *rhenana* Zone; C16, Nismes.
4. *Icriodus symmetricus* Branson & Mehl, 1934; b2441; upper view, x 92; Early *rhenana* Zone; C16, Nismes.
5. *Polygnathus aequalis* Klapper & Lane, 1985; b2442; upper view, x 41; Early *rhenana* Zone; C16, Nismes.
6. *Polygnathus alatus* Huddle, 1934; b2443; upper view, x 39; Late *hassi* or *jamieae* Zone; C2, Nismes.
7. *Polygnathus angustidiscus* Youngquist, 1945; b2444; upper view, x 48; Early *rhenana* Zone; C13, Nismes.
8. *Polygnathus brevis* Miller & Youngquist, 1947; b2445; upper view, x 74; Early *rhenana* Zone; C17, Nismes.
9. *Polygnathus* aff. *brevis* Miller & Youngquist, 1947; b2446; upper view, x 66; Early *rhenana* Zone; C16, Nismes.
10. *Polygnathus independensis* Müller & Müller, 1957; b2447; upper view, x 36; Early *rhenana* Zone; C16, Nismes.
11. *Polygnathus webbi* Stauffer, 1938; b2448; upper view, x 50; *jamieae* Zone; C8, Nismes.
12. *Polygnathus xylus* Stauffer, 1940; b2449; upper view, x 85; Early *rhenana* Zone; C16, Nismes.
13. *Polygnathus* sp. A; b2450; upper view, x 61; Early *rhenana* Zone; C16, Nismes.
14. *Polygnathus* sp. B; b2451; upper view, x 46; Early *rhenana* Zone; C16, Nismes.

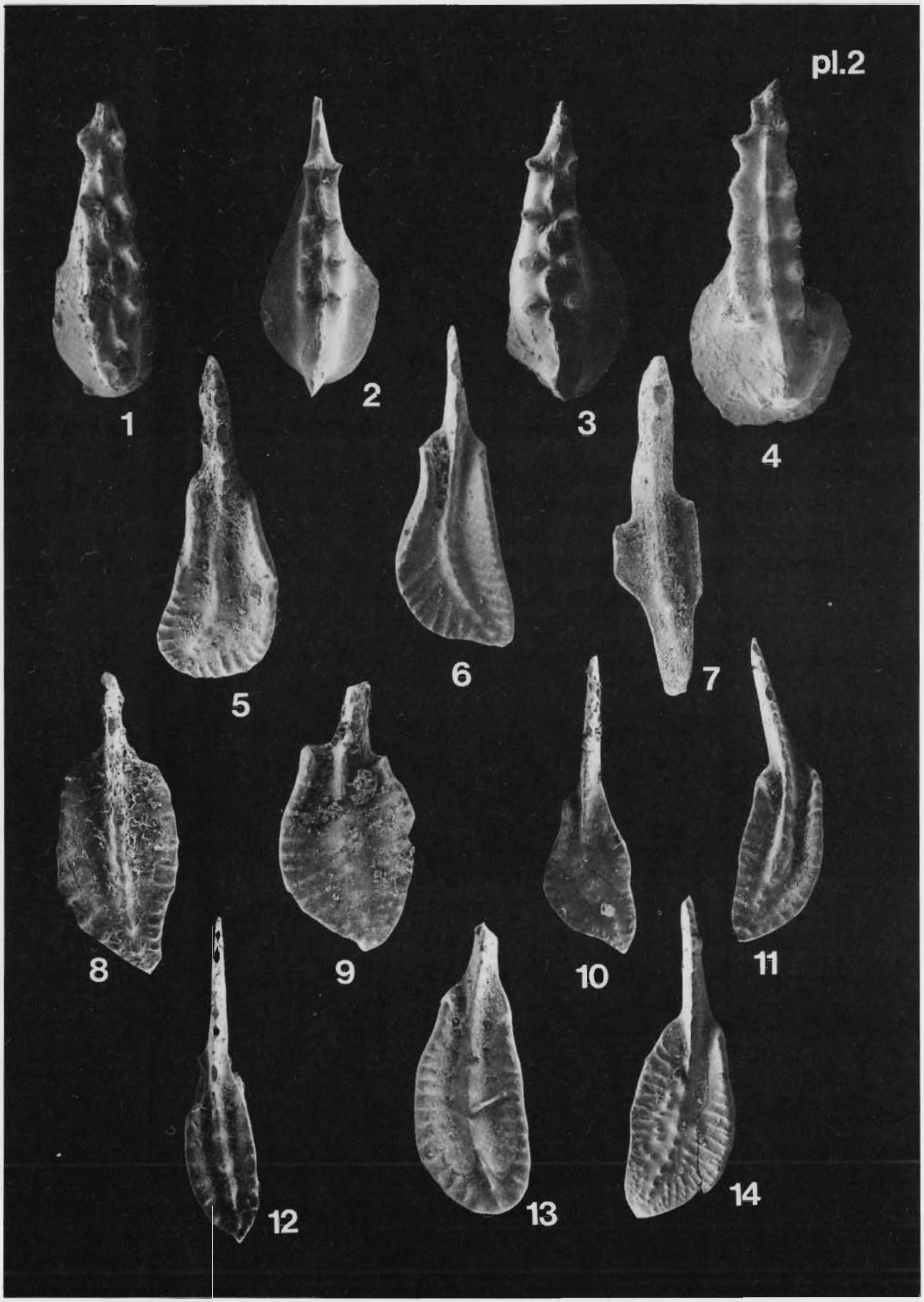
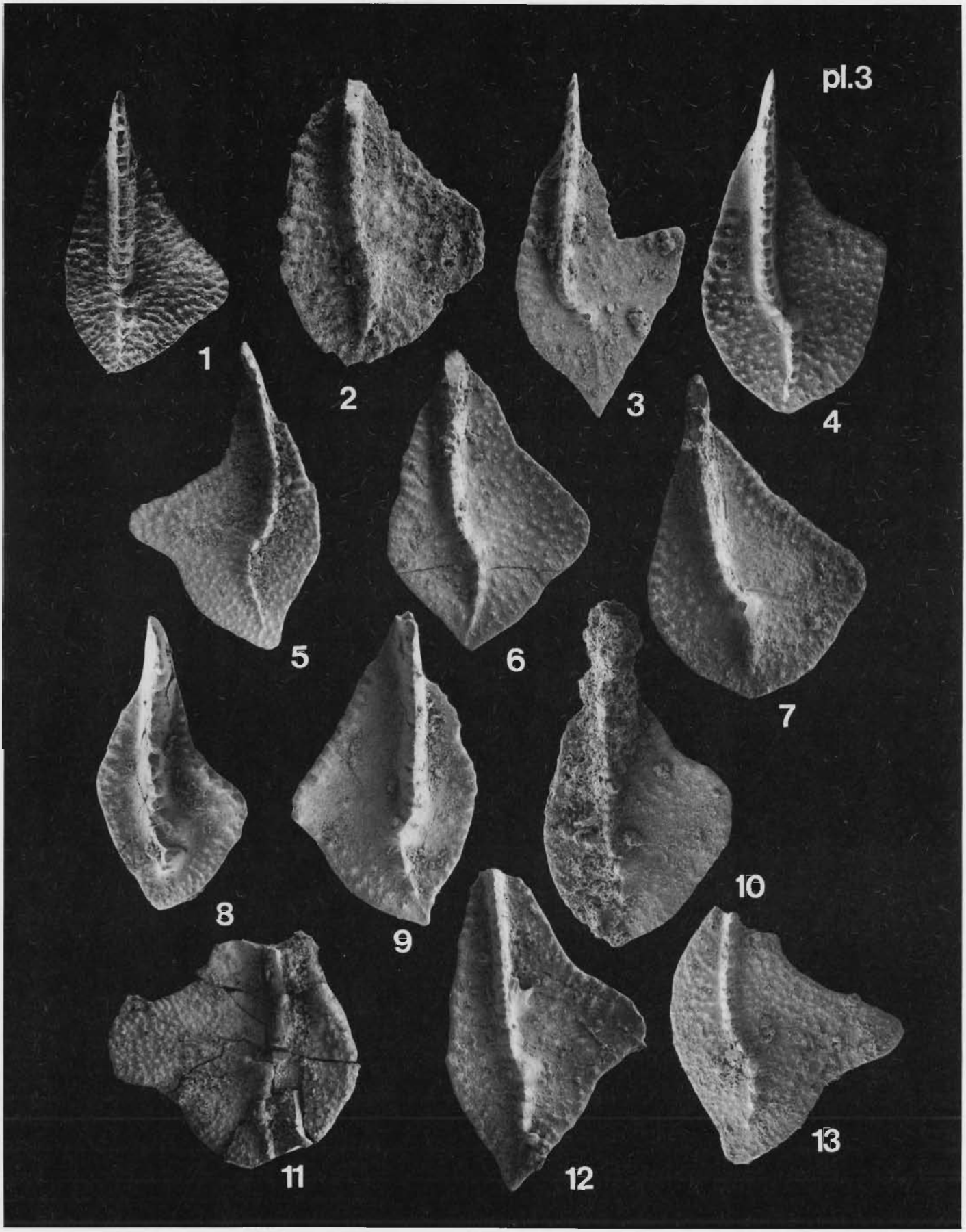

pl.2
1
2
3
4
5
6
7
8
9
10
11
12
13
14

PLATE 3

1. *Palmatolepis punctata* Hinde, 1879; b2452;
   upper view, x 46; *jamieae* Zone; C8, Nismes.
2. *Palmatolepis punctata* Hinde, 1879; b2453;
   upper view, x 60; *jamieae* Zone; C10, Nismes.
3. *Palmatolepis proversa* Ziegler, 1958; b2454;
   upper view, x 58; Late *hassi* or *jamieae* Zone; C1A, Nismes.
4. *Palmatolepis simpla* Ziegler & Sandberg, 1990; b2455;
   upper view, x 36; Early *rhenana* Zone; C16, Nismes.
5. *Palmatolepis hassi* Müller & Müller, 1957; b2456;
   upper view, x 47; Early *rhenana* Zone; C19, Nismes.
6. *Palmatolepis jamieae* Ziegler & Sandberg, 1990; b2457;
   upper view, x 58; Early *rhenana* Zone; C13B, Nismes.
7. *Palmatolepis jamieae* Ziegler & Sandberg, 1990; b2458;
   upper view, x 72; *jamieae* Zone; C10B, Nismes.
8. *Palmatolepis foliacea* Youngquist, 1945; b2459;
   upper view, x 48; Early *rhenana* Zone; C16, Nismes.
9. *Palmatolepis foliacea* Youngquist, 1945; b2460;
   upper view, x 78; Early *rhenana* Zone; C16, Nismes.
10. *Palmatolepis plana* Ziegler & Sandberg, 1990; b2461;
    upper view, x 70; Late *hassi* or *jamieae* Zone; C1, Nismes.
11. *Palmatolepis gigas gigas* Miller & Youngquist, 1947; b2462;
    upper view, x 33; Early *rhenana* Zone; C17, Nismes.
12. *Palmatolepis gigas paragigas* Ziegler & Sandberg, 1990; b2463;
    upper view, x 70; Early *rhenana* Zone; C17, Nismes.
13. *Palmatolepis rhenana nasuta* Müller, 1956; b2464;
    upper view, x 53; Early *rhenana* Zone; C17, Nismes.


pl.3
1
2
3
4
5
6
7
8
9
10
11
12
13