

Conodonts from a potential Eifelian/Givetian Global Boundary Stratotype at Jbel Ou Driss, southern Ma'der, Morocco

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Abstract

Conodonts from a section at Jbel Ou Driss in the Ma'der (pre-Sahara of Morocco) with neritic and pelagic megafaunas, are studied in an attempt to define the Eifelian/Givetian boundary. The conodont succession ranges from the *T. kockelianus* Zone into the Lower *P. varcus* Subzone. The ancestry of *Polygnathus hemiansatus* is established. The section may be considered as a potential global stratotype for the Eifelian/Givetian boundary.

Key-words : potential boundary stratotype, Eifelian/Givetian, conodonts.

Résumé

Les conodontes d'une coupe dans le Jbel Ou Driss, Ma'der (Maroc pré-saharien), contenant des macrofaunes néritiques et pélagiques, sont étudiés afin de définir la limite Eifélien/Givetien. La succession des conodontes s'étend de la Zone à *T. kockelianus* jusque dans la Sous-zone inférieure à *P. varcus*. L'origine de *Polygnathus hemiansatus* est établie. La coupe peut être prise en considération en tant que stratotype global de la limite Eifélien/Givetien.

Mots-clefs : stratotype possible, limite Eifélien/Givetien, conodontes.

At its meeting in August 1988, the International Subcommittee on Devonian Stratigraphy unanimously adopted a motion, that the Subcommittee should focus its attention on the first occurrence of *Polygnathus hemiansatus* BULTYNCK, 1987 and discover its ancestry in order to assess its value as a marker for the Eifelian/Givetian boundary. Furthermore, it was agreed that special attention be given in order to provide a wide range of taxonomic documentation on other groups. At the same meeting, the Bou Tchrafine section (Tafilalt, Morocco) was not accepted as stratotype section for the Eifelian/Givetian boundary, mainly because of the occurrence of a mostly barren shaly interval, 40 cm thick (= *otomari* event of WALLISER, 1982; Kacak event of HOUSE, 1985 or Odershausen level of WEDDIGE, 1988), below the earliest occurrence of *P. hemiansatus*, but to some extent because of the condensed nature of the succession.

In order to meet these recommendations, an upper Eifelian to lower Givetian section in the eastern part of the Jbel Ou Driss (ODE) was sampled in detail for conodonts in 1989; accessory rugose corals, brachiopods, goniatites and trilobites were collected. A preliminary sampling for cono-

donts at this section was carried out in 1975, jointly with H. HOLLARD, who identified some goniatite species listed below.

Location and general characteristics of the Ou Driss sections (Fig. 1, Pl. 1)

The Jbel Ou Driss, a southwestern outlier of the Ma'der Basin, is located in the Zagora Graben, 55 km northeast of Zagora. It can easily be reached by the track to Tisse-moumine. The Jbel Ou Driss is made up of upper Emsian, Eifelian and lower Givetian rocks forming a narrow syncline orientated southwest-northeast. The 8 km long, continuous exposure along the northwestern side of the Jbel Ou Driss was studied in detail at two sections. HOLLARD (1974, p. 31, fig. 26) described the latter, "Jbel Ou Driss est" (ODE) and "Jbel Ou Driss ouest" (OD), and discussed the megafauna, which contains pelagic and neritic elements: rugose corals, brachiopods, bivalves, nautiloids, goniatites and trilobites. A detailed upper Emsian to upper Eifelian conodont succession ranging from the *Polygnathus dehis-cens* Zone into the *Tortodus kockelianus* Zone was described by BULTYNCK (1985) from the OD section. Conodont results from a preliminary sampling of the ODE section are given in HOLLARD (1981, tabl. 3, samples ODE-11 to ODE-1), a succession ranging from the *T. kockelianus* Zone into the Lower *P. varcus* Subzone of ZIEGLER, KLAPPER & JOHNSON, 1976 (*P. rhenanus/P. varcus* Zone of BULTYNCK, 1987) was recognized. The lowermost sample, ODE-11, is located 2 m above sample OD-37 from the Ou Driss section described by BULTYNCK (1985, pp. 262-264). The sampled interval between ODE-8 and ODE-6, about 20 m thick, has now been completed with 35 samples.

Conodont succession (Figs. 2-3)

Thirty-five 3 to 5 kg samples were taken. The interval between the preliminary samples ODE-8 and ODE-6 has been subdivided into 67 beds or groups of beds, numbered from ODE-8-1 to ODE-8-24, ODE-7-1 to ODE-7-26 and ODE-6-1 to ODE-6-17. The vertical succession of this

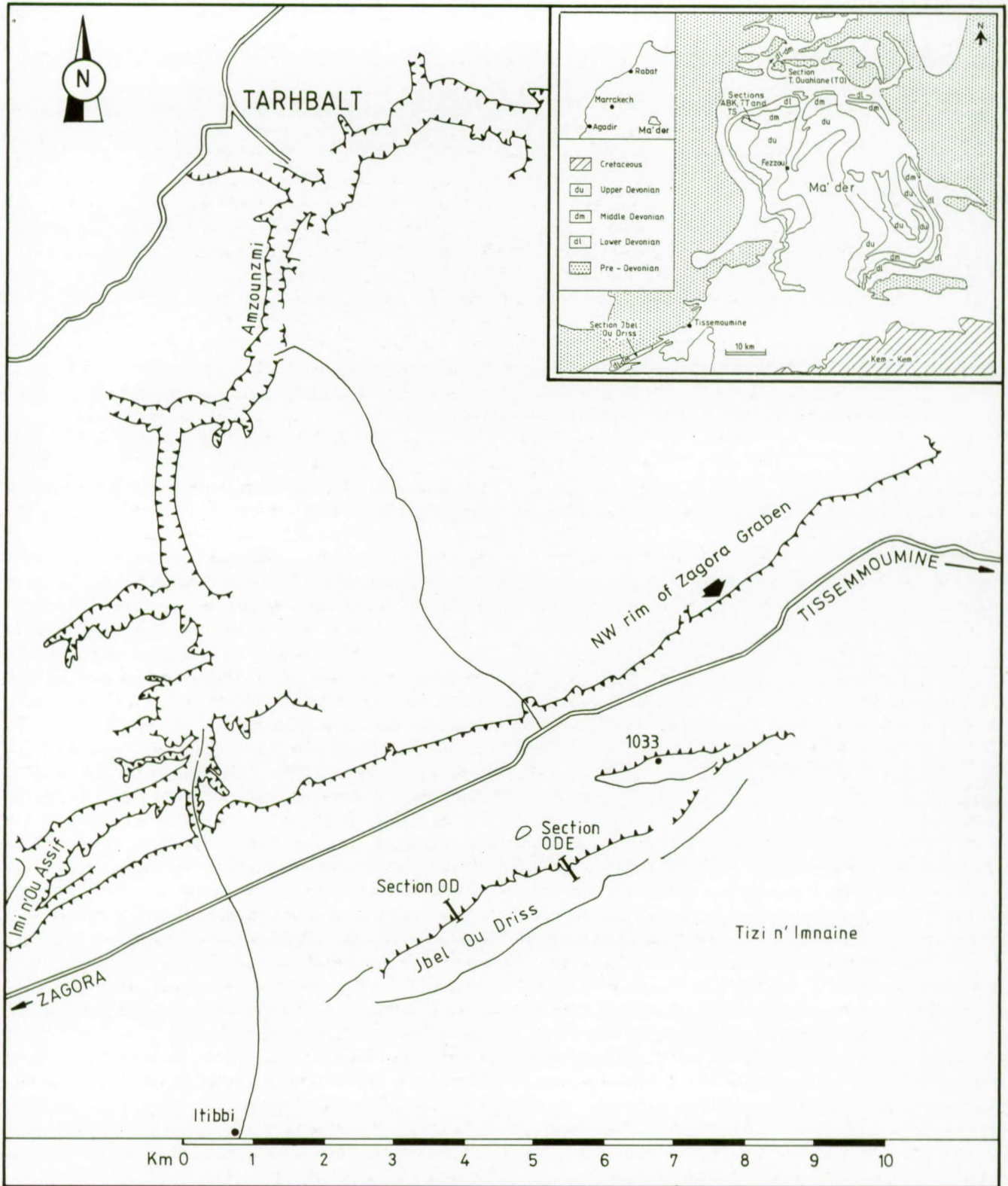


Fig. 1. - Sketch map showing the two sections in the Jbel Ou Driss referred to in the text. Inset map shows a geological sketch map of the Ma' der (modified from HOLLARD, 1974, fig. 1) with location of the Jbel Ou Driss and other Eifelian/Givetian boundary sections.

interval is represented in Figure 2; beds sampled for conodonts are indicated. Conodont frequency is very good according to Eifelian-lower Givetian standards. All samples produced conodonts: 11 samples with 50 to 100 specimens, 13 samples with 101 to 200 specimens and 11 samples with 201 to 900 specimens. Species of *Polygnathus* HINDE, 1879, particularly in the *P. linguiformis* HINDE, 1879 group are abundant. Species of *Icriodus* BRANSON & MEHL, 1938 occur regularly; they are frequent in the interval between samples ODE-8-5 and ODE-8-12 and between ODE-8-19 and ODE-8-23, but are absent in sample ODE-7-3 to ODE-7-9. Panderodontacea occur regularly. The most characteristic features of the conodont succession are summarized as follows.

1. *Tortodus kockelianus kockelianus* BISCHOFF & ZIEGLER, 1957 has been recognized in ODE-10, 15.50 m below ODE-8-1.
2. Typical specimens of *Polygnathus ensensis* ZIEGLER & KLAPPER, 1976 occur from ODE-7-1 upwards; a few questionable specimens were found below in ODE-8-23 and ODE-8-10. In this interval that may belong either to the *T. kockelianus* Zone or to the *P. ensensis* Zone, several common Eifelian species have their last occurrence: *Polygnathus robusticostatus* BISCHOFF & ZIEGLER, 1957 - *P. angusticostatus* WITTEKINDT, 1965 group, *P. angustipennatus* BISCHOFF & ZIEGLER, 1957, *Icriodus struvei* WEDDIGE, 1977 and *Icriodus amabilis* BULTYNCK & HOLLARD, 1980. It probably corresponds to the clear faunal break recognized in the Bou Tchrafine section between sample 15+ and 15bis (BULTYNCK, 1987, p. 155) and in the Freiling Formation of the Eifel (WEDDIGE & STRUVE, 1988, fig. 6).
3. *Polygnathus hemiansatus* and typical specimens of *Icriodus obliquimarginatus* BISCHOFF & ZIEGLER, 1957 appear within the *P. ensensis* Zone in ODE-7-11. *P. aff. P. hemiansatus* occurs from ODE-7-3 upwards. This taxon is considered here as the ancestral form of *P. hemiansatus* (see palaeontological notes).
Specimens transitional between *Icriodus regularicrescens* BULTYNCK, 1970 and *I. obliquimarginatus* occur from ODE-8-21 to ODE-7-1. A 1.60 m interval without icriodids occurs between ODE-7-1 and ODE-7-11 with typical specimens of *I. obliquimarginatus*.
4. *Polygnathus timorensis* KLAPPER, PHILIP & JACKSON, 1970 first occurs in ODE-6-5; questionable specimens were found 2.6 m below in ODE-7-23. *Icriodus brevis* STAUFFER, 1940 appears within this interval.
5. *Polygnathus rhenanus* KLAPPER, PHILIP & JACKSON, 1970 and *Icriodus difficilis* ZIEGLER & KLAPPER, 1976 first occur in ODE-3, about 26 m above ODE-6-17c.

Megafauna (Fig. 2, letters A, B, C, D and E; Pl. 1)

Provisional identifications of recently collected megafauna are due to M. COEN-AUBERT (rugose corals) and J. GODEFROID (brachiopods). Some brachiopods from the Jbel Ou Driss were described by DROT (1964, 1971). Faunal lists are given in HOLLARD (1974, pp. 32-33, fig. 4). Goniatites

were collected jointly with H. HOLLARD in 1975 and identified by the latter.

- Sample interval A: goniatites *Agoniatites nodiferus* (HALL, 1886).
- Sample interval B: rugose corals: *Acanthophyllum heterophyllum* (MILNE-EDWARDS & HAIME, 1851); brachiopods: *Pseudosieberella* sp., "*Camarotoechia*" *getulorum* DROT, 1971; goniatites: *Sobolewia* sp.
- Sample interval C: rugose corals: Metriophyllidae; brachiopods: *Fascicostella* sp., *Isorthis* sp., *Schizophoria schnuri schnuri* STRUVE, 1965, Orthida, *Atrypa* (*Atrypa*?) sp., cf. *Eoreticularia? aviceps* (KAYSER, 1871) in DROT (1964, pp. 74-75), Reticulariidae (*Minatothyris-Warrenella* group), *Pyramidalia?* sp., *Myriospirifer* sp., *Dicamara scalprum* cf. *antescalprum* STRUVE, 1964, *Subrensselandia* sp., "*Camarotoechia*" *getulorum* DROT, 1971; trilobites: Phacopidae.
- Sample interval D: goniatites: *Agoniatites* sp.
- Sample interval E: rugose corals, brachiopods.
- Sample interval between ODE-5 and ODE-4: goniatites: *Agoniatites obliquus* (WHIDBORNE, 1889).
- Sample interval between ODE-3 and ODE-2: rugose corals: *Heliophyllum halli moghrabiense* LEMAÎTRE, 1947, *Acanthophyllum heterophyllum* (MILNE-EDWARDS & HAIME, 1851), *A. vermiculare* (GOLDFUSS, 1826), *Stringophyllum* cf. *primordiale* WEDEKIND, 1922, *Cystiphyllodes secundum* (GOLDFUSS, 1826), *Mesophyllum* sp., *Siphonophrentis* sp., *Thamnophyllum* sp.; brachiopods: *Isorthis* sp., *Spinatrypa* (*Isospinatrypa*) sp., *Athyris* sp., cf. "*Uncinulus*" *coronatus* (KAYSER, 1871) in DROT (1971, pp. 71-73).
- Sample interval between ODE-2 and ODE-1: brachiopods: *Stringocephalus* cf. *burtini* DEFRANCE, 1824 (see HOLLARD, 1974, p. 33).

Palaeontological notes

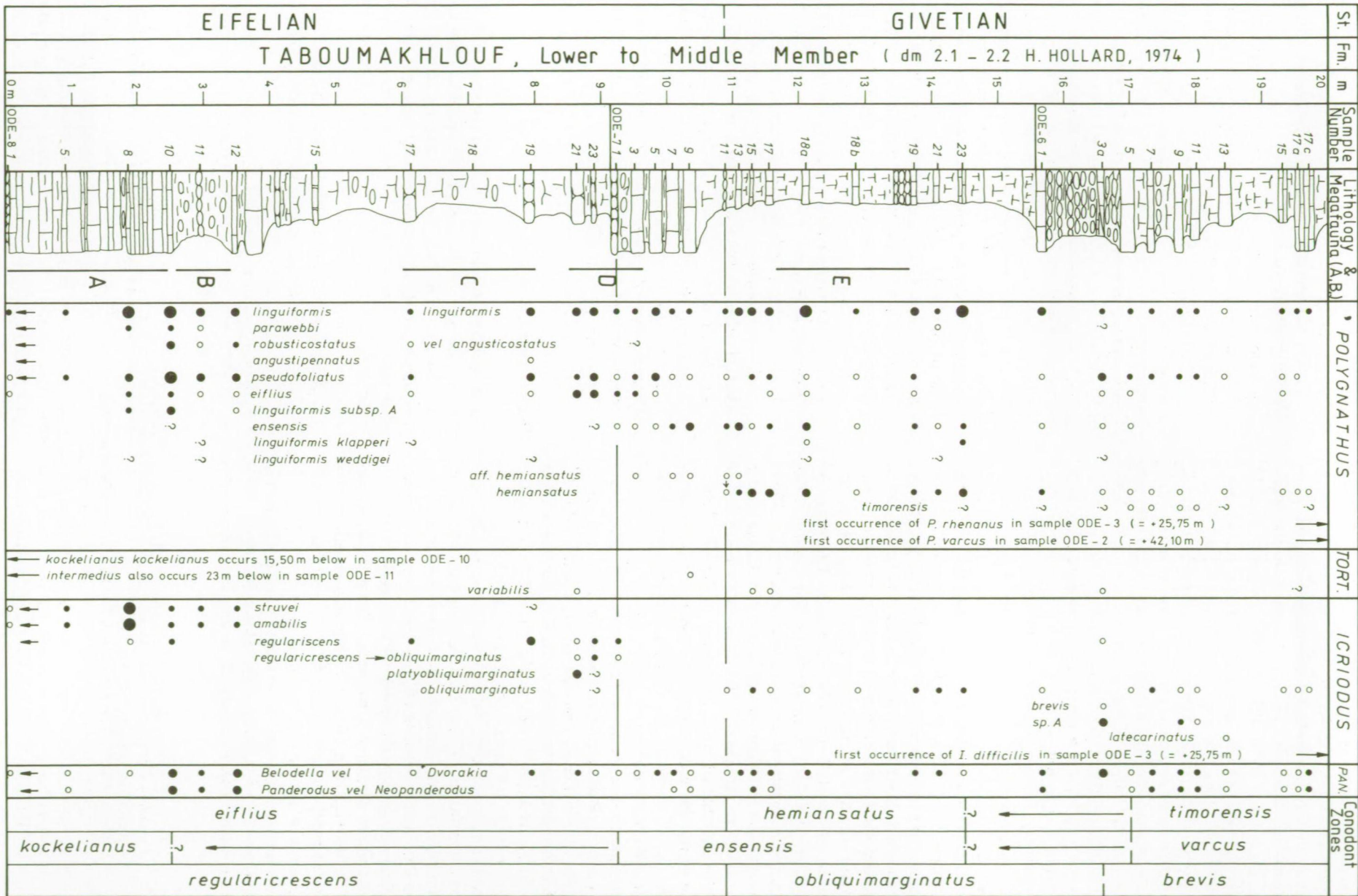
The main purpose is to document the ancestry of *Polygnathus hemiansatus* on the basis of the material from the Ou Driss East section. *Polygnathus ensensis* is discussed in comparison to the type material. All remarks refer to Pa elements.

Polygnathus ensensis ZIEGLER & KLAPPER, 1976
(Plate 2, Figures 12-21)

- * 1976 *Polygnathus xylus ensensis* n. subsp. - ZIEGLER & KLAPPER in ZIEGLER, KLAPPER & JOHNSON, pp. 125-127, pl. 3, figs. 4-9.

Remarks:

Most specimens assigned here to *P. ensensis* have a free blade that is slightly longer than the platform, and a more or less symmetrical platform with margins that are essentially parallel and serrated just anterior of the geniculation point; the platform is clearly arched downward posterior to these serrations. These characteristics agree well with



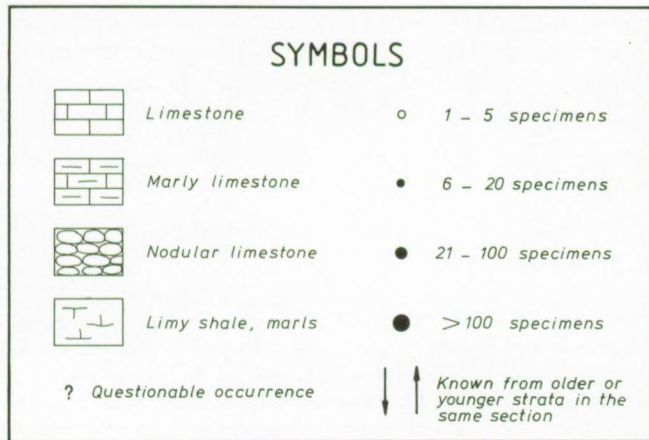


Fig. 3. - Symbols for figure 2.

the original diagnosis of the species. However, the degree of development of the serrations on the platform margins, just posterior to the geniculation point, is generally not so distinct as in the holotype; this may be a matter of preservation. In their original diagnosis ZIEGLER & KLAPPER also mentioned that: "characteristically there are three to five serrations on both sides, but in phyletically late forms, there are two to three on the inner side and none to one on the outer side". Most of the Ou Driss specimens have two or three weak to distinct serrations on the inner side and none or one to two weak serrations on the outer side. There is no stratigraphic evidence for considering these specimens as late forms. In one specimen (Pl. 2, Fig. 12) the serrations seem to be obscured by diagenetic processes.

Polygnathus hemiansatus BULTYNCK, 1987
(Plate 2, Figures 6, 7, 10, 11)

* 1987 *Polygnathus hemiansatus* n. sp. - BULTYNCK, pp. 161-162, pl. 7, figs. 16-27; pl. 8, figs. 1-7.

Remarks :

Typical specimens of *P. hemiansatus* have a distinct constriction starting just anterior to the outer geniculation point; the outer anterior trough margin is bowed outward and declines obliquely. In *P. aff. P. hemiansatus* the constriction at the outer geniculation point is not so distinct; more important, the outer anterior trough margin declines steeply as in *P. pseudofoliatus*. See also under *P. aff. P. hemiansatus*.

The nearly straight inner platform margin without an outward bowing of the inner anterior trough margin constitutes the main difference from *P. ansatus*. As *P. ansatus*

is considered to derive directly from *P. hemiansatus* the range of variation in outline of the inner platform margin in the two species may overlap in the higher part of the range of *P. hemiansatus*.

Polygnathus aff. *P. hemiansatus* BULTYNCK, 1987
(Plate 2, Figures 3-5, 8, 9)

Remarks :

This form is considered as transitional between *P. pseudofoliatus* and *P. hemiansatus* with respect to the characteristics of the platform outline. Differences from *P. hemiansatus* are discussed under that species. *P. aff. P. hemiansatus* can be distinguished from *P. pseudofoliatus* by the presence of a weak constriction just anterior to the outer geniculation point. By contrast the anterior platform of *P. pseudofoliatus* narrows progressively and is most constricted at its anterior end. The specimen of *P. pseudofoliatus* with narrow platform figured by WITTEKINDT (1965, pl. 2, fig. 22) is similar in platform outline to the specimen of *P. aff. P. hemiansatus* figured here on Plate 2, Figure 5.

Polygnathus pseudofoliatus WITTEKINDT, 1965
(Plate 2, Figures 1, 2)

* 1965 *Polygnathus pseudofoliata* n. sp. - WITTEKINDT, pp. 637-638, pl. 2, fig. 19-23 (fig. 22, transitional form between *P. pseudofoliatus* and *P. hemiansatus*).

Remarks :

Differences from and affinity with *P. aff. P. hemiansatus* and *P. hemiansatus* are discussed under those species.

Conclusions

If the Subcommittee on Devonian Stratigraphy decides that the Eifelian/Givetian boundary should correspond with the earliest occurrence of *Polygnathus hemiansatus*, I recommend that the section Ou Dris east (ODE) in the Jbel Ou Driss should be considered as a candidate Global Stratotype Section and Point. The advantages of this section are summarized as follows.

1. The Eifelian/Givetian boundary beds are part of a thick succession ranging from the Emsian (*P. dehiscens* Zone) into the lower Givetian (Lower *P. varcus* Subzone), exposed without interruption along the 8 km long northwestern side of the Jbel Ou Driss (see pl. 1).

◁ Fig. 2. - Conodont distribution and frequency in the Ou Driss East (ODE) section, sample interval ODE-8-1 to ODE-6-17c.
Column St. : chronostratigraphy.
Column Fm : lithostratigraphy after HOLLARD (1974 and 1981).
Column megafauna (A, B...) : see list megafauna in text.
Column conodont zones : first column = refined *Polygnathus* zonation after BULTYNCK (1987); second column = conodont standard zonation after ZIEGLER, KLAPPER & JOHNSON (1976); third column = alternative *Icriodus* zonation after BULTYNCK (1987).

2. Conodonts are abundant for upper Eifelian/lower Givetian standards; *P. hemiansatus* has its earliest occurrence in ODE-7-11 and its ancestor occurs in the same sample and in ODE-7-9, ODE-7-7 and ODE-7-3, respectively 0.40 m, 0.65 m and 1.20 m below. Typical specimens of *I. obliquimarginatus* occur for the first time together with *P. hemiansatus*.
3. The megafauna of the Ou Driss east section contains pelagic and neritic elements: rugose corals, brachiopods, bivalves, nautiloids, goniatites and trilobites. Some of the brachiopods were described by DROT (1964, 1971) and brachiopods, bivalves and trilobites were listed by HOLLARD (1974). Further systematic study of the different megafaunal groups should provide additional evidence for the position of the Eifelian/Givetian boundary.
4. Correlation with other sections in the Sub-Sahara of southeast Morocco in the neritic (Ma'der area, Akka Bou Khedach, Ouahlane; BULTYNCK, 1985 and 1987)

References

- BULTYNCK, P. 1985. Lower Devonian (Emsian) - Middle Devonian (Eifelian and lowermost Givetian) conodont successions from the Ma'der and the Tafilalt, southern Morocco. *Courier Forschungsinstitut Senckenberg*, 75 : 261-286.
- BULTYNCK, P., 1987. Pelagic and neritic conodont successions from the Givetian of pre-Sahara Morocco and the Ardennes. *Bulletin van het Koninklijk Belgisch Instituut voor Natuurwetenschappen. Aardwetenschappen*, 57 : 149-181.
- DROT, J., 1964. Rhynchonelloidea et Spiriferoidea siluro-dévonien du Maroc pré-saharien. *Notes et Mémoires du Service Géologique du Maroc*, 178 : 1-287.
- DROT, J., 1971. Rhynchonellida siluriens et dévonien du Maroc pré-saharien. Nouvelles observations. *Notes du Service géologique du Maroc*, 31 (237) : 65-108.
- HOLLARD, H., 1974. Recherches sur la stratigraphie des formations du Dévonien Moyen, de l'Emsien Supérieur ou Frasnien, dans le Sud du Tafilalt et dans le Ma'der (Anti-Atlas oriental). *Notes du Service géologique du Maroc*, 36 (264) : 7-68.
- HOLLARD, H., 1981. Tableaux de corrélations du Silurien et du Dévonien de l'Anti-Atlas. *Notes du Service géologique du Maroc*, 42 (308) : 23, tabl. 1-5.
- HOUSE, M., 1985. Correlation of mid-Palaeozoic ammonoid evolutionary events with global sedimentary perturbations. *Nature*, 313 : 17-22.
- WALLISER, O.H., 1982. Goniatite correlation at the Lower/Middle Devonian boundary. In: SOKOLOV, B.S. and RZHONSNITSKAYA, M.A. (Editors), *Biostratigraphy of Lower and Middle Devonian boundary deposits*. Proceedings of Field Symposium of the International Subcommittee on Devonian Stratigraphy. Akademia Nauk U.S.S.R., Leningrad, pp. 51-53.
- WALLISER, O.H., 1988. Proposal for an Eifelian/Givetian boundary stratotype. Document submitted to the Subcommittee on Devonian Stratigraphy, Rennes, August 1988, pp. 1-4.
- WEDDIGE, K. & STRUVE, W., 1988. Towards a "natural" Givetian boundary. Voting for a conodont based boundary close to the culmination of the otomari event. Document submitted to the Subcommittee on Devonian Stratigraphy, Rennes, August 1988, pp. 1-12.
- WITTEKINDT, H., 1965. Zur Conodontenchronologie des Mitteldevons. *Fortschritte in der Geologie von Rheinland und Westfalen*, 9 : 621-646.
- ZIEGLER, W., KLAPPER, G. & JOHNSON, J.G., 1976. Redefinition and subdivision of the varcus-Zone (conodonts, Middle-?Upper Devonian) in Europe and North America. *Geologica et Palaeontologica*, 10 : 109-140.

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PLATE 1

- Upper : Section Ou Driss East (ODE) from sample ODE-10 to sample ODE-1. The prominent cliff with sample ODE-10 near the base and sample ODE-9 at the top is about 12 m high.
- Lower : Exposure along the northwestern side of the Jbel Ou Driss. A : location of the section Ou Driss East; B : cliff with sample ODE-10 near the base and sample ODE-9 at the top.

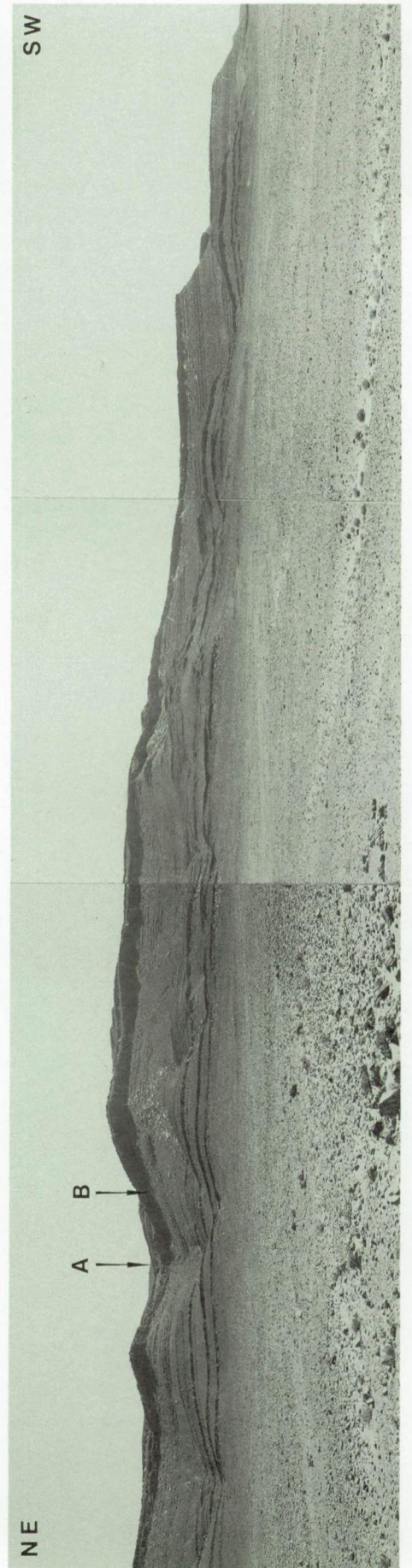
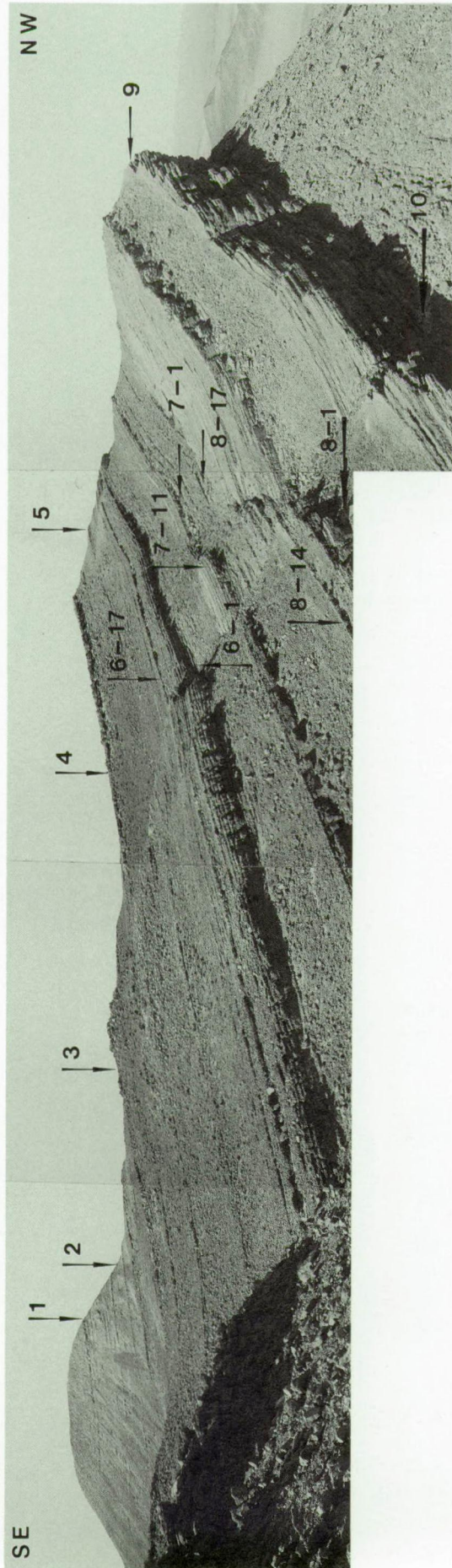


PLATE 2

All magnifications are $\times 45$, except fig. 1b, $\times 90$.

- Figs. 1-2. – *Polygnathus pseudofoliatus* WITTEKINDT, 1965; sample ODE-7-3; figs. 1a, b, oblique-lateral view and detail of anterior trough margins of I.R.Sc.N.B. N° b2219; fig. 2, upper view of I.R.Sc.N.B. N° b2220.
- Figs. 3-5, 8, 9. – *Polygnathus* aff. *P. hemiansatus* BULTYNCK, 1987; figs. 3-5, upper views of I.R.Sc.N.B. N° b2221, N° b2222, N° b2223, sample ODE-7-3; figs. 8a, b, upper and outer oblique-lateral views of I.R.Sc.N.B. N° b2224, sample ODE-7-11; fig. 9, upper view of I.R.Sc.N.B. N° b2225, sample ODE-7-9.
- Figs. 6, 7, 10, 11. – *Polygnathus hemiansatus* BULTYNCK, 1987; figs. 6a, b, upper and outer oblique-lateral views of I.R.Sc.N.B. N° b2226, sample ODE-7-13; fig. 7, upper view of I.R.Sc.N.B. N° b2227, blade broken, sample ODE-7-11; figs. 10, 11, outer lateral and lower views of I.R.Sc.N.B. N° b2228, N° b2229, blade incomplete, sample ODE-7-23.
- Figs. 12-21. – *Polygnathus ensensis* ZIEGLER & KLAPPER, 1976; fig. 12, inner lateral view of I.R.Sc.N.B. N° b2230, sample ODE-7-3; figs. 13, 14, upper and inner lateral views of I.R.Sc.N.B. N° b2231, N° b2232, sample ODE-7-5; figs. 15a, b, inner oblique-lateral and oblique-upper views of I.R.Sc.N.B. N° b2233, sample ODE-7-7; fig. 16 inner lateral view of I.R.Sc.N.B. N° b2234, blade incomplete, sample ODE-7-7; figs. 17, 18, 19, oblique-upper, upper and oblique-upper views of I.R.Sc.N.B. N° b2235, N° b2236, N° b2237, sample ODE-7-9; figs. 20, 21, inner lateral and upper views of I.R.Sc.N.B. N° b2238, N° b2239, blade incomplete, sample ODE-7-11.
- Figs. 22-23. – *Icriodus obliquimarginatus* BISCHOFF & ZIEGLER, 1957; upper and inner lateral view of I.R.Sc.N.B. N° b2240, N° b2241, anterior end of spindle incomplete; sample ODE-7-11.

