MIOCOPRES, THE LEMURATA AND TRIANGULATUS LEVELS
AND THEIR FAUNAL INDICES NEAR THE EIFELIAN/GIVETIAN
BOUNDARY IN THE EIFEL (F.R.G.)

by

Stanislas LOBOZIAK², Maurice STREEL³ & Karsten WEDDIGE⁴

(5 figures, 3 tables and 2 plates)

ABSTRACT. - 42 productive samples taken from the Eifelian Freilingen Formation to the Givetian Kerpen Formation in the Hillesheim Syncline (Eifel, F.R.G.) contain abundant and well preserved miocores from the Oppel Zones acanthomammillatus-devonicus and triangulatus-ancyrea. The incoming of Geminospora lemurata and Samarispites triangulatus, which are important key-species, is demonstrated and illustrated. All miocore data are compared to conodont, trilobite and brachiopod zonations. They are all included in the ensensis-obliquimarginatus and ensensis-bipennatus conodont standard Zones. The traditional Ardenne and Eifel boundaries of the base of the Givetian Stage and the levels still in discussion in the Commission on Devonian Stratigraphy are mentionned.


1.- INTRODUCTION

This analysis concerns miocores from the Eifelian/Givetian Boundary beds and their stratigraphic significance. The upper part of the Eifelian in particular is a relatively less calciferous interval within the limestone sequences of the Eifel region (fig. 1). Thus, it partly reveals complete microfloras with sufficient preservation as Streel (1986) has already mentioned, after usual palynological techniques being applied. In the Eifel region are the reference localities of the internationally accepted base of the Eifelian Stage as well as one of the traditional German base of the Givetian Stage. Faunas are rich and very well known.

2.- LOCATION OF THE MIOSPORE SAMPLES

The miocore bearing samples were taken in classical outcrops within the Hillesheim Syncline (Topographic map-sheet n° 5605 Dollendorf, 1/25 000) : A display of the involved formations is shown on figure 5. A first set of samples, taken in

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1987, concerns the interval from the Freilingen Formation to the Loogh Formation. Preliminary results were given as a document submitted to the I.U.G.S. Devonian Subcommission Meeting at Washington (U.S.A.) in July 1989. A second set of samples was taken in 1989 in the upper part of the Lahr Member and in the lowermost part of the Müllert Member of the Abbach Formation in order to duplicate the sampling in a critical rock interval. A third set of samples, collected both in 1987 and 1989, concerns the Cürten and Kerpen Formations which are stratigraphically higher than the former-ones.

2.1.- The first set of samples corresponds to the following formations (fig. 2)

1.- Freilingen Formation with samples no 30-32, 34, 35 and 40 from the Weinberg Quarry, west of Kerpen village (R 51 000 / H 75 680; further locality references in Struve 1988:128, Stop A 16). The marls are predominantly obscured in the abandoned quarry.

2. Abbach Formation with samples no 14-26 from the Müllertchen Quarry, south of Aahütte village (R 54 940 / H 77 960; e.g. Struve, 1982:119, Stop 16; Host, Kräusel & Struve 1955:111-116). Nearly the whole marly sequence is exposed.

3. Loogh Formation, lowermost part, with samples no 9-11 from the abandoned railway cut Dreimühlenwald northeast of Niederehe village (R 54 830 / H 76 590; e.g. Struve 1988:138-140, Stop A 17c). The marls are slightly obscured by surface debris.

Sampling is unfortunately not homogeneous - because of the unfavourable exposure conditions of the pure marly sequences (fig. 2: Bohnert Member 1-4 of Freilingen Fm., lower- and uppermost parts of the Müllert Member of the Abbach Fm.) or - because of intercalating reefal limestones of Abbach Fm. (fig. 2: most of Hallert Member and Lahr Member 1-3).

Despite these large gaps in sampling, 22 levels were prolific and diverse enough to bring new and more data from this time span than those analyzed formerly in the Eifel area by Tiwari & Schaar-schmidt (1975) and Riegel (1982). Moreover, this is the first investigation of miospores done in sections well dated by conodonts, trilobites, brachiopods, and other faunas. These «Eifel standard sections» are thoroughly the main reference sections for the conodont zonations of Weddig (1977), Weddig & Ziegler (1977) and Weddig (1988) as well as for trilobite or brachiopod zonations having been introduced by Struve during the last three decades.

2.2.- The second set of samples was taken from the Katzenley section in the abandoned railway cut near Dreimühlenwald (fig. 1b) and again from the Müllertchen quarry where they almost duplicate the samples 14 to 18 of the first set (fig. 3 and tables 1 and 2).
2.3.- The third set of samples corresponds to the Curten and Kerpen Formations.

4. Curten Formation, with samples n° 46-48 from the «Waldweg am Felsbach», 1 km south of Kerpen and samples n° 27-29 from the «Hohlweg auf dem Meerbusch», 2 km northeast of Kerpen.

5. Kerpen Formation from the abandoned railway cut sections near Kerpen : sample 44 southeast of Kerpen (near the sportfield) and samples 168-170, east of Kerpen at Rodert Hill (compare Struve, 1988, pages 148-149, text-figs. A18/4-5).

3.- MOSPORE DISTRIBUTION IN THE INTERVAL FROM THE FREILINGEN FORMATION TO THE LOOGH FORMATION

One single assemblage (Oppel Zone) was encountered in all these samples. Occurrences in the lowermost and subsequent samples of Acinosporites acanthomammillatus, A. macrospinuosus, and Densosporites devonicus and the absence in all samples of Samarispores triangulatus allow to determine the Oppel Zone AD (acanthomammillatus-devonicus) (Streel et al., 1987).

The following species are also present which first occur elsewhere (for instance in the Old Red Sandstone Continent, see Richardson & McGregor, 1986: fig. 3) in the same time range, amongst others: Ancyrospora laevis, Archaeozonotrilletes variabilis, Chelinospora rigurata, C. timanica, Densosporites inaequis, Geminospora lemurata, Grandispora inculta and Grandispora naumovii (both in one sample only and for that reason not in the chart), Hystricosporites aff. reflexus, Verrucosispores prenus, V. scurrus and V. cf. uncatus.

The occurrence of H. aff. reflexus from the lowermost sample and the first occurrence of G. lemurata in sample 22 in the Müllert Member indicate the subsequent Interval Zone. Ref and Lem inside the limits of the Oppel Zone AD.

The second set of samples carry a similar assemblage of miospores (Oppel Zone AD). The samples (fig. 3 and tables 1 and 2) were rich enough in miospores content to ascertain that no G. lemurata was present.

3.1.- FACIAL CONTROL OF THE MOSPORE DISTRIBUTION

As to the interpretation of the miospore distribution, it has to be considered that the succession from Freilingen up to Ahbach and Loogh Formations is distinctly shifting in facies (compare e.g. Struve 1988:128-131, 134-140; Weddige, 1988: 108-109, 132-133, 140-142, Text-fig. A14-18/12, Weddige & Struve 1988). The Freilingen Fm. was deposited on the shallow outer shelf under higher influence of open-marine faunas, particularly of cosmopolitan conodonts. The following Hallert-Lahr reef (= mud-mounds) obviously represents that barrier which gave rise for special faunas of a sheltered-marine environment. During the Ahbach- and Loogh time interval, the latter are characterized for instance by increasing occurrences of < Pre-> and < Pseudo-> and final <Eu-> Stringocephalids in brachiopods as well as by the lack of cosmopolitan Polygnathus representatives in conodonts.

Microfloral distribution might also reflect the facial difference between Freilingen and upper Ahbach miospores and explain the presence of more species and more specimens of these species in the sheltered-marine environment than in the outer shelf environment.

3.2.- THE GEMINOSPORA LEMURATA LEVEL

3.2.1.- Biostratigraphical assignments

The first occurrence of G. lemurata represents the main palynological limit within the studied stratigraphical interval. The inception of this important cosmopolitan species is now fixed by the findings (Pl. 1) in the Eifelian Müllertchen Quarry in the Müllert Member of the Ahbach Formation. Riegel (1982, fig. 1) shows, on a schematic chart, the first occurrence of Geminospora antaxis at the base of the same formation in the Eifel region without mentioning any definite sections. Streel et al. (1987, p. 217, footnote) indicate that G. antaxis (Chibrikova) Owens in Riegel 1982 is believed to belong to the concept of G. lemurata Balme emend. Playford 1983.

Unfortunately, the Müllert Member is precisely that interval that yields the poorest conodont record of the whole Eifelian stage of the Eifel area. Despite this short-termed deficiency of conodonts, the lemurata Level is datable as upper part of lower ensensis Zone of conodonts (Weddige 1977), respectively to the ensensis-obliquimarginatus Subzone sensu Weddige (1984). As to the refinements of the standard conodont zonation (compare fig. 2):

Firstly, the level is distinctly positioned above the base of the obliquimarginatus Icriodus-Zone as well as of the hemiansatus Polygnathus-Zone in the sense of the substitutional zonation of Bulletyn (1987).

Secondly, it is closely above the main occurrences of Ozarkodina bidentata Bischoff & Ziegler, i.e. above the centre of the obliquimarginatus &
Fig. 2.- Vertical distribution of miozospores and associated conodont faunas of Eifelian/Givetian boundary beds in the Hillesheim Syncline, Eifel. The four studied sections Weinberg, Katzenle, Mullertchen, and Dreimuhlenwald are combined vertically in the column on the left.
Table 1.- Repartition of the main miospores in N Mü samples from the Katzenley Section.

<table>
<thead>
<tr>
<th>MAIN MIOSPORES</th>
<th>Dibiosporites eichnaeus and a.f.</th>
<th>Dibiosporites eichnaeus and a.f.</th>
<th>Acinosporites acanthohermamillatus</th>
<th>Acinosporites angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIOSPORE SAMPLES</td>
<td>35.0/20.18</td>
<td>32.0/34.2</td>
<td>31.4</td>
<td></td>
<td></td>
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Thirdly, it is higher but very close to the inception of the first conodont of *Polygnathus ensensis* *ensensis* Ziegler & Klapper as it was recently proposed as a most favourable boundary level (Weddige 1989).

Regardless of their less world-wide significance, the actually finest datings of the *lemurata* Level are provided by shorter-termed zones of megafossils, particularly of trilobites with the Zone of *Pedinopariops (Hypsipariops) lahrensis* Struve and brachiopods with *Invertypa kelusiana* Struve. World-wide stratigraphical significance, however, is assigned to the entry of the shallow-water brachiopod *Stringocephalus* sensu stricto which, according to Struve (1961), characterizes the lowermost Loogh Fm. and the base of the Givetian...

Table 2.- Repartition of the main miospores in Müllert and Müx samples from the Müllertchen Quarry.

<table>
<thead>
<tr>
<th>MAIN MIOSPORES</th>
<th>Samaritispores extinctus</th>
<th>Samaritispores extinctus</th>
<th>Dibiosporites eichnaeus and a.f.</th>
<th>Dibiosporites eichnaeus and a.f.</th>
<th>Acinosporites acanthohermamillatus</th>
<th>Acinosporites angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
<th>Acinosporites angulata var. angulata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miospore Samples</td>
<td>Müllert 4</td>
<td>Müllert 4</td>
<td>Müllert 1</td>
<td>Müllert 3</td>
<td>Müllert 2</td>
<td>(Müx)</td>
<td>0.3/0.15</td>
<td>0.5/0.35</td>
<td>0.85/0.75</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
stage in the sense of Beyrich (1837). Thus, the entries of *G. lemurata* and of *Stringocephalus* are nearly coeval.

### 3.2.2.- Regional comparisons

The basis of *G. lemurata* was crudely demonstrated by McGregor (1981) to occur within the conodont *Polygnathus ensensis* Zone. This record of the miospore in conodont dated section is from the Weatherall Formation in the Beverley Inlet section, Melville Island in the Canadian Arctic. Conodonts are from a single level some 150 m below the first occurrence of *G. lemurata*. Five samples otherwise rich in palynomorphs were macerated within this interval which do not contain this species. These five samples and the first sample containing *G. lemurata* originated from a deltaic marine shelf facies. Conodonts indicate an age probably within the *australis* to *ensensis* Zones according to Uyeno (unpublished GSC report, 1980). Although the data of the present work are more precisely documented than those from the Canadian Arctic, they do not contradict.

In the Boulonnais region (Loboziački & Strel, 1980), the first occurrence of *G. lemurata* was demonstrated in the lowermost part of unit H (Membre de Couderousse) of the Formation de Blacourt between Fauna IV and Fauna V of Bultynck (Brice et al., 1976, 1979). Fauna IV is now considered to belong to the Middle *varcus* Zone (Bultynck, personal communication, in Loboziački & Strel, 1988: fig. 2). The entry of *G. lemurata* is therefore delayed in the Boulonnais compared to the Eifel and Arctic Canada. The shales of the Membre de Couderousse occur immediately on a reef formation which ends the Membre du Griset of the Formation de Blacourt. These are poor environmental conditions for palynomorphs in marine sedimentation and could explain a sorted assemblage of miospores.

One single sample taken slightly above the base of the Formation de Blacourt, some 180 m below the Membre de Couderousse samples also yielded no *G. lemurata*. This sample is shown immediately below a productive conodont sample belonging to the *ensensis* Zone (Loboziački & Strel 1988: fig. 2). It is assigned now by Bultynck
(personal communication, 1988) to the ensensis-bipennatus Subzone. As this time level is distinctly younger than that of the G. lemurata in the Eifelian Mullert Member, it should also reveal the miospore. (Unless a time gap between spore sample and conodont sample would be responsible in the French section which seems to be unprobable). The absence of the species is better referred to poor conditions of sedimentary environment and scarce sampling.

McGregor (1979: text-fig. 11) plotted on a Middle Devonian palaeocontinental assembly the geographic occurrences of this species. G. lemurata stratigraphic and geographic distribution has been extensively reviewed by Playford (1983). This species is virtually cosmopolitan.

3.2.3.- Conclusions on the Geminospora lemurata Level

Now, it is documented herein that the inception of the miospore Geminospora lemurata is slightly below the classic Stringocephalus Boundary sensu Beyrich (1837) the level of which was identified in the Eifel region by Struve (1961) based on the occurrence of the first taxonomically true Stringocephalus (= sensu stricto). The base of the Givet Limestone in the type area of the Belgian Ardenne sensu d’Omalius d’Halloy (1862) and Maillieux (1933), which apparently does not bear miospores, is believed to correspond to an upper part of the ensensis Zone near the base of the varcus Zone after Bultynck (1985). According to the Eifel standard section, the Givetian Boundary of the Ardenne points to a level about 70 m above the Stringocephalus Boundary (fig. 4).

It is striking that the inception of G. lemurata is very close to that of the first conodont of Polygnathus ensensis sensis Ziegler & Klapper as it was recently proposed as a favourable boundary level (Weddige 1989). The most important advantage of this level is that it is positioned distinctly above an event interval (= notomari Event) which is obviously represented by upper Junkerberg Fm. and by Freilingen Fm. in the Eifel, respectively by the pelagic Odershausen Fm. in the Eastern Rhenish Mountains. On the contrary, two lower candidate levels of the Eifelian/Givetian Boundary are directly connected with the event interval which, in general agreement of the Devonian Subcommission, should be avoided by the boundary definition. Thus, the base of the conodont Polygnathus-hemiansatus Bultynck is found within the event interval - exactly, within its gradual end, whereas the «Boundary of the Eastern Rhenish Mountains» was originally defined more or less lithostratigraphically after the first black coloured event sediments of the Odershausen Fm. Consequently, the adjacent position of the G. lemurata base would argue for a preference of the «ensensis Boundary» from the actual palynological and conodontological viewpoint.

4.- MIOSPORE DISTRIBUTION IN THE CURTEN AND KERPEP FORMATIONS (fig. 5 and table 3)

4.1.- THE ACME OF GEMINOSPORA LEMURATA IN THE CURTEN FORMATION

Six samples taken from the base to the top of the Curten Formation carry also an assemblage referable to the Oppel Zone AD. The genus Geminospora is well represented and sometimes abundant in all samples. G. lemurata is present in all samples but one (table 3). Compared to the irregular distribution of this genus in the Mullert Member of the Abach Formation, one can assume that the Acme Zone of G. lemurata has
Fig. 5: Combined sections ranging from the Eifelian to the Givetian in the Halsfeld-Neumühlen area with the main lithostratigraphic and biostratigraphic limits.

Miospore samples

<table>
<thead>
<tr>
<th>Conodont Assemblage markers</th>
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</thead>
<tbody>
<tr>
<td>Icriodus Zone</td>
</tr>
<tr>
<td>Polygnathus Zone</td>
</tr>
<tr>
<td>conodont standard zones</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cf. regularicrescens</th>
<th>obliquimarginatus &amp; bidentata</th>
<th>bipennatus &amp; platyobliquimarginatus</th>
<th>bipennatus &amp; lilliputensis</th>
</tr>
</thead>
<tbody>
<tr>
<td>regularicr.</td>
<td>obliquimarginatus</td>
<td>hemiansatus</td>
<td></td>
</tr>
<tr>
<td>eiflius</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ensensis - obliquimarginatus</td>
<td>ensensis - bipennatus</td>
<td></td>
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</table>

EIFELIAN          GIVETIAN pars  Eifel  Traditional boundaries

"COUVINIAN"          GIVETIAN pars  Ardenne
Table 3. Repartition of the main miospores in the Curten (Nº 46, 47, 48 and 27, 28, 29) and Kerpen (Sportfield: Nº 44; Rodert Hill: 168, 170, 169) Formations.

| MAIN MIOSPORES | SAMARISPORITES | DIBOLISPORITES | ACTINOSPORITES | GRANDISPORITES | ACHIANTHOSPORITES | RYHODOSPORITES | GRANDISPORITES | HYSICOSPORITES | BULLATISPORITES | ACTINOSPORITES | DENSISPORITES | SAMARISPORITES | VERNUCISPORITES | DENDRALISPORITES | CHENINOSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES | MACROSPORITES |
|----------------|----------------|---------------|----------------|----------------|------------------|---------------|---------------|---------------|---------------|----------------|----------------|---------------|----------------|----------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| MIOSPORE SAMPLES |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |精通1ninus and a1f. |

been reached in the Curten Formation. The Curten Formation entirely belongs to the *ensensis-bipennis* condont standard Zone. These new data almost confirm the opinion of McGregor (1981, fig. 3) that the base of the Acme Zone of G. *lemurata* in U.S.S.R. is near the base of the varcus condont standard Zone but the data of the present work are more accurately documented than those originating from U.S.S.R. and a lower limit in the *ensensis-bipennis* is now demonstrated.

### 4.2. **The Samarapisporites Triangulatus Level in the Kerpen Formation**

Four samples taken from the Kerpen Formation carry a rather poor assemblage where several species of the AD Oppel Zone are absent but which is characterized by the entry of species of *Samarapisporites* with typical radial extensions of the zone including *S. triangulatus* (table 3). The co-occurrence of *Ankyrospora ancyrea* var. *ancyrea* allows to determine the Oppel Zone TA (*triangulatus-ancyrea*) (Streel et al., 1987) which is now dated, for the first time, from what is believed to be the upper part of the *ensensis-bipennis* Zone (Wedding 1988: p. 150). *Eogna-thodus bipennis* is well present in this section and its extinction was used by Bischoff & Ziegler (1957) to characterize the base of the succeeding «varca-Subzone». These new data are the lowest record of *S. triangulatus* in a section with faunal indices. In U.S.S.R., the first entry of *S. triangulatus* was shown near the base of the «varcus Zone» by McGregor (1981, fig. 3) and high in the varcus Zone by Richardson & McGregor (1986, fig. 6 if one excepts the record from the Boullonais).

The single specimen published in Loboziak & Streel (1980, Pl. II, fig. 11) from the *ensensis-Zone* in the Boullonais (Northern France) was considered later by Streel et al. (1987, p. 219) as an atypical specimen of *S. triangulatus* and therefore excluded from this species.
S. triangularis stratigraphic and geographic distribution has been extensively reviewed by Allen (1982) who considers the species as a widespread and important miospore from the Givetian to the Frasnian.

Smooth forms (= Samarisporites Sp. F in Stree l & Loboziai, 1987) are also present in these Kerpen samples. The joint incoming of S. triangularis and smooth forms with typical radial extensions (Pl. 2) is new. Samarisporites sp. F was recorded from Frasnian beds in the Booschot borehole in Belgium (Stree l & Loboziai, 1987).

5.- CONCLUSION

The successive inomings of G. lemurata and S. triangularis are now demonstrated to occur respectively in the sensous-obliquimarginatus and the sensenst-bipennatus conodont standard Zones. Compared to the traditional bases of the Givetian Stage, the lowest incoming is in the uppermost Eifelian (fig. 3), the highest in the basal Middle Givetian (sensu Struve 1988, text-fig. A 18/4). If one of the two conodont levels recently favoured for defining the boundary internationally were selected, both inomings would occur in the Givetian.

ACKNOWLEDGEMENTS

We are grateful to Dr. Wolfgang Struve, Frankfurt, for proposing localities for sampling and for checking the trilobite and brachiopod zonation in figure 2.

BIBLIOGRAPHY


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**PLATE 1**

**Figs. 1-4: Geminospora punctata** Owens 1971


3-4. Wotan Mb., slide 9 (1): Q 46; 3. x1000; 4. x1800.

**Figs. 5-9: Geminospora lemurata** Balme 1962 emend Playford 1983

5. Müllert Mb., slide 22 (3): T 49 /1; x1000.

6-7. Müllert Mb., slide 22 (1): T 48 /3; 6. x1000; 7. x1800.

PLATE 2

Figs 1-3: *Samarisporites* sp. *F in* Streel & Loboziak 1987
Kerpen Fm., slide 168 (2): H 25/2; 1-2. x1000; 3. x1560.

Figs. 4-12: *Samarisporites triangulatus* Allen 1965
4-6. Kerpen Fm., slide 168 (2): D33; 4-5. x1000; 6. x1560.
10-12. Kerpen Fm., slide 44 (2): D40/3; 10-11. x1000; 12. x1560.