

FAMENNIAN TRILOBITES : AN OUTLINE ON THEIR STRATIGRAPHICAL IMPORTANCE

by

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(8 figures)

ABSTRACT. - The Famennian trilobite fauna is characterized by the predominance of *Cyrtosymbolinae*, *Drevermanniinae* and certain *Phacopidae*. Both the base and the top are well marked by distinct changes in the trilobite succession. Several families and subfamilies (belonging to different orders), e.g. *Scutelluidae*, *Odontopleuridae*, *Tropidocoryphidae* and *Asteropyginae*, which were still abundant in the Middle Devonian, became extinct during the uppermost Frasnian. At the Famennian-Tournaisian (= Devonian-Carboniferous) boundary the *Phacopidae* and also the *Cyrtosymbolinae* (as defined by Hahn & Brauckmann, 1984) completely declined, whereas several typical Carboniferous subfamilies of the *Phillipsiidae* appeared for the first time. Two acmes are evident in the Famennian trilobite succession. The first one is restricted to the Nehdenian, whereas the second one ranges from the Dasbergian to the Wocklumerian and shows a strongly different specific and even generic composition.

RESUME. - Les faunes de Trilobites famenniens sont caractérisées par la prédominance de *Cyrtosymbolinae*, *Drevermanniinae* et de certains *Phacopidae*. Les successions de trilobites montrent des apparitions et des extinctions bien marquées. Plusieurs familles et sous-familles (appartenant à des ordres différents) telles que *Scutelluidae*, *Odontopleuridae*, *Tropidocoryphidae* et *Asteropyginae* qui sont encore abondantes au Dévonien moyen, s'éteignent au sommet du Frasnien. A la limite Famennien-Tournaisien (= Dévonien-Carbonifère), les *Phacopidae* et aussi les *Cyrtosymbolinae* (tels qu'ils ont été définis par Hahn & Brauckmann, 1984) disparaissent tandis que plusieurs sous-familles de *Phillipsiidae*, typiques du Carbonifère, apparaissent pour la première fois. Deux acmés sont évidents dans la succession des trilobites famenniens. Le premier est restreint au Nehdenien tandis que le second s'étend du Dasbergien au Wocklumerien. Ils montrent des compositions spécifiques et même génériques très différentes.

INTRODUCTION

The knowledge of Famennian trilobites is mainly based upon the classical monograph by Rud. & E. Richter (1926). These authors gave detailed comments on the stratigraphical distribution of nearly every single species known at that time all over the world. They also were the first ones who pointed out the great stratigraphical value of Upper Devonian trilobites, which formerly were almost completely neglected.

The richest collections came from Central Europe (Rhenish Massif, Frankenwald etc.), where - beyond it - also the zonation, based on the ammonoid succession, had been most advanced. Thus the most reliable data concentrated on this area. Further studies showed that only few and less significant modifications were necessary for Central Europe. More extensive was the increase of the knowledge of Famennian trilobites from other regions, especially from Poland, Moravia and the USSR,

from where several new taxa have been described. The main results of these studies have been summarized by G. & R. Hahn (1975, with detailed references to special publications). Subsequently, rich collections have been reported from Morocco in a series of papers by H. Alberti (1973 to 1976). Recently, while describing some new species from China, Xiang (1981) also mentioned the very few else records from Asia. But despite these international activities, the Central European trilobite sequence through the Famennian is still the most detailed known.

At present, Famennian trilobites are known from Europe (Great Britain, France, Portugal, Belgium, Germany, Poland, Moravia, the Carnic Alps, the Urals), North Africa (Morocco), Asia (Siberia, China, Afghanistan) and Australia. The Late Devonian age of the trilobite bearing Langgon red beds of Malaysia, as sup-

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posed by Kobayashi & Hamada (1973) has been doubted emphatically by Gandl (1980 : 313), who suggests a Visean-Namurian age for this sequence.

In spite of all these careful researches, many stratigraphical problems remain. Of course the occurrence of a great number of species can be well correlated with the ammonoid and conodont zones, but in many cases the exact range within these zones is still unknown. The most detailed investigations have been carried out on those faunas occurring around the Devonian-Carboniferous boundary, where several sections - especially in the Rhenish Massif - have been studied. A compilation of the most important ones of these sections has been submitted by Brauckmann & Hahn (1974). Less has been done up to now in this respect on Lower Famennian trilobite faunas except for collections from the southwestern part of the Hartz Mountains, which were published by Lütke (1968).

COMPOSITION OF THE FAMENNIAN TRILOBITE FAUNA

The Famennian trilobite fauna is well characterized by the predominance of certain late Phacopidae as well as late Proetidae (e.g. Drevermanniinae) and early Phillipsiidae (especially Cyrtosymbolinae). Prominent phacopid genera are "*Phacops*", *Trimeroccephalus*, *Dianops* and *Ductina* (*Ductina*). Drevermanniinae are represented by *Drevermannia* (*Drevermannia*), *D. (Formonia)*, *Pontipalpebralia* and *Chaunoproetus*, and Cyrtosymbolinae by *Cyrtosymbola* (*Cyrtosymbola*), *C. (Franconicabole)*, *Calybole*, *Pusillabole* and - if belonging to this subfamily - *Typhloproetus*.

Several other families and subfamilies, e.g. Scutelluroidae, Odontopleuridae, Tropicocoryphidae and Asteropyginae, which were still abundant in the Middle Devonian, became extinct during the uppermost Frasnian. These taxa did not cross the Frasnian-Famennian boundary, which thereby is very well marked.

Just as well marked is the Famennian-Tournaisian (= Devonian-Carboniferous) boundary, because the Phacopidae and also the Cyrtosymbolinae (as defined by Hahn & Brauckmann, 1984) completely declined at the top of the Famennian, whereas several typical Carboniferous subfamilies of the Phillipsiidae appeared for the first time at the base of the Dinantian; these are for example: Phillipsiinae, Cummingellinae and Griffithidiinae within the Carboniferous Limestone facies as well as the Cystispininae within the "Kulm facies".

Only few phillipsiid subfamilies cross the Devonian-Carboniferous boundary:

- The Archegoninae - formerly usually interpreted as a group of genera of the "Cyrtosymbolinae" (as used in a wider sense) - appear in the Upper Hembergian (= do IV) with *Archegonus* (*Waribole*) and *A. (Phillibole)*; later on, in the Dasbergian (= do V) and Wocklumerian (= do VI), *Silesiops* (*Silesiops*)

and *Mirabole* approach. While *Mirabole* is restricted to the Wocklumerian (and thus to the Upper Devonian), the other taxa occur in both, Famennian and Carboniferous strata. Especially *A. (Phillibole)* has its main distribution in the Dinantian and is represented in the Famennian by only few species. Another subgenus, *A. (Weania)* seems to appear just below the Devonian-Carboniferous boundary with its stratigraphically most important species *A. (Weania) abruptirhachis* (Rud. & E. Richter, 1951) (compare Brauckmann & Hahn, 1984 and G. Hahn in Luppold & Hahn & Korn, 1984).

- The Linguaphillipsiidae - also with their main distribution in the Carboniferous and Permian - are present in the Upper Famennian (do IV-VI) with several species of *Pseudowaribole* (*Pseudowaribole*).

Other important components of the Famennian trilobite fauna are *Brachymetopus* (Brachymetopidae) and *Perliproetus* (? Proetidae or ? Phillipsiidae). The latter is restricted to the Upper Devonian, where certain species occur especially in the Wocklumerian (do VI) and - like *A. (Weania) abruptirhachis* - perhaps just below the Devonian-Carboniferous boundary. Of *Brachymetopus* only one Famennian species, *B. drevermanni* G. Hahn, 1964 from the Velbert anticline (Rhenish Massif), is known with certainty; this genus becomes much more important in the Carboniferous and Permian.

As it can be recognized from these brief comments, particularly the whole phillipsiid complex as well as the Brachymetopidae are modern components of the Famennian trilobite fauna, which introduced the last trilobite radiation before their complete extinction at the end of the Paleozoic.

Many Famennian trilobites - Phacopidae as well as Proetidae, Phillipsiidae and Brachymetopidae - are very small-sized; often their eyes are strongly to completely reduced. But also medium-sized to large taxa and species with large to very large eyes occur, for example *Omegops*, *Pseudowaribole* (*Pseudowaribole*) and *Archegonus* (*Waribole*).

FAMENNIAN TRILOBITE BIOSTRATIGRAPHY

Generally, there are two acmes to be recognized within the Famennian trilobite succession: The first one is restricted to the Nehdenian (= do II), whereas the second one ranges from the Dasbergian (= do V) to the Wocklumerian (= do VI) and shows a strongly different specific and even generic composition. In detail, the Famennian stages are characterized as follows:

Nehdenian (do II = *Cheiloceras* stage)

After the strong decline during the Uppermost Frasnian (= do I), where Scutelluroidae, Odontopleuridae, Tropicocoryphidae (with the peculiar *Pteroparia*) and

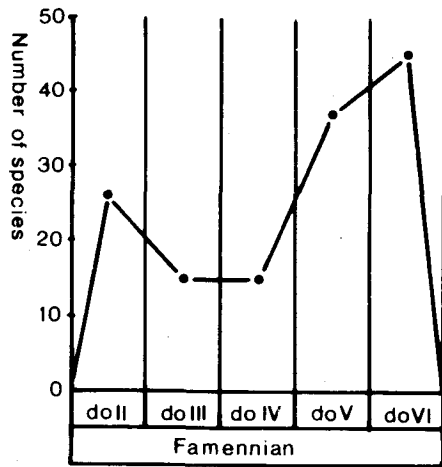


Figure 1

Diagram showing the number of trilobite species of exact known stratigraphical position within the Famennian stages.

Asteropyginae became extinct, only few taxa survived and crossed the Frasnian-Famennian boundary : "*Phacops*", *Chotecops*, *Nephranops*, *Cryphops* and - if *Illaenula* Chlupáč, 1977 is included as a subgenus - also *Ductina* of the Phacopidae, and perhaps *Cyrtosymbole* (*Cyrtosymbole*) of the Cyrtosymbolinae (= early Phillipsiidae).

The Nehdenian is characterized by the first appearance of several genera and subgenera : *Ductina* (*Ductina*), *Dienstina* and *Trimerocephalus* (all belonging to the Phacopidae); *Drevermannia* (*Formonia*) and *Pontipalpebralia* (both Drevermanniinae); *Cyrtosymbole* (*Franconicabole*) and *Calybole* of the Cyrtosymbolinae. *Cyrtosymbole* (*Cyrtosymbole*), which seems to be very rarely present in the Frasnian, also becomes much more important in the Nehdenian as well as *Nephranops*. The stratigraphical range of most of these taxa is relatively short and essentially limited to the Lower Famennium; *Ductina* (*Ductina*) and *Pontipalpebralia* are completely confined to the Nehdenian.

Hembergian (do III = *Prolobites* stage, and do IV = *Platyclymenia* stage)

During the Hembergian, the trilobites decrease considerably. Of the older taxa, *Nephranops*, *Trimerocephalus*, *Cryphops*, *Dienstina* and *Drevermannia* (*Formonia*) are only present in the do III. In this stage only very few new genera appear : *Perliproetus* and perhaps the cyrtosymbolinid *Pusillabole*. *Cyrtosymbole* (*Franconicabole*) is rather dominant.

During the do IV the composition of the trilobite fauna changes remarkably. The older genera here mentioned disappear or are at least thrust into the background, whereas several new taxa are added, at first with only few species : *Dianops* (Phacopidae); *Chaunoproetus* (Drevermanniinae); *Typhloproetus* (?Cyrtosymbolinae); *Archegonus* (*Waribole*) and *A. (Phillibole)* (Archegoniinae); *Pseudowaribole* (*Pseudowaribole*) (Linguaphillipsiinae). The first occurrence of these taxa announces the second acme of Famennian trilobites.

Nehdenian	Hembergian		
do II	do III	do IV	
■			<i>Nephranops miserrimus wiedensis</i>
■			<i>Trimerocephalus mastophthalmus</i>
	■		<i>Cryphops schlosseri</i>
■			<i>Ductina (D.) ductifrons</i>
■			<i>Drevermannia (Formonia) annulilobata</i>
■			<i>D. (F.) globigenata</i>
	■		<i>Pontipalpebralia pontifera</i>
	■	■	<i>Calybole gracilis</i>
	■		<i>C. denckmanni</i>

Figure 2

Stratigraphical distribution of trilobites in Lower Famennian sections of the SW Hartz Mountains. (simplified after Lütke, 1968)

Dasbergian (do V = *Clymenia* stage)

The specific and even the generic composition of the Dasbergian is distinctly different from those of the Nehdenian and Lower Hembergian. This stage is well characterized by a number of typical Late Famennian taxa : *Dianops*, *Chaunoproetus*, *Drevermannia* (*Drevermannia*), *Perliproetus*, *Pusillabole*, *Typhloproetus*, *Archegonus* (*Waribole*), *A. (Phillibole)*, *Silesiops* (*Silesiops*) and *Pseudowaribole* (*Pseudowaribole*), most of them with several species.

Wocklumerian (do VI = *Wocklumeria* stage)

The trilobite fauna of the Wocklumerian is very closely related to that of the Dasbergian. In several cases it is still impossible to distinguish between Dasbergian and Wocklumerian components. The same genera and subgenera, and often also the same species have been reported from both stages. Thus the Dasbergian-Wocklumerian boundary is poorly marked within the trilobite succession.

A separate development can be recognized in the shelf facies of the Uppermost Famennian (Strunian, do VI), where the phacopid *Omegops* occurs in several species in Europe (SW England, N France, Belgium, W Germany and Moravia), Asia (Kirghiz Steppes, China) and North Africa (Morocco). In the Velbert anticline, *Omegops* is associated with *Pseudowaribole* (*Pseudowaribole*) and the first species of the Brachymetopinae, *Brachymetopus drevermanni* G. Hahn, 1964.

At the top of the Wocklumerian the number of trilobite taxa seriously declined, and Phacopidae as well as Cyrtosymbolinae became completely extinct. In several

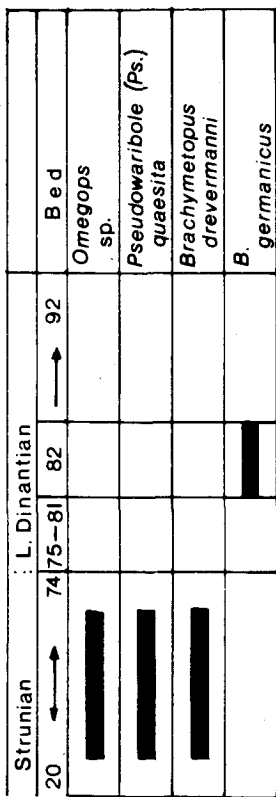


Figure 3

Stratigraphical distribution of trilobites around the Devonian-Carboniferous boundary in the Velbert section (Autobahnknoten Langenhorst); from Brauckmann & Hahn, 1984.

sections of the Rhenish Massif, *Archegonus (Weania) abruptirhachis* (Rud. & E. Richter, 1951) occurs immediately at the Devonian-Carboniferous boundary and seems to characterize this part of the sequence. The stratigraphical distribution of trilobite species around this boundary has been discussed in detail by Brauckmann & Hahn (1984); the most important data are here repeated in fig. 3-5.

**ADDENDUM :
NOMENCLATORICAL AND TAXONOMICAL NOTES**

To understand some nomenclatorial and taxonomical changes as used in this paper, a few explanatory notes should be added :

1. If the combination of cephalon and pygidium as generally accepted for *Archegonus* "*Waribole*" *abruptirhachis* (Rud. & Richter, 1951) is correct, this species cannot be grouped with *A. (Waribole)* Rud. & E. Richter, 1926 because of the presence of a long axis with well differentiated rings and because of prominent anterior bands of the ribs in the pygidium of *abruptirhachis*, which are completely

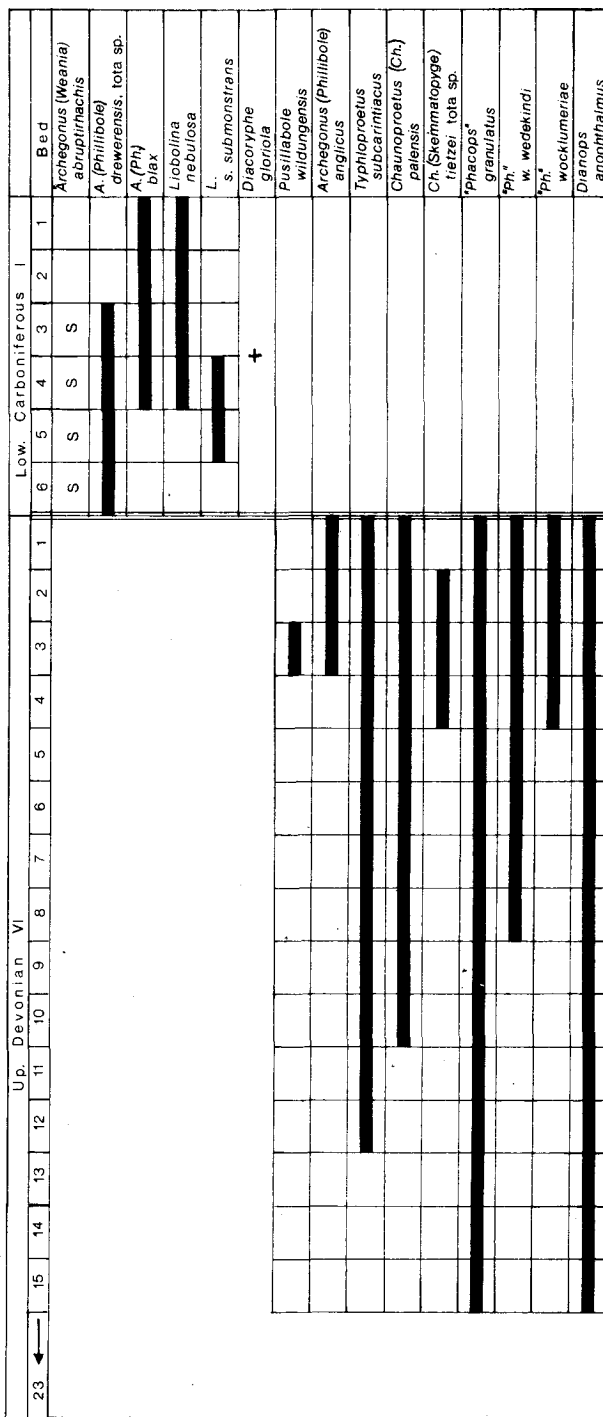


Figure 4

Stratigraphical distribution of trilobites around the Devonian-Carboniferous boundary in the Hönnetal section of Oberrödinghausen (except *A. (W.) abruptirhachis*); modified from Brauckmann & Hahn, 1984. S : occurrence in the Drever section, approximately projected into the sequence of the Hönnetal section; + : exact occurrence unknown.

unusual in *A. (Waribole)*. In these features this species very closely resembles *A. (Weania)* Campbell, 1963. Therefore *abruptirhachis* is here regarded as the most primitive member of *A. (Weania)*, being characterized by a plesiomorphic, still *Waribole*-like cephalon combined with an apomorphic, already *Weania*-like pygidium.

2. In this paper, *Weania* is regarded as a subgenus of *Archegonus* Burmeister, 1843, mainly because of the close phylogenetical relationships to *A. (Waribole)*. Consequently, *Archegoninae* Hahn & Brauckmann, 1984 is to be used as the correct name of this subfamily. But if one believes *Weania* to be a distinct

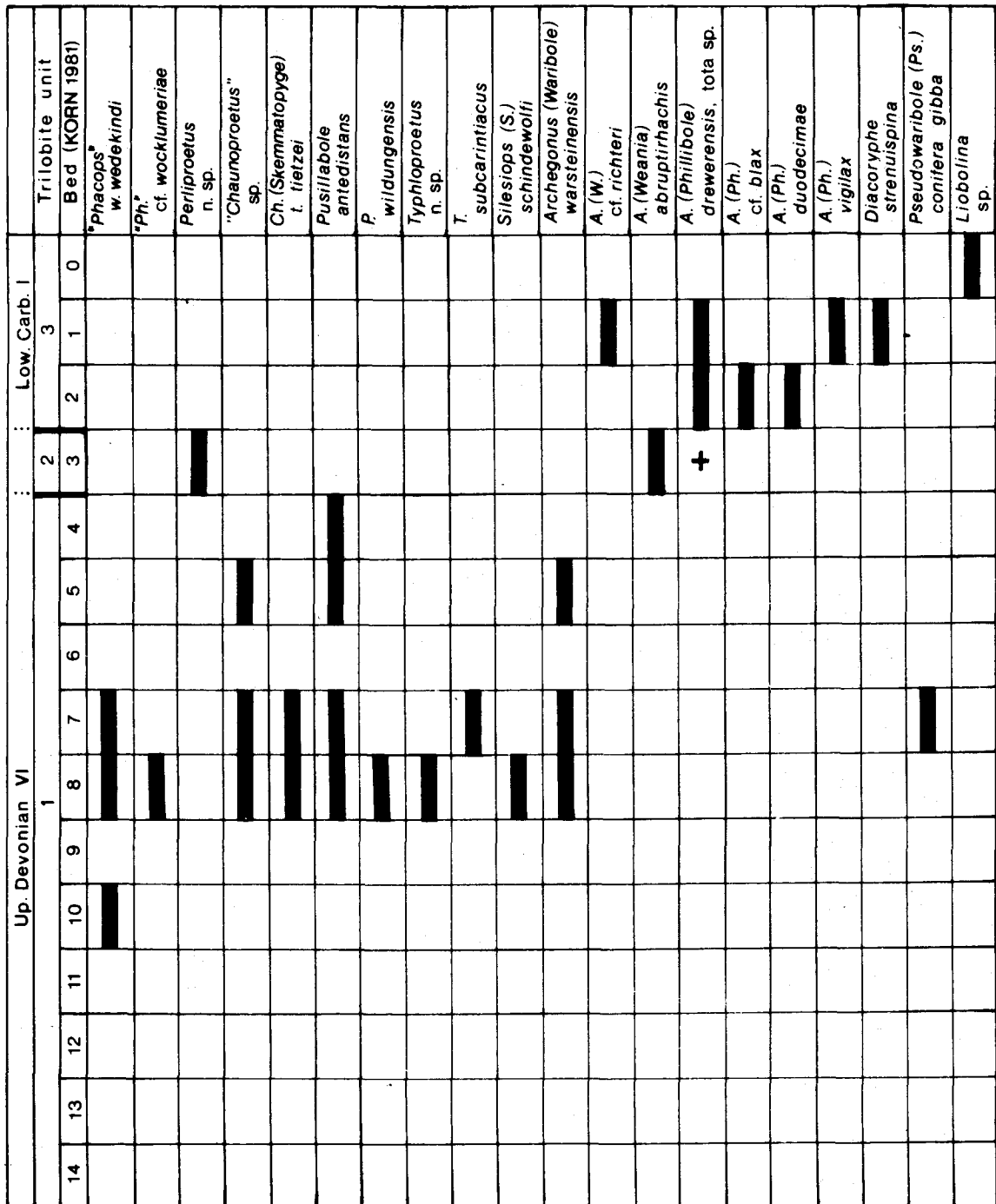


Figure 5
Stratigraphical distribution of trilobites around the Devonian-Carboniferous boundary in the Müsenberg section; modified from Brauckmann & Hahn, 1984. + : very rare.

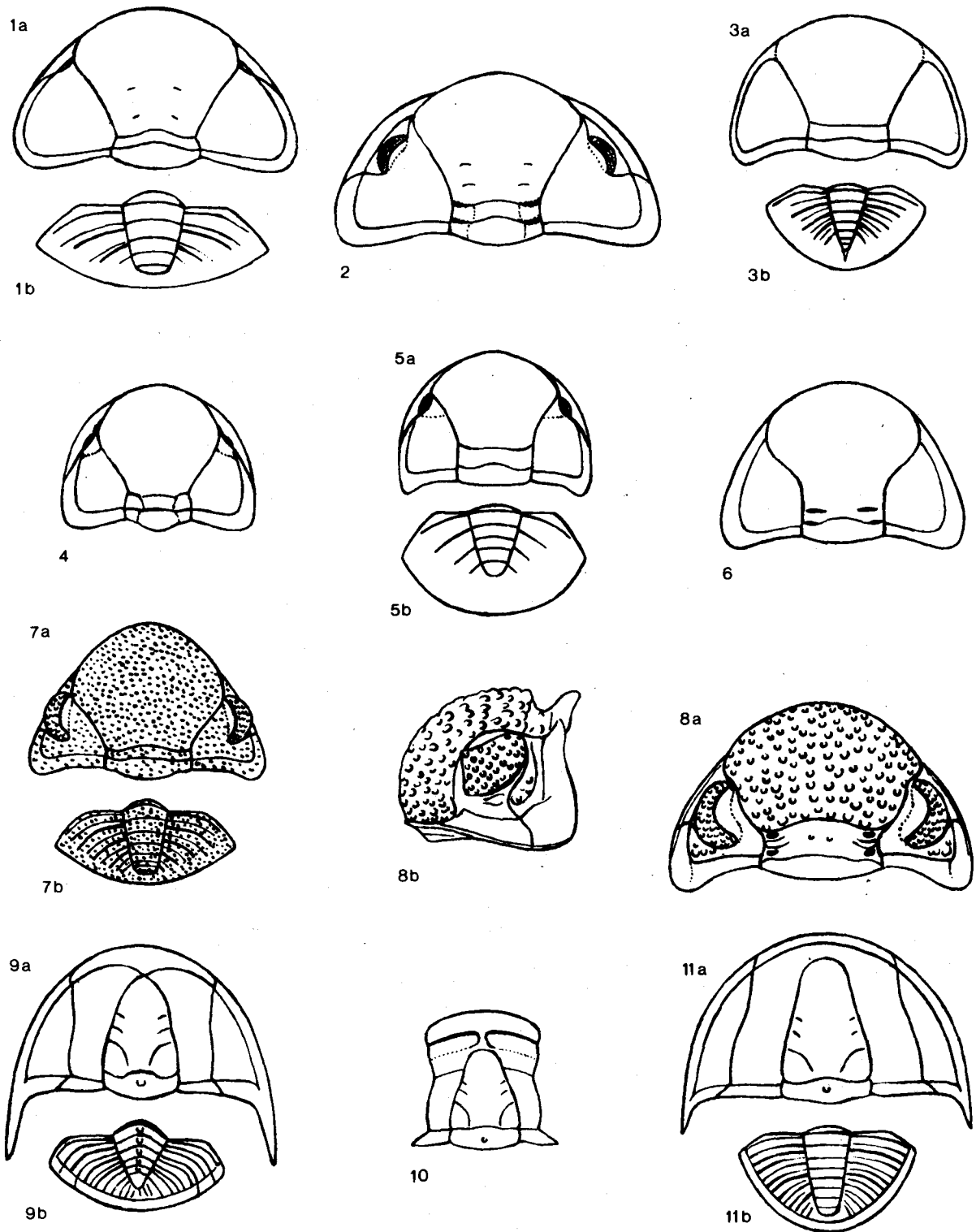


Figure 6. - Famenian Phacopidae (1-8) and Drevermanniinae (9-11) from Europe, not to scale; if not otherwise indicated :
a = cephalon, b = pygidium.

1. *Trimerocephalus mastophthalmus* (Reinh. Richter, 1856); do II.
2. *Nephranops miserrimus miserrimus* (Drevermann, 1901); do II.
3. *Ductina (Ductina) ductifrons* (Rud. & E. Richter, 1923); do II.
4. *Cryphops schlosseri* (Rud. & E. Richter, 1955); do III.
5. *Dienstina diensti* (Rud. & E. Richter, 1923); do II.
6. *Dianops griffithides griffithides* (Rud. & E. Richter, 1919); do V.
7. "*Phacops*" *granulatus* (Münster, 1840); ? do II, do III-VI.
8. *Omegops accipitrinus accipitrinus* (Phillips, 1841), a = dorsal view, and b = side view of cephalon; do VI.
9. *Drevermannia (Formonia) formosa* Rud. Richter, 1913; do ? II.
10. *Pontopalpebralia pontifera* (Lütke, 1968), cranidium; do II.
11. *Drevermannia (Drevermannia) schmidti* Rud. Richter, 1913; do V.

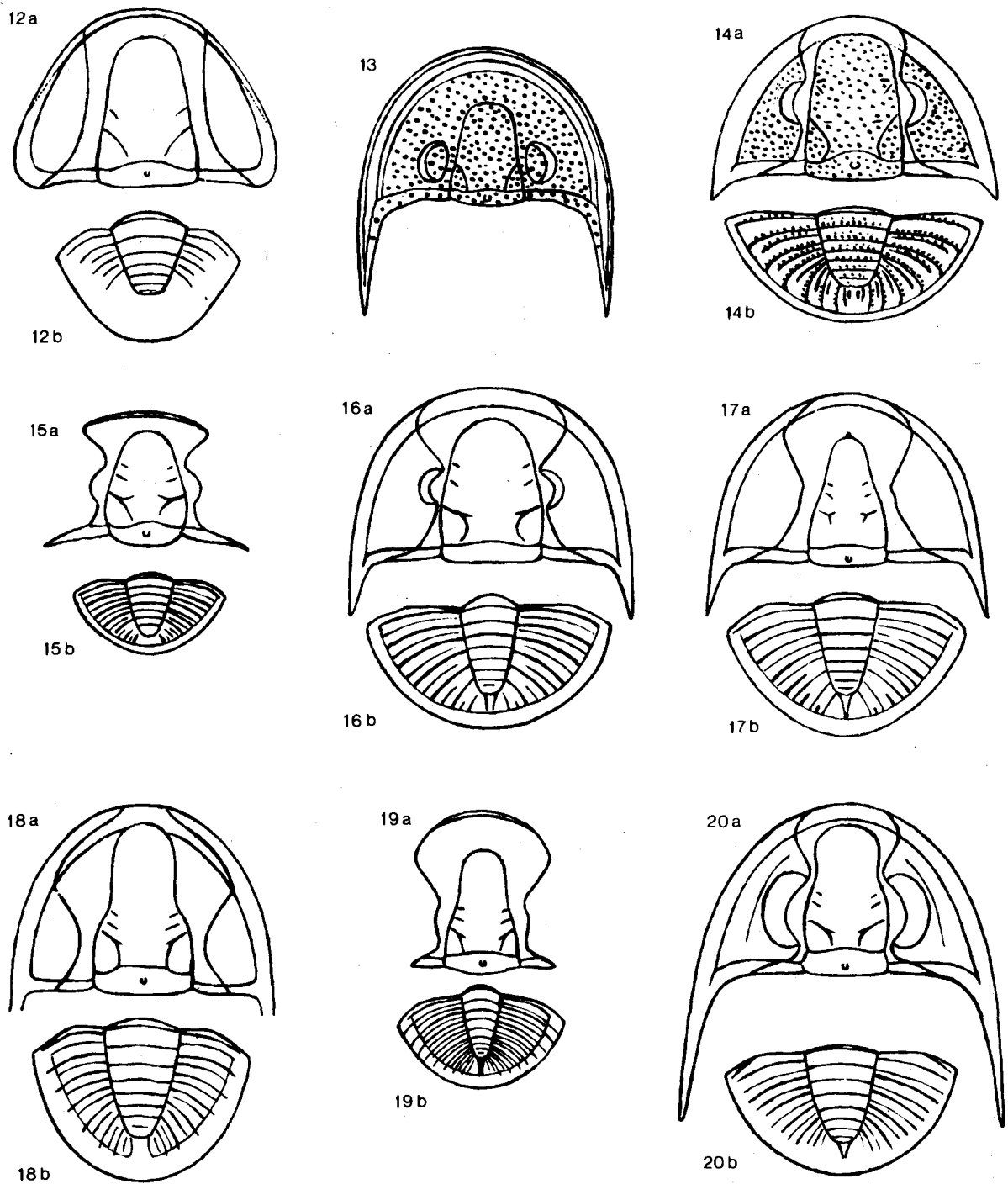


Figure 7. - Famennian Drevermanniinae (12), Brachymetopinae (13), ?Proetidae or ?Phillipsiidae (14),
 Cyrtosymbolinae (15-19) and Linguaphillipsiinae (20) from Europe, not to scale;
 a = cephalon or cranidium, b = pygidium

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| <p>12. <i>Chaunoproetus palensis</i> (Rud. Richter, 1913); do IV-VI.
 13. <i>Brachymetopus drevermanni</i> G. Hahn, 1964; do VI.
 14. <i>Perliproetus marginatus</i> (Münster, 1842); do VI.
 15. <i>Cyrtosymbole (Cyrtosymbole) escoti</i> (v. Koenen, 1886); do II.
 16. <i>Cyrtosymbole (Franconicabole) dillensis</i> (Drevermann, 1901); do II.</p> | <p>17. <i>Calybole gracilis</i> (Rud. & E. Richter, 1955); do II-IV.
 18. <i>Typhloproetus subcarIntiacus</i> Rud. Richter, 1913; do V-VI.
 19. <i>Pusillabole antedistans</i> (Rud. & E. Richter, 1926); do V-VI.
 20. <i>Pseudowaribole (Pseudowaribole) octofera octofera</i> (Rud. & E. Richter, 1926); do VI.</p> |
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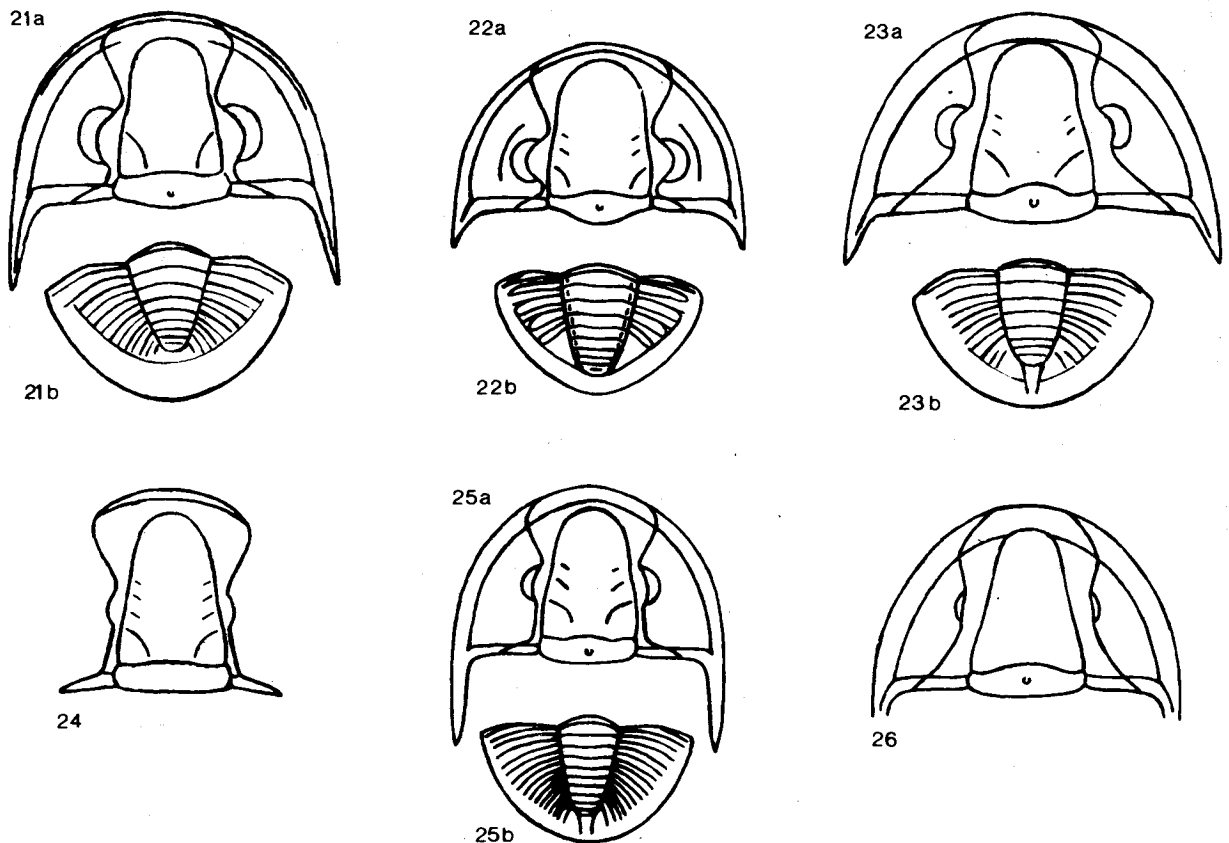


Figure 8. - Famennian and Lower Dinantian Archegoninae from Europe, not to scale.

a = cephalon or cranidium, b = pygidium.

21. *Archegonus (Waribole) warsteinensis* (Rud. & E. Richter, 1926); do VI.
 22. *Archegonus (Weania) abruptirhachis* (Rud. & E. Richter, 1951); ?uppermost do VI.
 23. *Mirabole kielanae* Osmólska, 1962; do VI.
 24. *Archegonus (Phillibole) anglicus* (Rud., Richter, 1913); do V-VI.
 25. *Archegonus (Phillibole) drewerensis drewerensis* (Rud. & E. Richter, 1951); Dinantium I.
 26. *Silesiops (Silesiops) schindewolfi* (Rud. & E. Richter, 1919), do V-VI.

genus - perhaps because of the strong apomorphic features of certain late species -, the name *Weaniinae* Owens, 1983 becomes valid.

3. In our opinion, the systematic position of *Perliproetus* is still uncertain. Despite several proetid-like features (as pointed out by Chlupáč, 1966), it cannot be excluded that this genus represents an early offshoot (perhaps on subfamily level ?) of the Phillipidae. The possibility of such phylogenetical relationships has increased, since G. Hahn *in* Luppold & Hahn & Korn (1984 : 96) mentioned a *Pseudowaribole*-like shape of a cranidium most probably belonging to a new species of *Perliproetus*. Perhaps further investigations, especially on the ontogenetical development of *Perliproetus*, will show, if this presumption is right or not.

REFERENCES

- ALBERTI, H., 1973. Neue Trilobiten (Cyrtosymbolen) aus dem Ober-Devon IV bis VI (Nord-Afrika und Mittel-Europa). Beitrag 1. N. Jb. Geol. Paläont. Abh. 144 (2) : 143-180, figs. 1-10, tabs. 1-3; Stuttgart.
 ALBERTI, H., 1976. Neue Trilobiten (*Richteraspis* und *Vittaella* n. g.) aus dem Ober-Devon I und III (Nord-Afrika und Mittel-Europa). Beitrag 7. N. Jb. Geol. Paläont. Abh. 152 (3) : 281-292, figs. 1-2, tabs. 1-3; Stuttgart.
 ALBERTI, H., GROOS-UFFENORDE, H., STREEL, M., UFFENORDE, H. & WALLISER, O.H., 1974. The stratigraphical significance of the *Protognathodus* fauna from Stockum (Devonian/Carboniferous boundary, Rhenish Schiefergebirge). Newsl. Stratigr., 3 (4) : 263-276, figs. 1-2; Leiden.

- BRAUCKMANN, C. & HAHN, G., 1984. Trilobites as index fossils at the Devonian-Carboniferous boundary. *Cour. Forsch.-Inst. Senckenberg*, 67 : 11-14, figs. 1-5; Frankfurt am Main.
- CHLUPÁČ, I., 1966. The Upper Devonian and Lower Carboniferous trilobites of the Moravian Karst. *Sborn. geol. Véd., Paleont. Řada P*, 7 : 1-143, figs. 1-35, tabs. 1-6, pls. 1-24, Prague.
- GANDL, J., 1980. Die Karbon-Trilobiten des Kantabrischen Gebirges (NW-Spanien), 3 : Trilobiten mit "Kulm-Charakter" aus dem Namur B. *Senckenbergiana lethaea*, 60 (4/6) : 291-351, figs. 1-27, pls. 1-4; Frankfurt am Main.
- HAHN, G. & BRAUCKMANN, C., 1984. Zur Kenntnis oberdevonischer Trilobiten aus dem Bergischen Land. *Jber. naturwiss. Ver. Wuppertal*, 37 : 116-124, figs. 1-3, tab. 1; Wuppertal.
- HAHN, G. & HAHN, R., 1975. Die Trilobiten des Ober-Devon, Karbon und Perm. Leitfossilien (2. Edition; Editor : K. Krömmelbein), 1 : I-VIII, 1-127, figs. 1-4, tabs. 1-5, pls. 1-12; Berlin & Stuttgart (Gebr. Borntraeger) (with many further references).
- KOBAYASHI, T. & HAMADA, T., 1973. *Cyrtosymbolids (Trilobita) from the Langgon Red Beds in Northwest Malaya, Malaysia.* *Geol. Palaeont. Southeast Asia*, 12 : 1-28, figs. 1-8, pls. 1-3; Tokyo.
- LUPPOLD, F.W., HAHN, G. & KORN, D., 1984. Trilobiten-, Ammonoiten- und Conodonten-Stratigraphie des Devon/Karbon-Grenzprofils auf dem Müszenberg (Rheinisches Schiefergebirge). *Cour. Forsch.-Inst. Senckenberg*, 67 : 91-121, figs. 1-7, tabs. 1-4, pls. 1-6; Frankfurt am Main.
- LÜTKE, F., 1968. Trilobiten aus dem Oberdevon des Südwest-Harzes. *Stratigraphie, Biotop und Systematik. Senckenbergiana lethaea*, 49 (2/3) : 119-191, figs. 1-17, tabs. 1-3, pls. 1-8; Frankfurt am Main.
- MAKSIMOVA, S.A., 1955. Trilobity srednego i verchnego devona Urali i severnykh Mugodshar. *Trudy VSEGEI, n. ser.*, 3 : 1-263, figs. 1-44, pls. 1-18; Moscow.
- OSMÓLSKA, H., 1962. Famennian and Lower Carboniferous *Cyrtosymbolinae (Trilobita)* from the Holy Cross Mountains (Poland). *Acta Palaeont. Polonica*, 7 (1/2) : 53-204, figs. 1-8, tabs. 1-7, text-pls. 1-9, photo-pls. 1-17; Warsaw.
- OSMÓLSKA, H., 1963. On some Famennian *Phacopinae (Trilobita)* from the Holy Cross Mountains (Poland). *Acta Palaeont. Polonica*, 8 (4) : 495-523, figs. 1-5, tabs. 1-4, text-pl. 1, photo-pls. 1-4; Warsaw.
- RICHTER, Rud. & RICHTER, E., 1926. Die Trilobiten des Ober-Devon. *Beiträge zur Kenntnis devonischer Trilobiten. IV. Abh. preuss. geol. L.-Anst.*, 99 : 1-314, figs. 1-18, tabs. A-C, pls. 1-12; Berlin.
- RICHTER, Rud. & RICHTER, E., 1955. Oberdevonische Trilobiten, Nachträge. 1. Trilobiten aus der *Prolobites*-Stufe III. 2. Phylogenie der oberdevonischen *Phacopidae*. *Senckenbergiana lethaea*, 36 (1/2) : 49-72, figs. 1-2, pls. 1-2; Frankfurt am Main.
- SCHINDEWOLF, O.H., 1937. Zur Stratigraphie und Paläontologie der Wocklumer Schichten (Ober-Devon). *Abh. preuss. geol. L.-Anst., n. F.*, 178 : 1-132, figs. 1-27, pls. 1-4; Berlin.
- STRUVE, W., 1976. Beiträge zur Kenntnis der *Phacopina (Trilobita)*, 9 : *Phacops (Omegops)* n. sp. (Trilobita, Ober-Devon). *Senckenbergiana lethaea*, 56 (6) : 429-451, figs. 1-33, pls. 1-2; Frankfurt am Main.
- XIANG LI-WEN, 1981. Some Late Devonian trilobites of China. *Geol. Soc. America, Spec. Pap.*, 187 : 183-190, pls. 1-2; New York.