INTERNATIONAL UNION OF
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SUBCOMMISSION ON DEVONIAN STRATIGRAPHY

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I.U.G.S. Subcommission on Devonian Stratigraphy
***Newsletter No. 10*, December1994**
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The *Newsletter* appears biannually at approximately 6 month intervals in the spring and fall. This schedule will generally coincide with SDS meetings and should better serve the membership. Contributions may be sent to the Editor any time during the year for inclusion in the next issue. The initial printing of this issue is 125 copies with distribution of 93 mailed to titular and corresponding members in 27 countries, 14 to honorary members and friends and 3 to libraries.

The cost of preparation, printing and postage for the *Newsletter* is shared by IUGS and the Department of Geology, University of Texas at Arlington.

CONTENTS

EDITORIAL NOTES

⇒ The next issue will be mailed in fall 1994 in order that the membership may receive news of the Moscow meeting. Thereafter the *Newsletter* will appear biannually at approximately 6 month intervals in the spring and fall. This schedule will generally coincide with SDS meetings and should better serve the membership. Please send information you wish included in the *Newsletter* at any time during the year and every effort will be made to include this material in the next issue.

⇒ The SDS reference data base is being updated periodically as articles are gleaned from published records and from member contributions. I have recently converted systems from IBM-PCs to Macintoshes and am in the process of converting the data base to FoxBase Pro on the Macintosh. The PC data base will be discontinued by the end of summer 1993, however, the data base will continue to be available on DOS disks in several formats readable by DOS based data bases, spreadsheets and text editors. All Macintosh formats are supported. Text files are arranged in reference format and can be searched with any basic word processor. Copies are free. Indicate the computer system and choice of format or formats.

⇒ I wish to thank all members and interested parties who supplied information for this issue. The response was unexpected in view of past contributions. The volume and timing of contributions did cause some delay but overall the delay served the membership well. I wish to especially thank those members who supplied contributions on computer disk or via e-mail. Receiving contributions in this manner makes life much easier on this end and has the added benefit of allowing authors to control content to a much greater degree. Supplying of information through e-mail (internet, etc.) is fast becoming the choice among academic institutions and is slowly invading the non-academic sector as well. There are some things to keep in mind however. If you wish to send a contribution of some length that contains type styles such as italics or bold, then you need to prepare the contribution as you would normally and then encode the file using methods such as UUencode or BINHex which are standard to most e-mail systems. This encoding preserves all formatting and styles as you wish them to appear. Graphic images can be encoded in the same way. Listed below are e-mail addresses of those who supplied information via e-mail. These addresses have been supplied to Dr. Rex Doescher, Smithsonian Institution, who maintains a list of e-mail addresses for paleontologists. If you wish a copy of this list in standard word processor form, contact me at the address below.

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CIRCULARS ON THE MOSCOW MEETING

The SDS circular sent to members in October included details of the Moscow Meeting as provided by Russian colleagues at the Göttingen Meeting and subsequently. It seemed necessary to let members have this information as soon as possible and a number have replied expressing their intention. I have received recent amendments from Moscow by e-mail. On 29 November I received as hard copy a complete First Circular from Moscow. This is included with this Newsletter.

Those wishing to attend are asked to send the questionnaire direct to Drs. Lebedev and Yatskov as requested. Please do so even if the earlier blue form was filled in. However, I will send copies of blue forms received to Moscow. It might be helpful if a copy was also sent to me since I can, from time to time e-mail Moscow with information and thus circumvent any delay there may be in the post to Moscow.

Prof. M.R House, Department of Geology, The University, Southampton, SO9 SNH, UK

FIRST CIRCULAR — MOSCOW MEETING

MOSCOW VENUE

July, 9-22 1954 Moscow Symposium "Devonian eustatic changes of the World Ocean Level"

JOINT SUBCOMMISSION ON THE DEVONIAN STRATIGRAPHY AND IGCP "PALAEOZOIC MICROVERTEBRATE BIOCHRONOLOGY AND GLOBAL MARINE-NON-MARINE CORRELATION" PROJECT NO. 328 MEETING, MOSCOW AND TIMAN

FIRST CIRCULAR

As it was agreed at the last joint SDS-IGCP 328 meeting (Goettingen, 1993), the next SDS "Devonian eustatic changes of the World Ocean Level" Symposlum and a field trip will be held in Russia. It is proposed to arrange the session, workshops and business meeting in Moscow, Palaeontological Institute of the Russian Academy of Sciences, July 12-14, 1994. There will be an excursion held to the South Timan region from 16 to 22 of July.

The IGCP 328 project participants might arrive before this session for a workshop, collections examination and a one-day field trip in the vicinities of Moscow.

ORGANIZING COMMITTEE:

Chairpersons:

Rzhonsnitskaya, M,A., Chairwoman, Devonian commission, Interdepartmental Stratigraphic Committee of Russia (All-Russian Geological Institute, Sankt-Petersburg, Russia)

House, M.R., SDS Chairman (University of Southampton, U.K.)

Rozanov, A.Yu., Director (Palaeontological Institute of the Russian Academy of Sciences, Moscow, Russia)

Vice-Chairmen:

Bogatsky, V.I. (All Russian Research Oil Geological Prospecting Institute, Territorial Industrial Union, Ukhta, Russia)

Feist, R., SDS Vice-Chairman (Universite de Montpellier II, Montpellier, France)

Secretaries:

Yudina, Yu.A. - Timan excursion Field Leader (All-Russian Research Oil Geological Prospecting Institute, Territorial Industrial Union, Ukhta, Russia)

Bultynck, P., SDS Secretary (Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel, Belgium)

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Teplov, E.L. (Ukhtaneftgazgeologiya Territorial Industrial Union, Ukhta, Russia)

Pankratov, Yu.A., (All-Russian Research Oil Geological Prospecting Institute, Territorial Industrial Union, Ukhta, Russia)

Moskalenko, M.N. (All-Russian Research Oil Geological Prospecting Institute, Territorial Industrial Union, Ukhta, Russia)

Ivanov, A.O. Earth Crust Research Institute of the Sankt-Petersburg University, Sankt-Petersburg, Russia)

Lebedev, O.A. (Palaeontological Institute of the Russian Academy of Sciences, Moscow, Russia)

PRELIMINARY SCHEDULE:

IGCP 328 project participants: July 8-11 - project session, business meeting, one-day field excursion to the Upper Carboniferous quarry in the suburbs of Moscow (excursion B), fish collections examination in the Palaeontological Institute of the Russian Academy of Sciences, Moscow.

SDS meeting: July 11-14 - arrival of the participants, "Devonian Eustatic Changes of the World Ocean Level" Symposium and SDS business meeting in the Palaeontological Institute of the Russian Academy of Sciences, Moscow;

examination of collections on conodonts, ostracods, cephalopods, brachiopods, fishes and probably radiolarians and spores (other groups proposed by you will be available by your personal request). July 15 - flight from Moscow to Ukhta.

Excursion"Frasnian of the South Timan" (excursion A): July 15-21 - meeting in Ukhta and field trips (Timan, Ustye Yaregi, Domanik, Vetlasyan and Sirachoy Formations; Upper Frasnian substage, the boundaries of the Frasnian). Borehole cores and collections on conodonts, brachiopods, ostracods and spores examinatlon.

Vezha Vozh River excursion (excursion C): July 21-22 - Vezha Vozh River localities (Lyaiol Formation, slope and basinal facies of the Upper Frasnian).

Vezha Vozh River excursion (excursion C) is optional. This will be a short field trip to a distant locality by helicopter, with a night to spend in a camp. Tents, field beds and other facilities will be provided. Those who would like to take part, might leave on July, 23 from Ukhta to Moscow or Sankt-Petersburg.

Weather in Moscow in July might differ from mild and cool to hot and dry, but is approximately the same as in the Central Europe at this time of the year. In Timan°(64 N.L.), the weather is changeable as well, average temperature varying within the limits of 12-20° C. It's recommended to bring your own rubber boots and mosquito repellents.

OFFICIAL LANGUAGES:

Languages officially recognized at the Symposium will be English and Russian. Due to the difficulties of the talks translations during the sessions, it is proposed, that English texts of the reports will be sent for the preparatory translations before May 1, 1994.

SYMPOSIUM PUBLICATIONS:

It is planned to issue a special volume containing the address list of the Symposium participants and abstracts of the reports. Please send your abstracts no later than February 15, 1994. Timan excursion field guide will be available as well. Post-Symposium publications are planned for the meeting reports, presumably in Modern Geology.

COSTS:

Registration fee is differentiated as follows:

For those who plans to participate in the IGCP 328 project meeting only 60 US$

For the IGCP 328 project meeting + the "Devonian Eustatic Changes of the World Ocean Level" SDS Symposium 100 US$

For the "Devonian Eustatic Changes of the World Ocean Level" SDS Symposium Timan, excursion 100 US$

Full participation (IGCP 328 project meeting + the "Devonian Eustatic Changes of the World Ocean Level" SDS Symposium + Timan excursion) 140 US$

Registration fees include an information package, coffees and transportation between the hotel the Institute and the airport in Moscow and Ukhta, Symposium dinner and other expenses.

Timan field trip (excursion A) costs 700 US$, including the registration fee for this part of the Symposium (60 US$), Vezha Vozh River excursion (excursion C) is 140 US$ extra. Approximate cost of a return ticket from Moscow to Ukhta is 240 US$.

Accommodation and meals expenses in Moscow will be announced in the Second circular after the approximate quantity of the participants is known. Hotel booking, if not requested otherwise, will be provided by the Organizing Committee in the Russian Academy of Sciences hotel. Prices indicated for the exchange rates in November 1993.

Please note, that the participants of the excursion A and C are advised to book their Moscow-Ukhta-Moscow air tickets together with their flight to Russia in your local Aeroflot agency.

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PALAEONTOLOGICAL INSTITUTE OF THE RUSSIAN ACADEMY OF SCIENCES

RUSSIAN NATIONAL GEOLOGISTS' COMMITTEE

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TERRITORIAL INDUSTRIAL UNION, ALL-RUSSIAN RESEARCH OIL GEOLOGICAL PROSPECTING INSTITUTE, TERRITORIAL INDUSTRIAL UNION, UKHTA

GLOBAL DEVONIAN CORRELATION

At the meeting of the Devonian Subcommission in Göttingen in August 1993 there was a symposium on Devonian Correlation in the light of SDS/ICS/IUGS stage boundary decisions. Most of the handouts provided there are included in this issue of the *Newsletter*. At the Business Meeting which followed it was agreed that a more permanent and thorough international review was required, and Willi Ziegler kindly indicated that such a publication would be appropriate for the *Courier Forschungsinstitut Senckenberg*. Raimund Feist and Pierre Bultynck were asked to assemble a list of desired regional cover, and instructions to authors. It is anticipated that a standard chronostratigraphic and zonal scale will be adopted, and a first draft of this was sent out with the October circular to members. Details of length and proposed contents will be sent out later but it is hoped that this publication will collate internationally the affects of SDS decisions on local terminologies and provide a source of global reference. It is hoped contributions will be received which will make this a near-complete international cover but this will require significant work from members. Standard style correlation charts will be needed and a comprehensive regional cover.

The following handouts from the Göttingen meeting are attached:

(1) Correlation of stage boundaries in the Appalachian Devonian, eastern United States. By W.T. Kirchgasser and W.A. Oliver Jr.

(2) Devonian correlation in the British Isles. By M.R. House and J.E.A. Marshall

(3) State of correlation in Belgium and adjacent areas etc. By M. Streel

(4) Confidence levels of correlations between Miospore biohorizons and standard conodont zones during Middle and Late Devonian time. By M. Streel and S. Loboziak

(5) Devonian of the Rhenish Massif. By Clausen, C.-D., K. Weddige and W. Ziegler.

(6) Devonian of the Czech Republic. By I. Chlupác and J. Hladil

(7) Correlation of Devonian chronostratigraphical boundaries in Spain. By J.L. Garcia-Alcalde and M. Tryols-Massoni

(8) Eastern Iberian Cordillera. By P. Carls and J.I Valenzuela-Rios

[Colleagues from the former Soviet Union sent a copy of the review published in the Calgary Symposium, 1989].

Michael House, Chairman

Editorial Note: Additional reports and contributions appearing here were contributed directly by members or other interested parties.

CORRELATION OF STAGE BOUNDARIES IN THE APPALACHIAN DEVONIAN, EASTERN UNITED STATES — KIRCHGASSER, W. T. AND OLIVER, W. A., JR.

The decisions of the Devonian Subcommission regarding the stage boundaries made since the 1987 Calgary Symposium do not alter significantly the correlations to the Appalachian section in general use at that time (15) (17) (35). The current status of correlation is documented here with references to recent work.

For the whole of the Devonian the Appalachian foreland basin sequence is one of the most complete in the world but conodont faunas necessary for precise correlation of the international boundaries are as yet only available for the Givetian-Frasnian and Frasnian-Famennian. Datable conodonts are rare in the carbonates which dominate the lower part of the succession (Helderberg-Onondaga) and are very unevenly distributed in the shifting facies of the predominately siliciclastic sediments of the Hamilton to Conewango Groups which lie above. The clastic deposits comprise a series of clastic wedges ("Catskill Delta") built into a NE-SW canoe-shaped basin (8) west of the Acadian Highlands. The facies relationships are exceedingly complex and thicknesses of equivalent sections vary widely across the basin. Patterns of cyclically at various scales are recognized throughout but matching particular cycles with global eustatic events is complicated by the effects of regional tectonics and climate change. The stage-boundaries are best recognized in sections around the center of the basin and the locations of regional stratotype sections follow the general westward shift, through the Devonian, of the basin-axis. Biostratigraphic control is especially poor in the thick sections east and southeast of the basin axis in the transition from the marine to non-marine facies. Discontinuitites of varying magnitude and condensed sections characterize the western margin of the basin where deposition of black shale predominated in the late Devonian (Chattanooga-New Albany-Ohio Shales)

The present framework of correlation follows the alignment of transgressive (T)-regressive (R) cycles to the Standard Conodont Zonation proposed by Johnson & others (1985, fig. 2) and to the ammonoid sequence proposed in House (1985, fig. 2) (Fig. 1). Where biostratigraphic control is limited, or lacking altogether, marker-beds of particular T-R cycles provide a means of estimating the position of the stage-boundaries. Key widespread carbonate horizons and black shales above discontinuities are the principal indicators of transgressive events. In most cases the stage-boundaries correlate to positions at the base of or within units in transgressive phases. For the most part the SDS-boundaries do not align with the regional stages in Eastern North America which are defined by megafossils.

The framework of T-R cycle correlation has been extended in detail from New York into the central and southern Appalachians (6) (8) and ammonoid correlations have refined the alignments in the New York Upper Devonian (14). Various models have been proposed to explain the apparent cyclic deposition (1) (6) (9) (10) (11) (15) (28) (29). Regional correlations in the Lower and Middle Devonian (Helderberg to lower Hamilton and equivalents) have been aided by the tracing of several widespread ash beds including the well known Tioga Ash in the Onondaga (5) (8) (31) (32) (33). In the Middle and Upper Devonian a succession of transgressive black shales, which splay eastward into the clastic wedges, are the principal marker horizons for regional correlation and lithostratigraphic subdivision (11) (12). They are differentiated in the subsurface by gamma-ray traces and two have widespread ash beds within them (Belpre Ash Bed in the lower Rhinestreet Shale and Center Hill Ash Bed in the Pipe Creek Shale) (7) (8).

The stage-boundaries are located as follows: (Fig. 1) :

Lower Devonian

LOCHOVIAN- *Woschmidti*-Zone conodonts indicating the S-D boundary occur in the upper Keyser Limestone in the Southern and North-central Appalachians, equivalent to the middle Rondout Fm. (Whiteport Dol. Mbr.) to the northeast; the level is below the Rondout Fm. to Helderberg Group transition in New York where the boundary was previously placed (4).

PRAGIAN-by position within the Port Ewen limestone and shale of the upper Helderberg Group, in a regressive phase in the upper Helderberg transgression (15).

EMSIAN-by position at the base of the Esopus Shale (Tristates Group) in the post- Oriskany (Ridgeley) Sandstone transgressive event (T-R Cycle I b) (6) (15).

Middle Devonian

EIFELIAN-by position and still very tenuous conodont evidence at or near the base of the Onondaga Limestone Formation (6) (15) (20) (25) (26). The level may be at the base of the Nedrow Member (with conodonts possibly representing the *partitus* Zone) although the base of the Onondaga (base of Edgecliff Member which is lacking in conodonts) is equally likely and the more practical and traceable horizon for regional correlation.

GIVETIAN-by position at the base of or within the Skaneateles Formation of the Hamilton Group (within T-R Cycle I f) (15); the Cherry Valley Limestone below as has *kockelianus* Zone conodonts and the Centerfield Limestone (base of Ludlowville Formation) above has *varcus* Zone conodonts (20) (25) (35).

Upper Devonian

FRASNIAN-The base of the Lower *asymmetricus* Zone in west-central New York is at or immediately above the contact between the black Geneseo Shale and gray Penn Yan Shale of the Genesee Group. The boundary is at a discontinuity horizon in black shale and locally overlies the Lodi Limestone (Lowermost *asymmetricus* Zone; *norrisi* Zone) at the base of the Penn Yan (16)(17) (18). These units are low in the Taghanic Onlap sequence (T-R Cycle II a), which follows the Tully-Taghanic unconformity in western New York where part or all of the *varcus* to *asymmetricus* interval may be missing. The start of the transgression is recorded by the widespread Tully Limestone which is succeeded by the black Geneseo black shale and Penn Yan gray shale. The equivalent post-Tully units south of New York are the Burket black shale and Harrell gray shale. The limited conodont and ammonoid evidence available suggests that the boundary is above the Burket-Harrell contact. As a practical and mapable boundary the base of the Geneseo and the base of the Burket continue to be used as the Middle-Upper Devonian boundary.

The Frasnian conodont sequence in New York correlates with all but three of the thirteen Montagne Noire conodont zones of Klapper (1989) (21) (22) (23) (24) and zones 8, 9 and 10 align by position within the Rhinestreet Shale. The first 7 zones in New York have been aligned by graphic correlation to a Frasnian Composite Standard (19) (23) (24). This Frasnian Composite Standard is independent of the Standard Conodont Zonation as recently revised by Ziegler & Sandberg (1990) (38).

FAMENNIAN-The base of the Lower *triangularis* Zone is located in western New York in black shales in the upper Hanover Shale (West Falls Group) a few meters below the base of the black Dunkirk Shale at the base of the Canadaway Group (27). The Dunkirk Shale (Lower Huron), is a major lithic marker in the Appalachian Basin (11) 12).

D-C (MISSISSIPPIAN)-Miospores from Kentucky indicate the boundary at the contact between the Bedford Shale (LN Biozone) (Berea Sandstone) and black Sunbury Shale (VI Biozone at base) (2). Foraminifera from Ohio and Kentucky indicate a late Devonian age for the Bedford (3). Below the Bedford, the black Cleveland Shale (Ohio Shale), representing T-R Cycle II f, has conodonts of the latest Famennian *expansus* and *praesulcatus* Zones (37). In the Central Appalachians latest Famennian miospores (LN Biozone) are reported in the transition between the Catskill and Hampshire Formations (Catskill clastic wedge) and overlying conglomerates (Pocono clastic wedge)(36).

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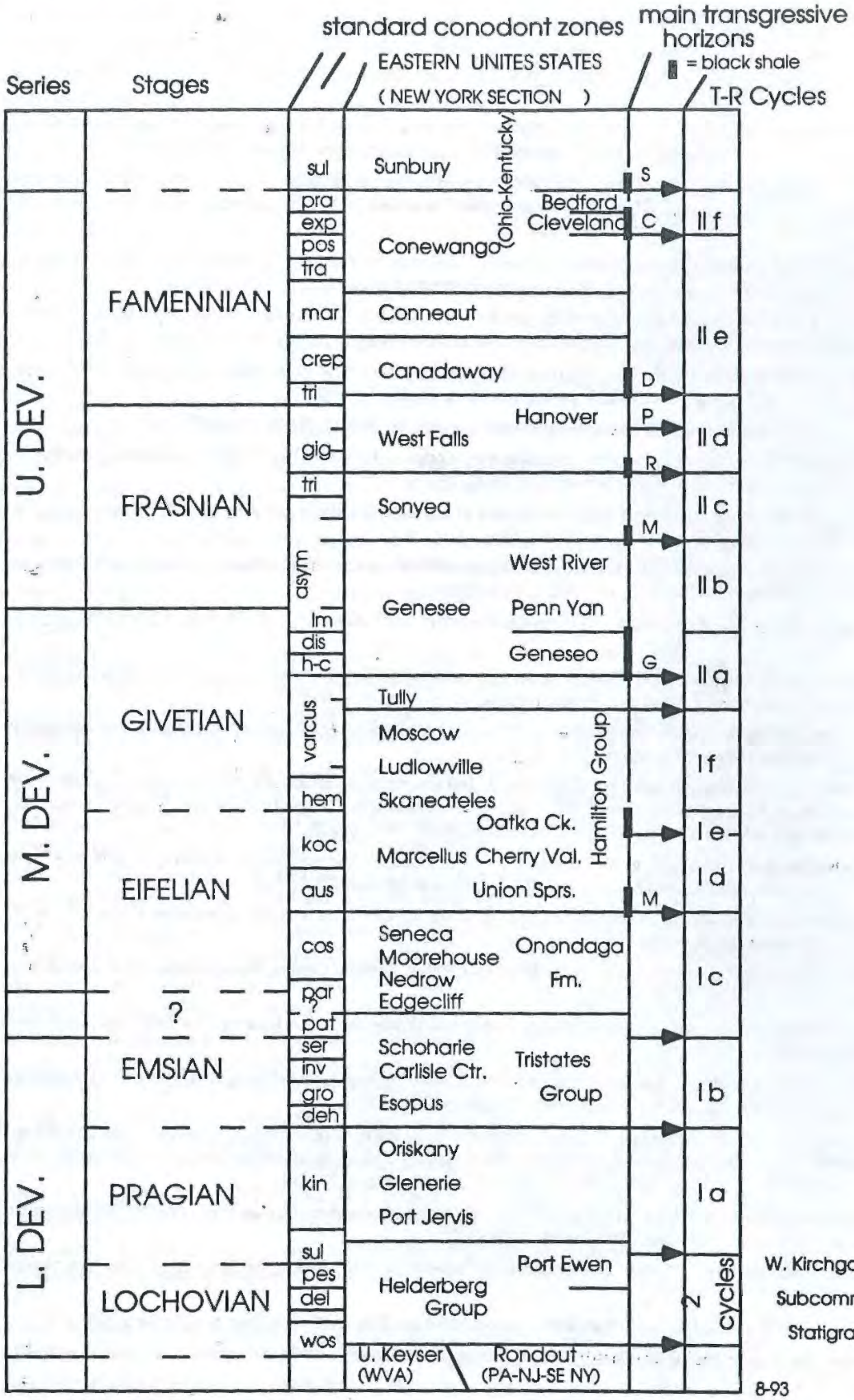

W. Kirchgasser & W. A. Oliver, Jr.
Subcommission on Devonian
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Fig. 1- Correlation of International Devonian stages to Appalachian section in the Eastern United States. Black shales: M-Marcellus; G-Geneseo; M-Middlesex; R-Rhinestreet; P-Pipe Creek; D-Dunkirk; C-Cleveland; S-Sunbury. T-R Cycles from Johnson & others (1985).

DEVONIAN CORRELATION IN THE BRITISH ISLANDS — M.R. HOUSE & J.E.A. MARSHALL

Marine Devonian is developed south of a line between the Severn Estuary and the Thames but is highly tectonised. In Wales, northern England and Scotland Old Red Sandstone facies predominate but it is now known that marine rocks occur well north in the Argyll field of the North Sea (1). There is a Frasnian marine transgression in the subsurface of East Anglia and southern central England (2). The latest review is in the Calgary volumes of 1989 (3). There are recent British Geological Survey *Memoirs* for many areas.

In southernmost Cornwall, in Roseland, *Scyphocrinites* and other Silurian/Devonian boundary marine faunas occur in a melange sequence but there is a good conodont-bearing calcareous and chert series across the Eifelian Givetian boundary. The Mylor Slates, with melange has yielded Famennian spores. In northern Cornwall, pre-Emsian rocks are nonmarine and pteraspid-bearing whilst Emsian rocks are littoral and shallow water. There is a very thick Middle Devonian argillite sequence which has recently been shown to extend into the late Famennian with Frasnian pillow lavas at Pentire Head (4). The Givetian/Frasnian sequence at Marble Cliff is perhaps the best sequence at this level in Europe (5). Good well-documented sequences of late Devonian occur as thrust slices in the early Carboniferous of North Cornwall. In South Devon similar Lower Devonian is followed by carbonate sequences which are well zoned using conodonts. The Devonian base is not seen in North Devon where the sequence is coarser-grained with non-marine intercalations.

In Wales a conformable non-marine sequence passes from the Silurian up to the Emsian and is fish-, plant- and microvertebrate-bearing and spores show Lower Devonian represented (6) detailed correlation with marine stages is not accomplished. After a non-sequence Famennian none-marine rocks grade into marine Carboniferous. In Ireland Old Red Sandstone rocks are conformable on Silurian in the Dingle Peninsula but otherwise disconformable on older rocks whereas late Devonian non-marine sequences are conformable into the early Carboniferous (2).

The Old Red Sandstone in northern England and Scotland is now recognised to have been intimately involved in late Caledonian tectonism and sedimentary basin development. The main developments of Old Red Sandstone are in the

Midland Valley and the Orcadian Basin. The Midland Valley is not as a thick 'molasse', but instead a series of three discrete superimposed basins each with their own margins and stratigraphy. The oldest of these basins at Stonehaven is dated palynologically (6) as late Wenlock to early Ludlow in age. The position of the Silurian/Devonian boundary is not known with the next stratigraphically correlateable fossils being early Gedinnian palynomorphs from the succeeding Crawton Basin. The separate Strathmore Basin is of Emsian age. A significant hiatus separates this Lower Old Red Sandstone from the overlying Stratheden Group, formerly referred to as Upper Old Red Sandstone. This contains fish faunas regarded (Westoll in (2)) as late Famennian in age. This unit is stratigraphically contiguous with the overlying Inverclyde Group from which the lowest fossils are miospores of late Tournasian age. Thus by implication the Stratheden Group is in part Carboniferous in age. The Orcadian Basin occupies the area approximately north of Inverness to Shetland and contains largely lacustrine sediments. Significant lithostratigraphic problems are now apparent which create difficulties in establishing good biostratigraphical schemes. Rocks of at least Emsian age are present in early small basins. Subsequent extension enlarges these basins with the main development of lacustrine facies being of Eifelian age. The major lithostratigraphical marker is the Achanarras/Sandwick Fish Bed with its excellent fish fauna, marking the episode of deepest stable lacustrine sedimentation. This is of Eifelian age. House has suggested this should correlate with the Kacác Event. A subsequent episode of further extension (base of the Eday Group) is broadly synchronous with the first occurrence of *Geminospora lemurata* and the base of the Givetian stage. A second episode of deep lacustrine sediments occurs at this time (Eday Flags). The Upper Old Red Sandstone of Hoy and Dunnet Head is now recognised (Astin, in press) as a correlative of the Eday Group. The age of the youngest rocks in the Orcadian Basin is not known but fish fossils are present south of the Moray Firth which date the sequence as at least Frasnian in age.

Document presented to the Subcommission on Devonian Stratigraphy, Göttingen, August 1993

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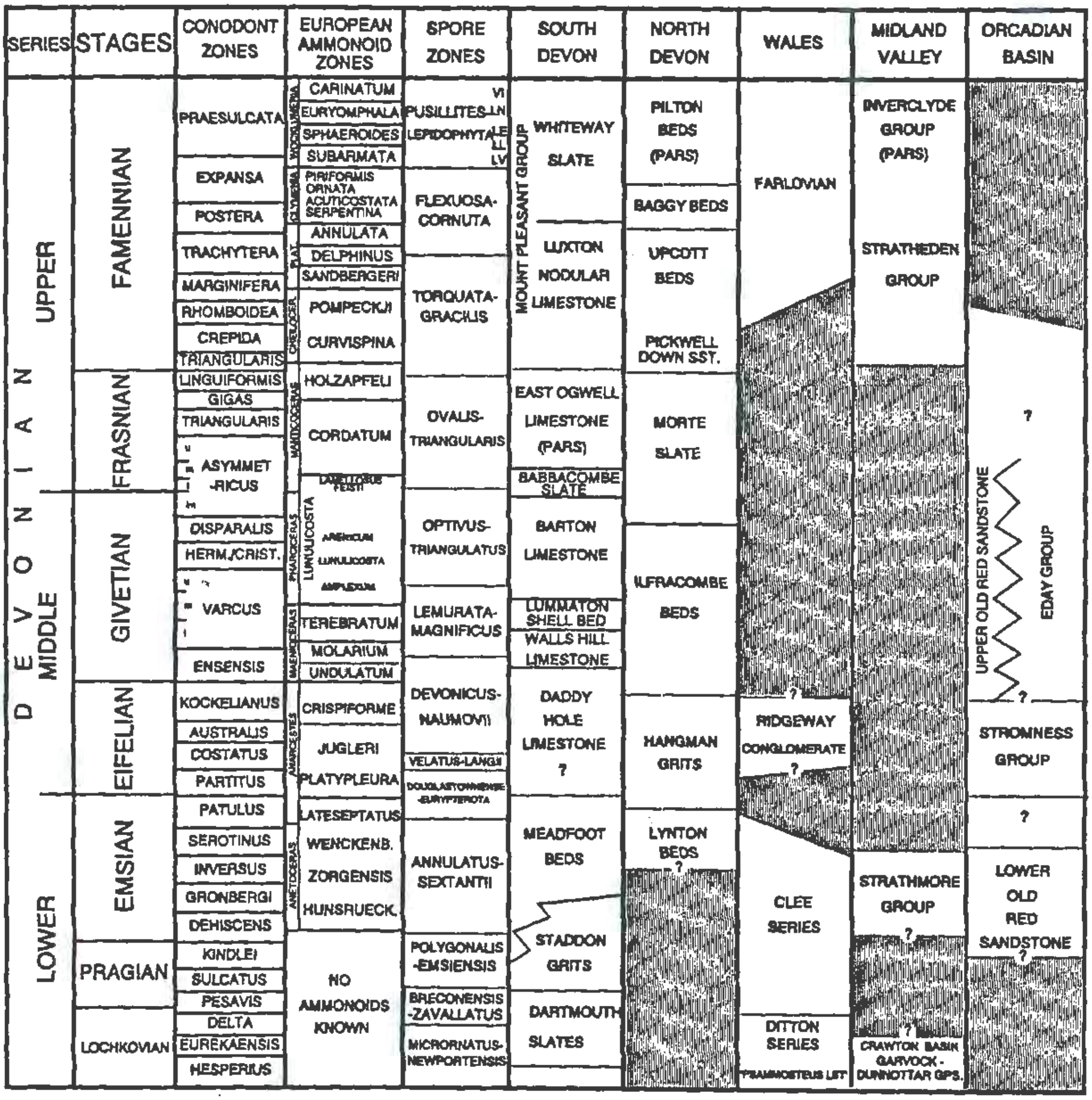
Southampton July 1993



STATE OF CORRELATION IN BELGIUM AND ADJACENT AREAS WHICH RESULTS FROM THE DECISIONS OF THE COMMISSION ON STRATIGRAPHY AND DEPENDS ON PALYNOLOGY — M. STREEL

Base of the Gedinnian

The base of the Ardennan Gedinnian Stage in the type region has been demonstrated by Steemans (1987, 1989 & in Streel et al., 1987) to be diachronous, ranging from the miospore Interval Zone N (*S. newportensis*) (locality Willerzie) to the Interval Zone R (*C. retorrida*) (locality Lahonry) (Fig. 1) and transgressing on Cambro-Ordovician rocks from SE to NW. He has also demonstrated that, in Brittany where miospores and Chitinozoa coexist in the same section, the base of the miospore Interval Zone R is higher than the base of the Chitinozoa Zone 27 (Paris 1981). As the Chitinozoa Zone 27 is within the Lochkovian Stage in Bohemia, it happens that the basal layers of the Gedinnian at Lahonry (30 km W of Gedinne) do not reach the base of the Lockkovian. Because the miospores demonstrate the diachronism of the Gedinnian base (the Fepin Conglomerate), it is not possible to tell whether it reaches the base of the Devonian in the most southern part of the Ardenne in France.

Top of the Gedinnian

The top of the Gedinnian in the type region occurs in the miospore Interval Zone E (*D. emsiensis*) which can be correlated through Brittany (Western France) (Fig. 1) with the Chitinozoa Zones 31 to 34. The base of the newly defined Pragian (the *Eognathodus*

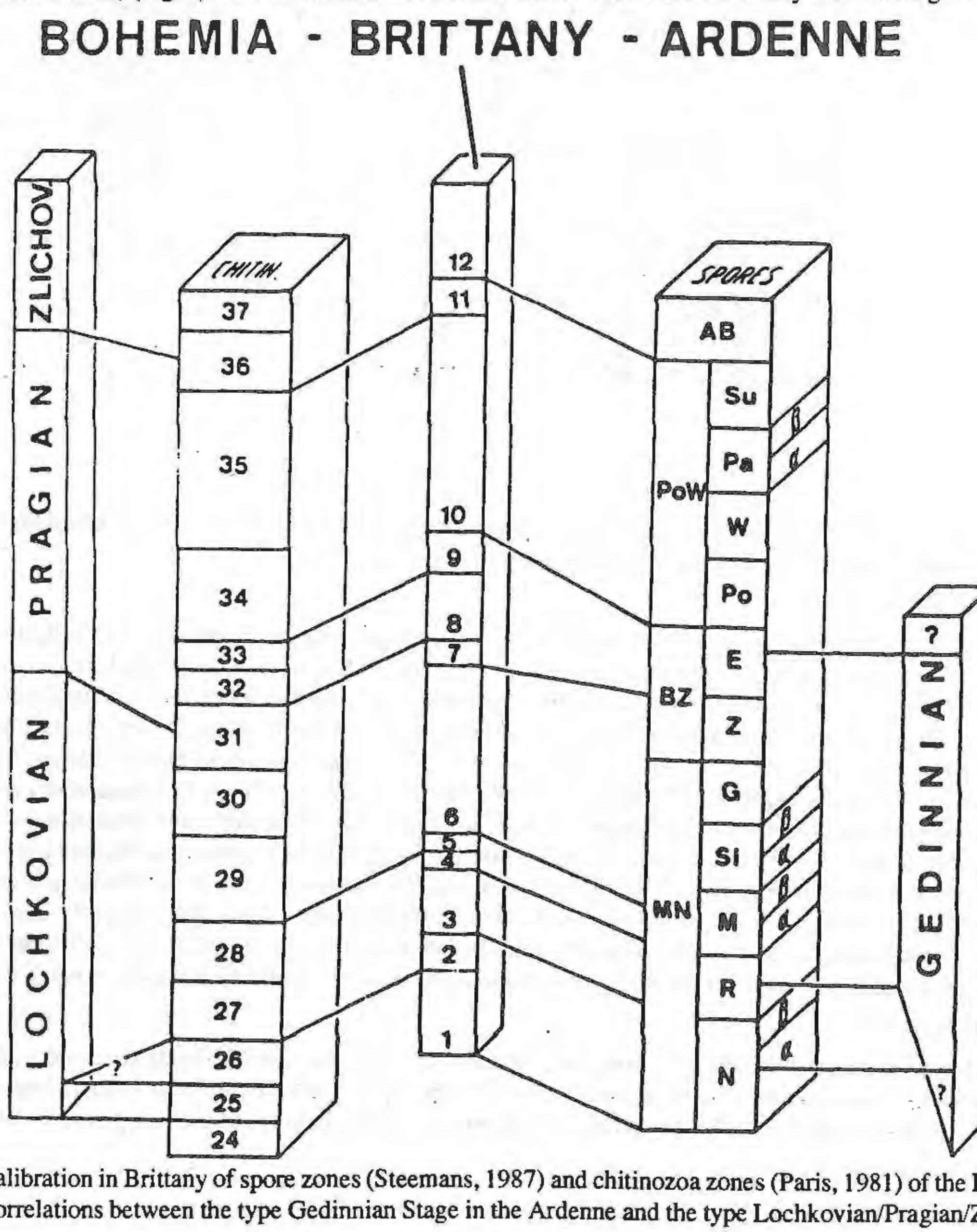


Fig. I - Intercalibration in Brittany of spore zones (Steemans, 1987) and chitinozoa zones (Paris, 1981) of the Lochkovian-early Emsian and correlations between the type Gedinnian Stage in the Ardenne and the type Lochkovian/Pragian/Zlichovian Stages in Bohemia.

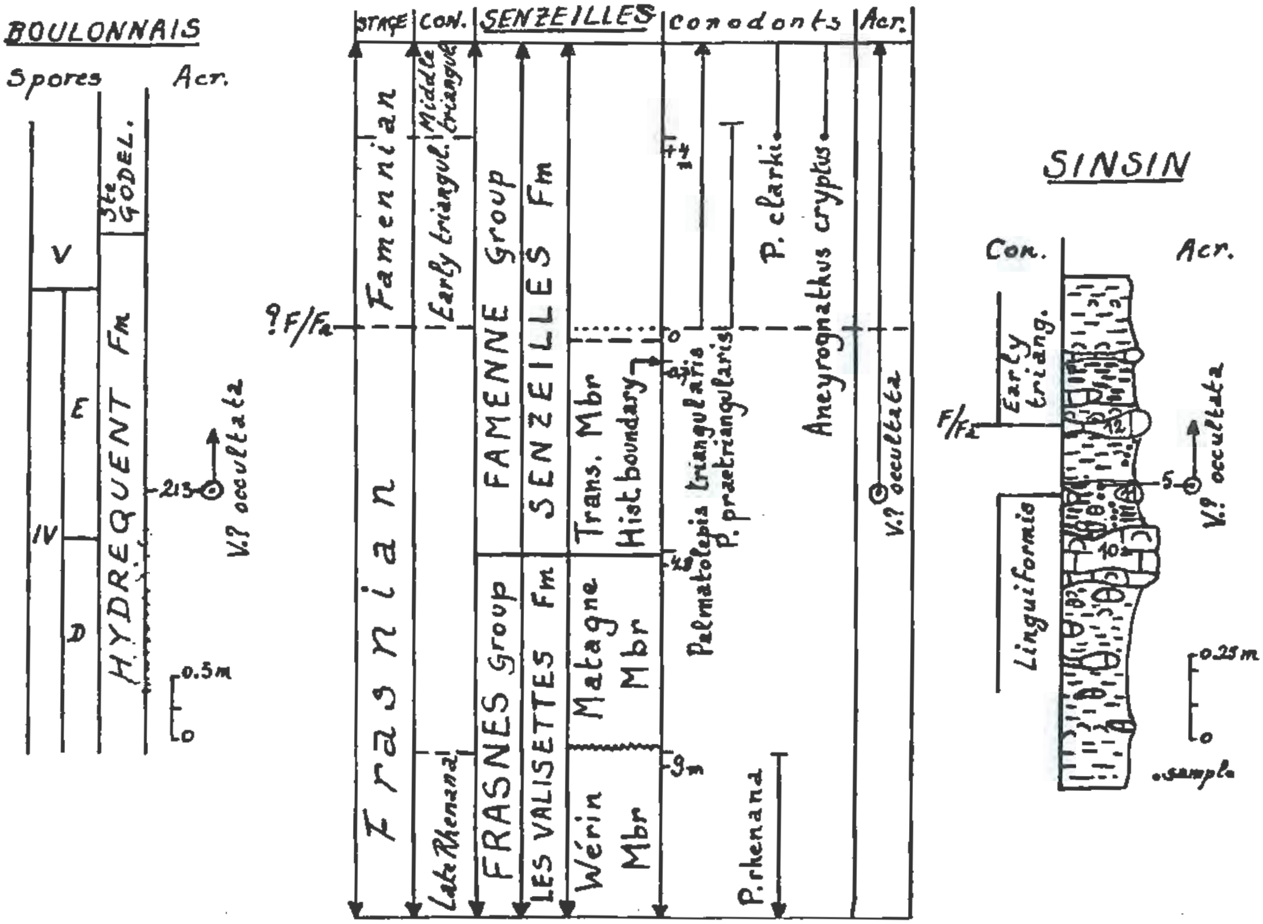


Fig. 2

sulcatus sulcatus first occurrence) in Bohemia occuring in the uppermost part of the Chitinozoa Zone 31 it happens that the base of the miospore Interval Zone E is very near the base of the Pragian Stage.

Base of the Famennian

In the type area of Senzeilles, the historical base of the Famennian lays in the uppermost part of a nearly 9 meters thick shaly interval devoid of Conodonts (Fig. 2). Acritarchs are abundant and one species (*Visbysphaera? occultata*) which first occurs within this shaly interval (Martin, in press), seems to have some significance for correlation. This species allows an accurate correlation (Fig. 2) with the section of Sinsin where a very detailed analysis of acritarchs have been made by Vanguestaine (Streel & Vanguestaine, 1989, 1993). It first occurs immediately on top of the last limestone with *Palmatolepis linguiformis* (The extinction level of Sandberg *et al.*, 1988). Consequently, if the first limestones containing the first occurrence of *Palmatolepis triangularis* in Senzeilles and in Sinsin represent the base of the Famennian Stage, then the 20 cm thick shaly layer without conodont at Sinsin is a lateral equivalent of the nearly 4 meters of shales occurring below the first limestone at Senzeilles. The same acritarch species (*V.? occultata*) allows a correlation (Fig. 2) with the uppermost part of the Hydrequent Fm in the Boulonnais area (Northern France) where a detailed zonation based on miospores have been described (Loboziak *et al.*, 1983) (Fig. 3). They demonstrate that there is no sharp change of flora at the F/Fa boundary in contradiction with the erroneous statement made recently in the SDS Newsletter n° 9 p. 5 (Proposal for the global stratotype section and point - GSSP - for the Frasnian-Famennian Boundary).

Top of the Famennian

The top of the Famennian in the type region of the Ourthe valley has recently been characterized by the occurrence of the miospore Interval Zone LE (*lepidophyta-explanatus*) in the uppermost shales of the Comblain-au-Pont Fm, 6.5 meters below the Hastière Fm (Dreesen *et al.*, 1993). The LE Zone is known in Sauerland (Germany) to occur in the uppermost part of the conodont early *praesulcata* Zone.

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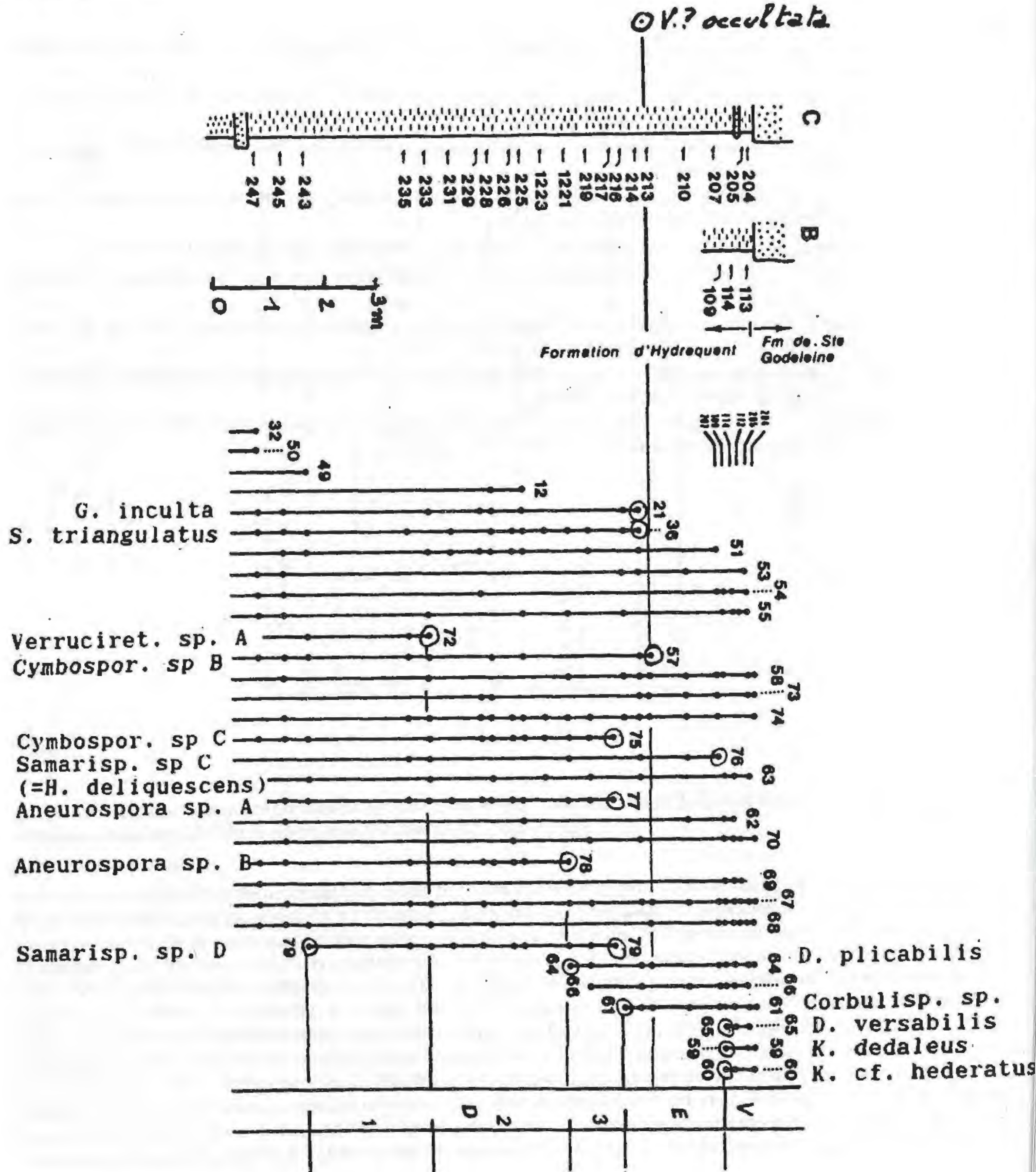


Fig. 3-Stratigraphic distribution of miospores in the upper part of the "Formation d'Hydrequent" compared to the first occurrence of the acritarch *V.? occultata*.

CONFIDENCE LEVELS OF CORRELATIONS BETWEEN MIOSPORE BIOHORIZONS AND STANDARD CONODONT ZONES DURING MIDDLE AND LATE DEVONIAN TIME — MAURICE STREEL & STANISLAS LOBOZIAK

Interval zones were introduced for the miospores of the whole Devonian by Streel *et al.* (1987). First or last occurrences of single species (first occurrence Biohorizon or foB., and last occurrence Biohorizon or loB.) are searched for in continuous marine miospore-bearing sequences, preferably in uniform lithologies. The advantage of the Interval Zone concept on the Assemblage Zone concept,the latter most commonly used in palynology, is that it allows unequivocal correlations with Interval Zones based on other fossils. The quality of these correlations depends on the distance between the miospore data and the faunal data (See table 1). The concept is applied here (See fig. 1) for 20 selected Middle and Late Devonian miospore taxa within the limits of a single major phytogeographic province: southern Euramerica.

Reference:

Streel, M., Higgs, K., Loboziak, S., Riegel, W. & Steemans, P. 1987: Spore stratigraphy and correlation with faunas and floras in the type marine Devonian of the Ardenne-Rhenish region; Review of Palaeobotany and Palynology, 50: 211-229.

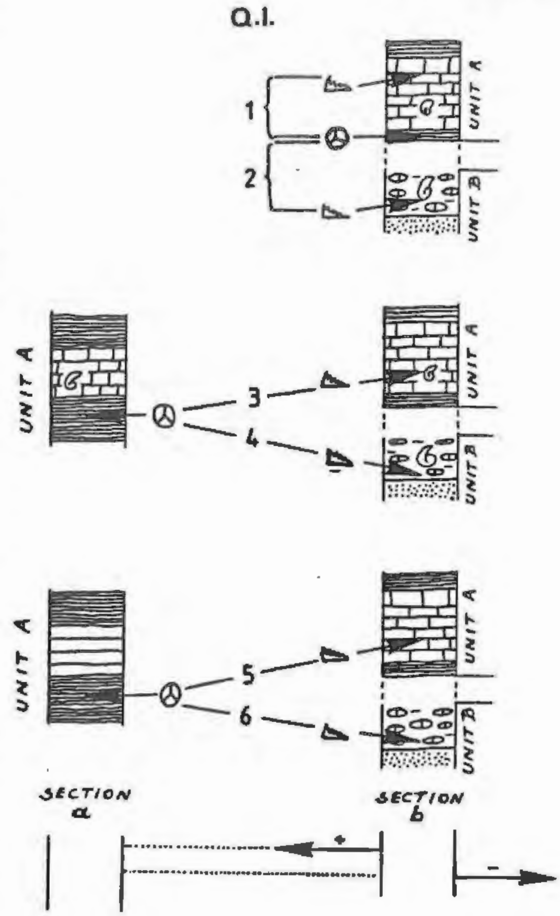


Table 1: Quality Index (QI) in correlation between any reference faunal (here conodont) and miospore zones.

From 1 to 6: best to worst.

1 reference fauna in same section and same lithological unit as reference point of miospore zone.

2 reference fauna in same section but other lithological units than reference point of miospore zone.

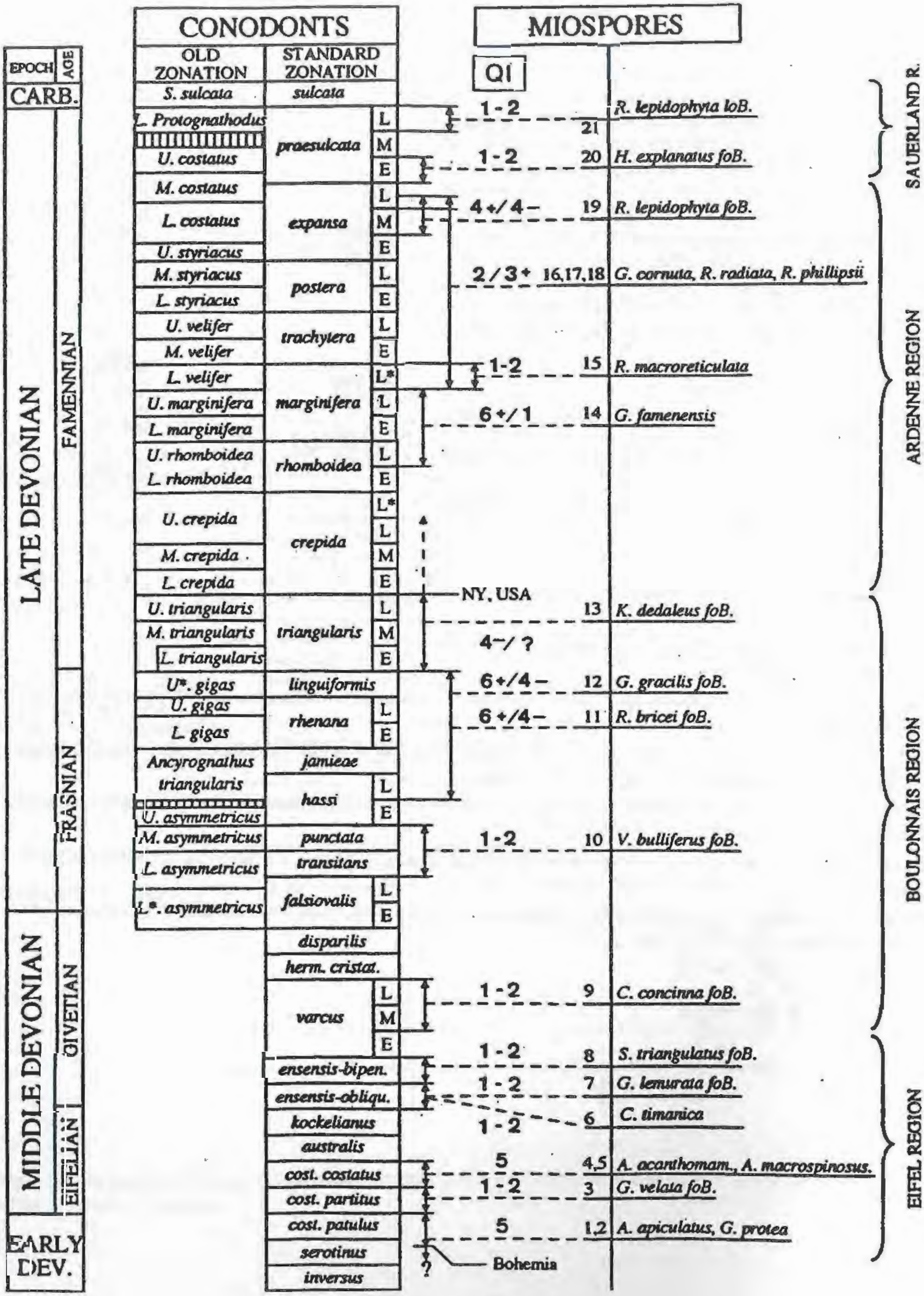
3 reference fauna in another section (3+ at short distance, 3- at long distance), but in same lithological unit containing <u>other</u> faunal or floral data also known in reference section of miospore zone.

4 reference fauna in another section (4+ at short distance, 4- at long distance), in other lithological units containing <u>other</u> faunal or floral data also known in reference section of miospore zone.

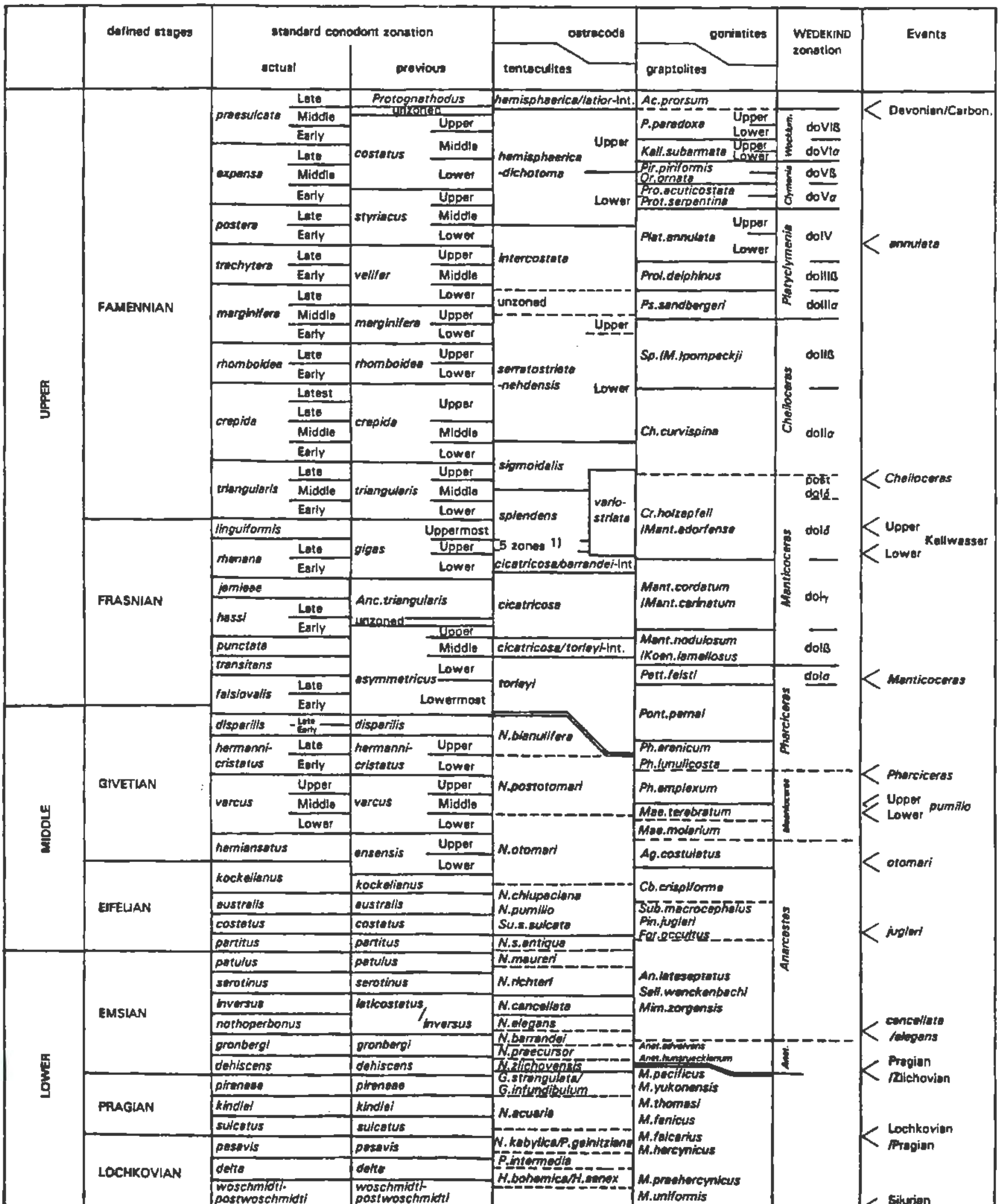
5 reference fauna in another section (5+ at short distance, 5- at long distance), in same lithological unit but without common faunal or floral data with reference section of miospore zone.

6 reference fauna in another section (6+ at short distance, 6- at long distance), in other lithological units but without common faunal or floral data with reference section of miospore zone.

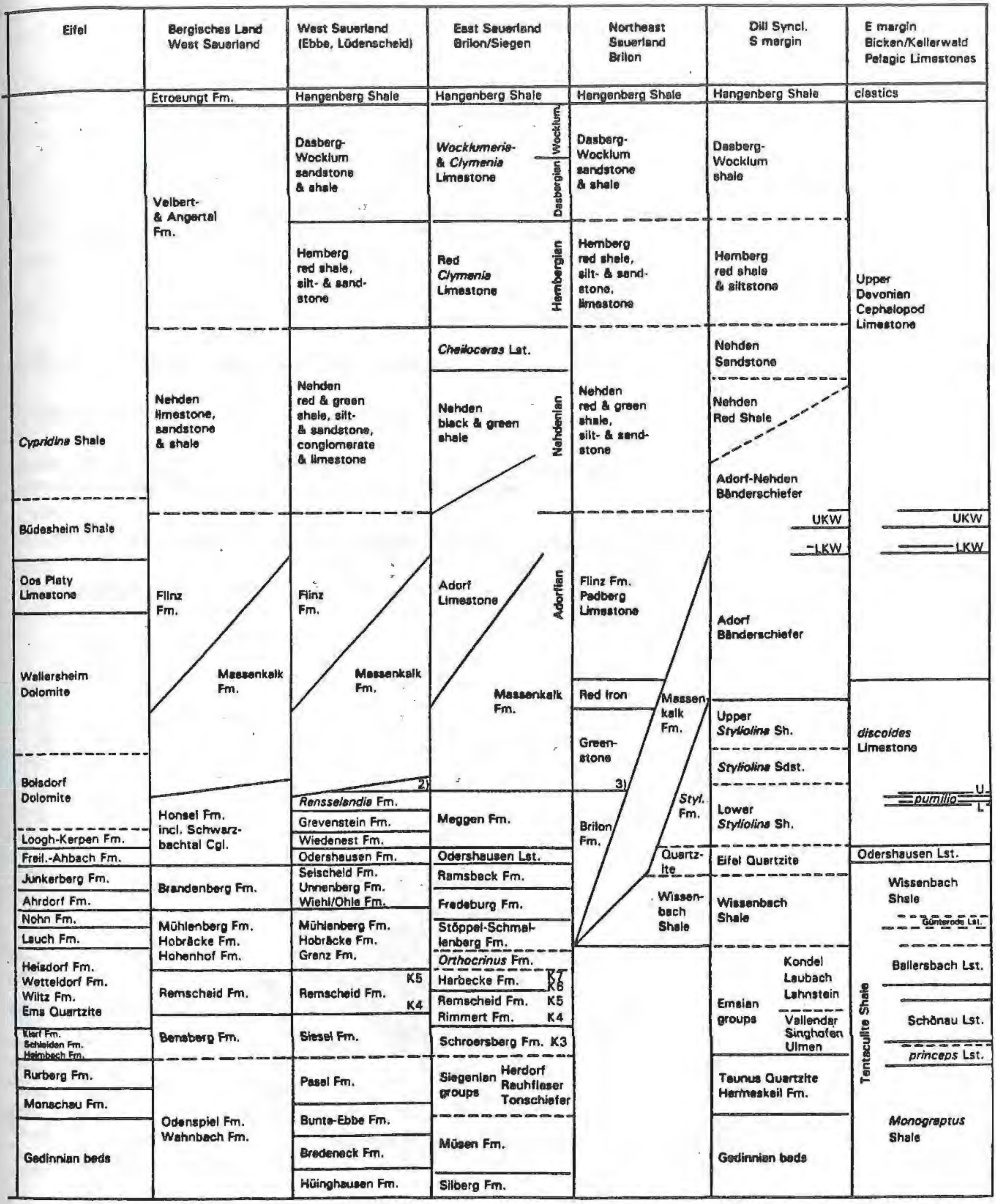
QI = Quality Index in correlation; 1-2: miospores and conodonts are of course never extracted from the same lithologies; 2/3+: QI of the highest correlation / QI of the lowest correlation.


CONODONTS
MIOSPORES
EPOCH
AGE
OLD ZONATION
STANDARD ZONATION
QI
CARB.
LATE DEVONIAN
FAMENNIAN
FRASNIAN
MIDDLE DEVONIAN
GIVETIAN
EIFELIAN
EARLY DEV.
S. sulcata
sulcata
L. Protognathodus
praesulcata
U. costatus
M. costatus
L. costatus
expansa
U. styriacus
M. styriacus
postera
L. styriacus
U. velifer
trachytera
M. velifer
L. velifer
U. marginifera
marginifera
L. marginifera
U. rhomboidea
rhomboidea
L. rhomboidea
U. crepida
crepida
M. crepida
L. crepida
U. triangularis
M. triangularis
triangularis
L. triangularis
U*. gigas
linguiformis
U. gigas
rhenana
L. gigas
Ancyrognathus triangularis
jamieae
hassi
U. asymmetricus
M. asymmetricus
punctata
L. asymmetricus
transitans
L*. asymmetricus
falsiovalis
disparilis
herm. cristat.
varcus
ensensis-bipen.
ensensis-obliqu.
kockelianus
australis
cost. costatus
cost. partitus
cost. patulus
serotinus
inversus
NY, USA
Bohemia
1-2 21 R. lepidophyta loB.
1-2 20 H. explanatus foB.
4+/4− 19 R. lepidophyta foB.
2/3+ 16,17,18 G. cornuta, R. radiata, R. phillipsii
1-2 15 R. macroreticulata
6+/1 14 G. famenensis
13 K. dedaleus foB.
4−/ ?
6+/4− 12 G. gracilis foB.
6+/4− 11 R. bricei foB.
1-2 10 V. bulliferus foB.
1-2 9 C. concinna foB.
1-2 8 S. triangulatus foB.
1-2 7 G. lemurata foB.
1-2 6 C. timanica
5 4,5 A. acanthomam., A. macrospinosus.
1-2 3 G. velata foB.
5 1,2 A. apiculatus, G. protea
SAUERLAND R.
ARDENNE REGION
BOULONNAIS REGION
EIFEL REGION

DEVONIAN OF THE RHENISH MASSIF. BY CLAUSEN, C.-D., K. WEDDIGE AND W. ZIEGLER.



1) from base to top: *barrandei*-, *materni*-, *volki*-, *schmidti*-, *reichi*-Zone and *reichi/splendens*-Int.



2) from base to top: *Sparganophyllum* Lst., Wallen Sh., Hauptgrünstein, Nuttlar Sh.   3) from base to top: *Sparganophyllum* Lst., Wallen Sh., Hauptgrünstein.

DEVONIAN OF THE CZECH REPUBLIC: COMMENTS TO STRATIGRAPHIC TABLE — I. CHLUPÁC AND J. HLADIL

The presented stratigraphic table belongs to a set of tables prepared in terms of the project "Stratigraphy of the Czech Republic" realized by the Czech Geological Survey, Prague (now prepared for print). The table should fix the present knowledge on the field o~ stratigraphy and to offer data for future investigations. Therefore, the authors tried to make a clear distinction between proved data and hypothetical concepts, and the degree of verification of each stratigraphical boundary was incorporated in the table. The lithology and accuracy of dating is expressed by varied colours (as exemplified in the Czech version). The upper half of the table summarizes the Devonian stratigraphy of the central Bohemian area with the Barrandian (1) and some other, mostly metamorphic units (2-3), and the N. Bohemian occurrences (4,5). The lower half of the table contains schemes of different Devonian developments in Moravia-Silesia, i.e. in the eastern part of the Republic, roughly arranged from the . towards the E (6-9). More exact data on the Devonian of the Czech Republic may be found particularly in the following papers:

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Chlupác I. (1993): Stratigraphic evaluation of some metamorphic units in the N part of the Bohemian Massif. - N.Jb.Geol. Paläont., Abh. 188: 363-3B3. Stuttgart.

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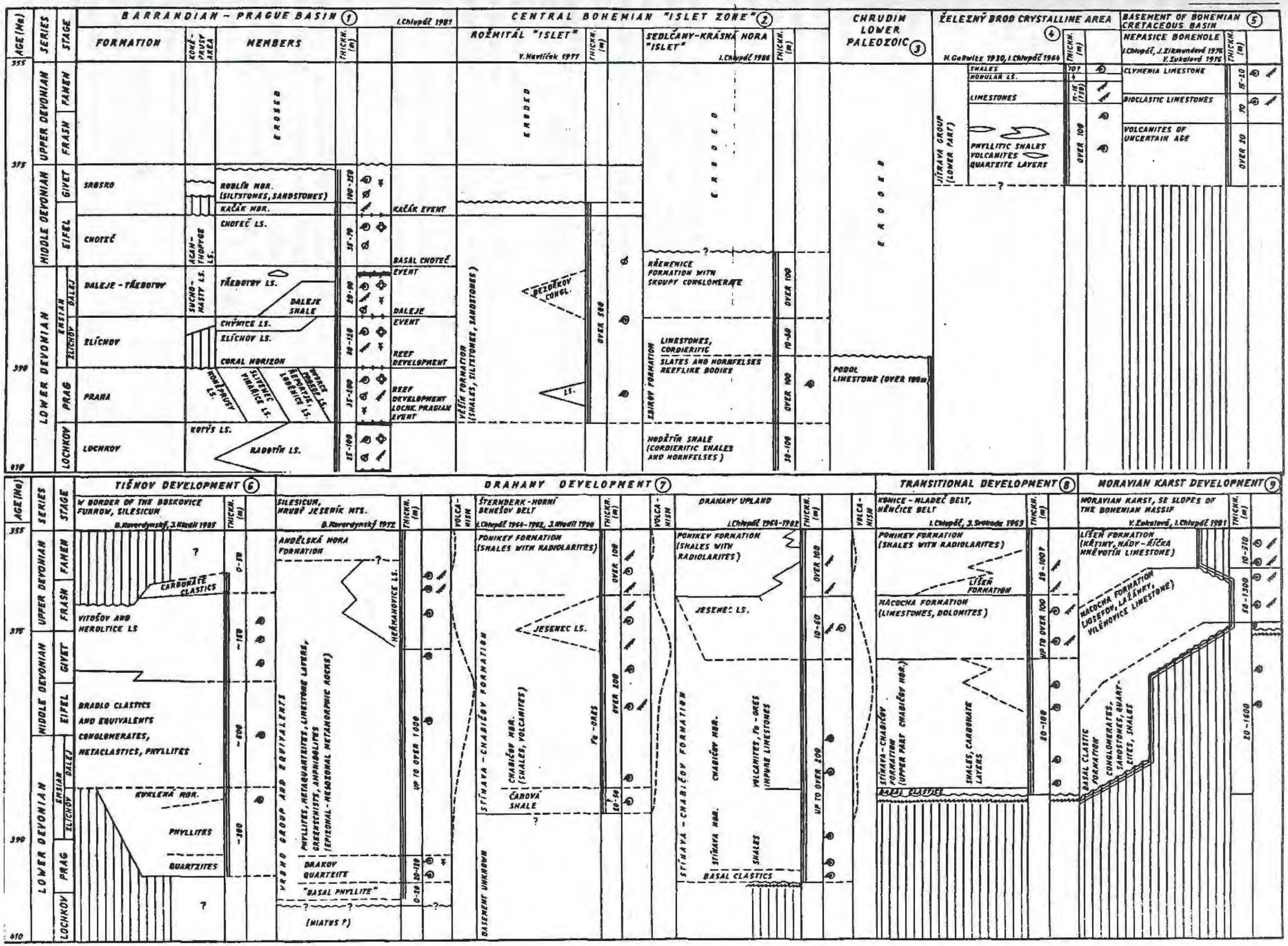
Map legend to accompany table on following page.

DEVONIAN of the Czech Republic – compiled by I. Chlupáč and J. Hladil (1991)



CORRELATION OF DEVONIAN CHRONOSTRATIGRAPHICAL BOUNDARIES IN SPAIN — J.L.GARCIA-ALCALDE & M.TRUYOLS-MASSONI

Introduction

Near of completion the SDS task on definition of Devonian chronostratigraphical boundaries it is indeed high time to check-up the state of correlation and terminology in the different world areas which result from the conclusions of the Subcommission.

This report synthesizes data concerning the Spanish Devonian, stressing those corresponding to the authors primary research area: the Cantabrian Mountains (Asturo-Leonese and Palentine Domains, N Spain) (Figs. 1-3).

Although the Devonian is very well represented in Spain, facies and dynamic conditions have in general prevented the occurrence of biochronological relevant fossil associations in suitable successions. Thereby very few of the critical Devonian biostratigraphic index (Oliver and Chlupac, 1991) are found in the Iberian Massif (including Celtiberia, cf. Julivert et al., 1974) and in the Catalonian Coastal Ranges (Fig. 1) and those known in other areas are mostly reworked (Menorca, Balear Islands, and Málaga, SE Spain) or they occur in exceedingly metamorphised and tectonised sections (Pyrenees Mts.).

IBERIAN MASSIF

Cantabrian Mountains (Figs. 1-3)

a) Base of Pragian.- Most of the index-fossils to the Lochkovian/Pragian boundary (Chlupac and Oliver, 1989, fig.6), including the primary one *Eognathodus sulcatus* sulcatus, are lacking. Other relevant guide-fossils as *Nowakia acuaria* and *Latericriodus steinachensis* occur in the upper part of their stratigraphical range because of facies constraints.

A very important L/P Cantabrian guide-fossil is the brachiopod *Vandercammenina sollei*. After a Spanish-French chain of correlations based on the *V. sollei, Caudicriodus angustoides castilianus*, and *E. sulcatus* relative co-occurrences, the appearance of *Vandercammenina sollei* (and of the genus *Vandercammenina*) would be nearly synchronous with the *E. sulcatus sulcatus* L/P boundary (Carls, 1987; Garcia-Alcalde et al., 1990a; Morzadec et al., 1991; Garcia-Lopez and Arbizu, 1993).

Measured sections in the Cantabrian Mts. have shown that *V. sollei* first occurs in the upper part of the Nieva Limestone Fm., in Asturias (Santa Maria del Mar section), and at the top of the lower tiers of the Lebanza Limestone Fm., in Palencia (Figs. 2-3). *V. sollei* has not been found so far in Leon, but Grötsch (1988) has reported conodonts of the *C. angustoides alcoleae-C. a.castilianus* lineage, and *Ozarkodina pandora*, in several localities of the Abelgas Fm. of the La Vid Shale and Limestone Group (Figs. 2-3).

b) Base of Emsian.- The overlap of *Polygnathus pireneae* and *P. dehiscens* and most of the biostratigraphical features that characterize the Pragian/Emsian boundary in the proposed GSSP at Zinzilban Gorge (Yolkin et al., 1989) are not observed.

In Palencia *P. dehiscens* (and other important conodont as *Caudicriodus sigmoidalis* and *Pandorinellina steinhornensis miae*) first appears in the uppermost part of its true stratigraphic range, associated with *P. gronbergi*, well above the first occurrence of *Nowakia zlichovensis*, at the base of the Requejada Limestone Mb. (Abadia Shale Fm.) (Fig. 3) (Garcia-Alcalde et al., 1990a). In Leon, the distribution of *P. dehiscens* is also very irregular. The oldest occurrence of this species is recorded in the dolostone and marlstone-limestone transition between the Wavy Limestone and Limestone/Marlstone members of the Abelgas Fm. (Keller and Grötsch, 1990) (=Units 1-2 of the La Vid Gr., Garcia-Alcalde et al., 1979) (Fig. 3). At this level *P. dehiscens* is associated with abundant *Caudicriodus celtibericus* (Grötsch, 1988).

After very indirect (and therefore admittedly hazardous) correlations mainly based on the ocurrence of classical "Lower Emsian" brachiopods below the first appearance of *P. dehiscens*, the base of the *Dehiscens* Chronozone could be coincident or nearly so with an important litho-event, representing a transgressive pulse of supra-regional incidence (Garcia-Alcalde, 1992). The litho-event would be represented in Asturias and Leon by the above mentioned dolostone and marlstone-limestone transition (Bañugues Dolostone Fm.-La Ladrona Shale and Limestone Fm., in Asturias; Units 1-2 of La Vid Gr., in Leon), and in Palencia by the transition siltstone-shale in the lower part of the Abadia Fm. (Fig.3).

c) Base of Eifelian. Lower/Middle Devonian boundary. Conodonts of the *Polygnathus. costatus patulus-P. c. costatus* lineage and other Emsian/Eifelian boundary index-fossils (Werner and Ziegler, 1982) are relatively abundant in the Cantabrian Mts.

In Palencia the Emsian/Eifelian boundary could be placed in measured sections at the upper part of the Polentinos Fm. (Fig. 3) where *P. c. partitus* and *P. c. patulus* occur (Henn, 1985) (Fig. 2). In the same beds or a little higher, *Icriodus retrodepressus* occurs. This correlation is underlined by other biostratigraphical guides. Thus the ranges of *Nowakia gr. sulcata* and *N. holynensis* straddle generally the boundary (Garcia-Alcalde et al., 1990b); in some sections, at the top of the Polentinos Limestone Fm. *Agoniatites (Fidelites) occultus* appears and at the base of the overlying Gustalapiedra Shale Fm., *Foordites platypleura* and *Pinacites sp.* occur.

In Asturias and Leon (Fig. 2), *P. c. partitus* is lacking. The E/E boundary could however be roughly traced in measured sections at the upper part of the Moniello and Santa Lucia Limestone Fms. (Fig. 3), after the occurrence of *I. retrodepressus* and *P. c. costatus* and after the distribution of rhenan brachiopods as *Tetratomia parvula, Cimicinella loxogonia, Arduspirifer mosellanus* and *A. (?) intermedius* (Arbizu et al., 1979; Garcia-López, 1987).

d) Base of Givetian. Eifelian /Givetian boundary index-fossils are partially known in the Cantabrian Mts. but the critical conodont lineage *Polygnathus pseudofoliatus-P. hemiansatus* (Walliser, ed., 1991) is not well developed.

In fact *P. hemiansatus* has only been found in Leon in the Varcus Zone in a measured section at the lower part of the Portilla Limestone Fm. (Figs. 2, 3) associated with *P. ensensis, I. obliquimarginatus*, and *P. cf. timorensis*, a little higher than *P. cf. ansatus* (Garcia-Lopez, 1987; Garcia-Alcalde et al., 1990a). The E/G boundary would therefore be placed in the underlying Huergas Shale and Sandstone Fm. Unfortunately, conodonts are virtually unknown in this last Formation because of unsuitable facies. In Asturias the situation is very close. Conodonts of the base of the Candás Limestone Fm. (Fig. 3) (*Polygnathus rhenanus* and other, Garcia-López, 1987) belong to the Varcus Zone and the underlying Naranco Sandstone Fm. has sandy-shale facies unsuitable for conodont.

Whereas in the Asturo-Leonese sections conodonts faunas are well developed from the Varcus Zone onwards, in the Palentine Domain (Figs. 2, 3) the situation is nearly the opposite: conodonts are relatively abundant up to the *Kockelianus* Zone but become scarce upwards. In these conditions, the E/G boundary could roughly be traced at the top of the Gustalapiedra Fm. (Fig. 3) in connection with the Kacak-Otomari Global Event (Truyols-Massoni et al., 1990). This Event is represented in Palencia by marked litho- and bio-events (deposition of the Man Sandstone Mb., a remarkable departure of the Gustalapiedra Fm. shaly pelagic sedimentary conditions indicating a regressive pulsation, and/or the removal by giant storms of distant sandy masses, and the extinction of *Pinacites, Fidelites, Cabrieroceras crispiforme, C. ougartense*, and *Subanarcestes macrocephalus* recorded at the Man Mb or a little lower, arising in the Lower *Ensensis* Subzone according Becker and House, 1991). Other auxiliary guide-fossils for the E/G boundary would be *Nowakia otomari* that straddles the Man Mb. and the ammonoid genera *Tornoceras* and *Wedekindella* that occur above the Man Mb. in the uppermost part of the Gustalapiedra Fm. (Fig. 3).

e) Base of Frasnian. Middle/Upper Devonian boundary. Conodonts of the *Ancyrodella* early phylogeny (Klapper et al., 1987) and *Mesotaxis asymmetrica* are largely distributed in Cantabrian sections but require re-examination on account the taxonomic changes proposed by Sandberg et al. (1989).

In the Asturo-Leonese Domain (Figs. 2, 3) facies constraints prevent the complete development of the A. *binodosa-A. rotundiloba* lineage. However if the *A. pristina* range and synonymy proposed by Sandberg et al. (1989) will be advisable the occurrence in Leon (Fig. 2) of *A. isabelae* (=*A. pristina*) and *A. rotundiloba* in the lower part of the unit E of the Nocedo Sandstone Fm. (García-López, 1986) (Fig. 3) would reveal rather well the G/F boundary at the base of the unit E or a little lower.

The occurrence of "*A. binodosa*" in the uppermost part of the D member of the Candás Limestone Fm. in several Asturian measured sections, and that of *P. webbi, A. rotundiloba, A. alata* and *A. africana* in limestone beds of the overlying Piñeres Sandstone Fm. (Garcia-López, 1987) (Fig. 3) would indicate an intermediate position between both levels of the G/F boundary. Unfortunately the sandy-shale facies of the intervening beds prevents the accurate boundary positioning.

In the Palentine Domain (Figs. 2, 3) the G/F boundary is to be placed in the lower part of the Cardaño Limestone and Shale Fm. (Fig. 3). The accurate positioning is however greatly conditioned by strong tectonics. The very sparse and uncertain available information (mainly Adrichem-Boogaert, 1967; Mouravieff and García-López, in Lobato, 1977; Henn, 1985; Montesinos and Henn, 1986; Montesinos, 1988, unpublished Doctoral Thesis; Montesinos, 1990) requires yet further studies. It would indicate the lower Cardaño Fm. nodular reddish limestone and intervening gray to dark shale holds conodonts and ammonoids of the *Varcus* to *Transitans* Zones (*Polygnathus ensensis, P. varcus, P. timorensis, P. cristatus, Schmidtognathus hermanni, S. wittekindti, S. peracutus, Palmatolepis disparilis, Ancyrodella binodosa, A. rotundiloba, A. alata, A. africana, A. lobata; Pharciceras spp., Stenopharciceras cf. kseirense, Timanites ? taouzense, Schindewolfoceras alcaldei, Petteroceras errans, Koenenites sp., Pseudoprobeloceras sp., Manticoceras sp., Mesobeloceras housei*, and *Beloceratidae* indet.) but no clearly undisturbed and continuous section is known until to now.

f) Base of Famennian. (Becker et al., 1989). The conodont *Palmatolepis praetriangularis-Pa. triangularis* lineage (Ziegler and Sandberg, 1990) is unknown in the Cantabrian Mts.

The research addressed to the correlation of the Frasnian/Famennian boundary in the Cantabrian Mts. is very disappointing. In the most part of the Asturo-Leonese Domain (Figs. 1, 3) there is a pre-Upper Famennian gap including the critical levels. In his turn the more complete western- and southernmost sections have, in general, poorly fossiliferous sandy facies, unsuitable for conodonts or nearly so. In the other hand, although the more basinal Devonian of the Palentine Domain (Figs. 1, 2) provides often interesting faunas they are found in strongly tectonised and discontinuous sections.

In a very rough correlation the F/F boundary could be placed in the southernmost Asturo-Leonese sections in the lower part of the Fueyo Fm. (Fig. 3) at the base of a thin polymict conglomerate. Below the conglomerate possibly Upper Frasnian sparse brachiopod and mollusc faunas occur (*Douvillina, Aulatornoceras, Lobobactrites, Buchiola, Guerichia*; Rodriguez-Fernández et al., 1985), and above it Loevezijn (1988) reported Middle *Pa. triangularis* to Upper *Pa. crepida* Zones conodonts (*Icriodus alternatus alternatus, I.a.helmsi, Polygnathus brevilaminus, Palmatolepis* sp.).

In the Palentine Domain (Figs. 1, 2) the F/F boundary is to be placed in the upper part of the Cardaño Fm., just above the last relevant nodular limestone interval (Fig. 3). In the topmost of these limestones, in several sections of the Gildar-Montó area (Fig. 2), conodonts of the *Linguiformis* Zone (*Ancyrognathus asymmetricus, Ancyrodella curvata, Palmatolepis subrecta, P. hassi, P. gigas, P. decorosus, Icriodus alternatus*; Adrichem-Boogaert, 1967; Henn, 1985) has been reported. In a measured section SSE of Peñaquebrada peak (Fig. 2) several of the characteristic steps of the Kellwasser crisis as described by Schindler (1990) can be traced. Just below the upper nodular limestone interval, the last manticoceratids (*Manticoceras* spp., *Sphaeromanticoceras* sp. and *Crickites* ? sp.), styliolinids and the trilobite *Cryphops* disappear. Overlying the nodular limestone in gray shale with abundant isolated nodules 5 m thick rich bivalve (Pterinopectinids, *Buchiola*) ostracods, and homoctenids faunas occur. Higher on there are a lot of internal molds of nepionic ammonoid shells, bivalves, small glassiinid brachiopods, ostracods, and new trilobite (*Trimerocephalus*), ammonoid (*Aulatornoceras* (*Aulatornoceras*) sp., and *Falcitornoceras*), and bivalve (*Guerichia*) faunas. In a similar position in the Cardaño Area (*Palencia*) (Fig. 2) Mouravieff (in Lobato 1977) reported conodonts of the F/F transition (*Ancyrodella curvata, Palmatolepis gigas, P. delicatula*, and *P. minuta*). The F/F boundary in the SSE Peñaquebrada section is roughly placed at the top of a barren black shale interval 1 m above the last homoctenid and pterinopectinid occurrence. In the lower part of the overlying Murcia Sandstone and Shale Fm., *Cheiloceras* and the trilobite *Ductina ductifrons* first occur (Arbizu et al., 1986).

Central-Iberian, Ossa-Morena and South-Portuguese Zones (Fig. 1)

Other Devonian Iberian Massif basins, in particular those located in the so-called Central-Iberian, Ossa-Morena, and South Portuguese Zones (Lotze, 1945 modified by Julivert et al., 1974) have developed very shallow, poorly fossiliferous sandstone-shale facies unsuitable in general for conodonts, ammonoids, dacryoconarids and other chronostratigraphically relevant faunas. Therefore no direct correlation of Devonian Stage or Series boundaries can be made in this region and published attempts are inaccurate and very rough. The situation is further complicated by the occurrence of important sedimentary gaps embracing virtually the Middle Devonian rocks in the Central-Iberian and Ossa-Morena Zones and the pre-Famennian rocks in the South Portuguese one.

The best known area in this vast region is constituted by the southern Central-Iberian Zone Herrera del Duque, Almadén, and Guadalmez Synclines. The most documented Devonian correlations in this area, mainly based on brachiopods (but also in conodont icriodiid faunules found in limestone lenses), have been published by Puschmann (1970), and Pardo and Garcia-Alcalde (1984a, b). Overall works on conodonts and brachiopods by A. Calvo and M.V. Pardo, respectively, are in progress, but the available data do not allow neat correlation improvements. Perhaps the more promising interval could be that of the F/F boundary. In the southern Central-Iberian Zone there is an abrupt facies turnover in the upper part of the Devonian succession represented by a sandy-shale to black nodular shale transition (Kellwasser Event ?). In calcareous lenses of the uppermost part of the sandy-shale series in the Almadén Syncline *Ancyrognathus asymmetricus* (Uppermost *Gigas* Zone=*Linguiformis* Zone ?) occurs. In the other hand, at the lower part of the black nodular shale of the Guadalmez Syncline, there are very interesting *Amblylobum* Zone Lower Famennian ammonoid faunas with *Falcitornoceras falciculum wagneri, Tornoceras, Lobotornoceras*, and *Cheiloceras* spp. (House and Price, 1985; Oliveira et al., 1986).

Eastern Guadarrama.(Fig. 1). In this region only an incomplete Lower Devonian succession has been reported (Bultynck and Soers, 1971).

Conodonts of the *Ozarkodina pandora-Eognathodus sulcatus sulcatus* lineage are lacking in eastern Guadarrama. Nevertheless, a rather good correlation of the Lochkovian/Pragian boundary can be made after the first occurrence of *Vandercammenina sollei* (and of the genus *Vandercammenina*) at the base of bed MS-11 (Carls, 1987) (= base of the Ce3 Member of the Cercadillo Limestone and Shale Fm.; Bultynck and Soers, 1971). *Caudicriodus angustoides angustoides* and *C.a. castilianus* occur a little higher at the base of bed MS-12.

The Pragian/Emsian is roughly placed at the base of bed 41, in the upper part of the Ce7 Member of the Cercadillo Fm. (Bultynck and Soers, 1971) in an important lithological turnover from calcareous sandstones, shales and thin dolostone beds to massive dolostones. 1 m or nearly so above this lithological event, *Caudicriodus sigmoidalis, Pandorinellina steinhornensis miae*, and early forms of *Polygnathus dehiscens* occur (Bultynck, 1979).

Celtiberia. (Fig. 1) (Topic to be extensively discussed by CM P.Carls).

The Lochkovian/Pragian boundary is roughly correlated as in the Cantabrian Mts. by the occurrence of *V. sollei* and conodonts of the *Caudicriodus angustoides alcoleae-C.a.castilianus* lineage in the lower part of the Nogueras Fm. (d2bα-d2bβ boundary) (Carls, 1987; Garcia-Alcalde et al., 1990a).

After indirect correlations, as in the Cantabrian Mts. and in Guadarrama (see above), based on the distribution of classical "Lower Emsian" brachiopods below the first reported occurrence of *Polygnathus dehiscens*, the Pragian/Emsian boundary could be placed at the lowermost part of the Mariposas Shale Fm. in or near the important lithological turnover recorded there (Garcia-Alcalde, 1992; *contra* Carls, 1988).

Conodonts of the *P. c. patulus-P. c. costatus* lineage occur in Celtiberia but the primary Lower Eifelian index-fossil *P. c. partitus* is lacking. The E/E boundary correlation can be made after the first occurrence of *Icriodus retrodepressus* and *I. struvei* at the lowermost part of the Monforte Shale Fm. Near the boundary, in the uppermost part of the underlying Molino Shale Fm. the local extinction of the *Arduspirifer mosellanus* spiriferid group occurs.

The Eifelian/Givetian and Givetian/Frasnian boundaries have been hitherto not recorded in Celtiberia because of tectonics (Carls, 1988).

The Frasnian /Famennian boundary is to be found in the area of Tabuenca (northwestern Celtiberia) (Fig. 1) in a very thick Upper Devonian siliciclastic succession unsuitable for conodonts. No primary F/F boundary index-fossil has been reported there. However in a rough correlation the boundary could be placed near the Bolloncillos Sandstone and Shale Fm.-La Hoya nodular Shale and Sandstone Fm. transition after the local extinction of homoctenids (*Homoctenus krestovnikovi, H. ultimus* sspp., and *H. deflexus*) in the upper part of the Bolloncillos Fm. and the first occurrence of *Falcitornoceras falciculum* in the lower part of the La Hoya Fm. (Montesinos et al., 1990)

CATALONIAN COASTAL RANGES

The Catalonian Coastal Ranges trend parallel to the Mediterranean coast, in northeastern Spain across the Catalonian region (Fig. 1). The Devonian of this area is characterized by Hercynian limestones and thin intervening graptolitic black shales. Tectonics and metamorphism have hampered during a long time the establishment of the stratigraphical series. New research in quarries near Barcelona have allowed to recognize a nearly continuous Lochkovian to Emsian succession ca. 50 m thick with abundant conodont and dacryoconarid faunas (Garcia-López et al., 1990).

Eognathodus sulcatus sulcatus has been not found. However the base of Pragian is rather well traceable at the lowermost part of the C Member of the Olorda Fm. by the occurrence of Upper Lochkovian-Lower Pragian guide-fossils (*Ozarkodina pandora* α and β morphotypes, *O. remscheidensis remscheidensis, O stygia* β and γ morphotypes, *Ancyrodelloides omus, A. trigonicus, Pandorinellina steinhornensis miae, Homoctenowakia bohemica, Paranowakia cf. intermedia, Nowakia acuaria, and Monograptus hercynicus*)

The Pragian/Emsian boundary is roughly indicated by the occurrence of early forms of *Polygnathus dehiscens* in the upper part of the C Member of the Olorda Fm. Unfortunately *P. pireneae* has been not found there.

BETIC CORDILLERA (INCLUDING THE BALEAR ARCHIPELAGO)

The Betic Cordillera extends more or less parallel to the Mediterranean Sea, in the southeastern part of Spain. Topographic, stratigraphic, and structural features allow the prolongation of the Cordillera in the Balear Archipelago (Fig. 1) (Herbig, 1985; but see Bourrouilh, 1983).

Sedimentary Devonian rocks in the Balear island of Menorca (Fig. 1) are well known long ago (cf. Bourrouilh, 1983). Instead the peninsular Betic Devonian, located in the Malaguides tectonic unit, has been more overlooked because of strong metamorphism affecting the most part of the Paleozoic series and the "exotic" sedimentological setting of the datable successions.

The Malaguides Devonian is mainly documented from conodont faunas found in limestone pebbles or slide blocks (olistoliths) plunged in Carboniferous, sometimes turbiditic successions. Similar pebbles and blocks have been reported in Menorca. In the Malaguides below the Carboniferous series there are flyschoid unfossiliferous sandy limestones and greywackes of the Santi Petri Fm., that embodies limestone olistoliths with Silurian to Middle Devonian conodont faunas (Kockel, 1958; Herbig, 1985). In spite of its anomalous geological setting the Malaguides Devonian pebbles include amazingly rich and varied conodont faunas. A comprehensive work in progress by R. Rodriguez-Cañero proves the occurrence of all Devonian chronostratigraphical boundaries but the Emsian/Eifelian one. Especially the E/G, G/F, and F/F boundaries can be correlated after the occurrence of the critical *Polygnathus pseudofoliatus-P. hemiansatus, Mesotaxis falsiovalis-M.asymmetrica, and Palmatolepis praetriangularis-P.triangularis* lineages, and other relevant index-fossils.

The most part of the Balear Devonian has been generated by turbidity currents or mud flows. The consequent reworking prevents the accurate establishment of the stratigraphic series. The abundant conodont, ostracod and dacryoconarid faunas allow Stage identifications, indicating the occurrence of a rather complete Devonian succession. Nevertheless the precise Stage boundary correlations are hampered by the lack of documented conodonts accounts.

PYRENEAN CORDILLERA (FIG. 1)

The correlation of Devonian Stages boundaries in the Pyrenean Cordillera is strongly hindered by the lack of recent reviews or overall works on critical paleontological groups as conodonts, ammonoids or dacryoconarids. A great deal of the available bibliography is either unpublished, out-of-date, unsubstantiated, or dispersed in unespecialized papers. Therefore not precise comprehensive account can be made at this stage.

After the published accounts the occurrence of a rather complete Pyrenean Devonian succession might be inferred, but the ranges of index-fossils are, in general, badly substantiated. See for example the classic Boersma (1973) monography on Devonian conodont biostratigraphy in the Central Pyrenees; rich and varied conodont faunas reported in this paper might indicate great correlation possibilities after the occurrence of many biostratigraphical keystone fossils. In fact this paper is badly useful because of lack of descriptions and figurations.

Herein we are on purpose restricted to reliable and documented (figured fossils) recent information.

In Central Pyrenees there is a rich Lochkovian conodont succession (Valenzuela-Rios, 1990) but the L/P boundary interval is very poorly fossiliferous. Although forms of the early phylogeny of *Eognathodus sulcatus sulcatus* occur (*Ozarkodina pandora* group), the primary L/P boundary index-fossil itself and other relevant guide-fossils are lacking. The L/P boundary is roughly traced at the first occurrence of *Latericriodus steinachensis* in the lithosome C of the so-called Compte Unit, near Seo de Urgel.

The base of Emsian is likewise difficult to correlate in Central Pyrenees. Work in progress by J.I.Valenzuela-Rios proves that *Polygnathus pireneae* and *P. dehiscens* occur in the area but they have never found hitherto in a continuous sequence. The P/E boundary could be roughly traced in the upper part of the Basibé Limestone Fm. below the first occurrence of early *P.dehiscens* forms.

Lack of documented occurrences of conodonts of the *P. c. partitus-P.c.costatus* and *P. pseudofoliatus-P.hemiansatus* lineages prevent the accurate correlation respectively of the Emsian/Eifelian and Eifelian/Givetian boundaries.

The association of *Ancyrodella binodosa*, *A. rotundiloba* and transitional forms between both species in the uppermost part of the Montcorbissun Limestone (Montpius-Montcorbissun section, SW of the Arán Valley Synclinorium, southern Central Pyrenees) allows a rather good Givetian/Frasnian boundary correlation (Garcia-López et al. ,1991).

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Figure 1 - Devonian outcrops of sedimentary rocks in Spain (in black). Dots: the Iberian Massif; 1, Cantabrian Mountains (Asturo-Leonese and Palentine Domains).; 2, West-Asturian-Leonese Zone; 3, Central-Iberian Zone; 4, Ossa-Morena Zone; 5, South-Portuguese Zone; 6, Eastern Guadarrama; 7, Celtiberia; 8, Catalonian Coastal Ranges; 9, Betic Cordillera; 10, Pyrenean Cordillera; a, Herrara del Duque Syncline; b, Almadén Syncline; c, Guadalmez Syncline; d, Tabuenca area.

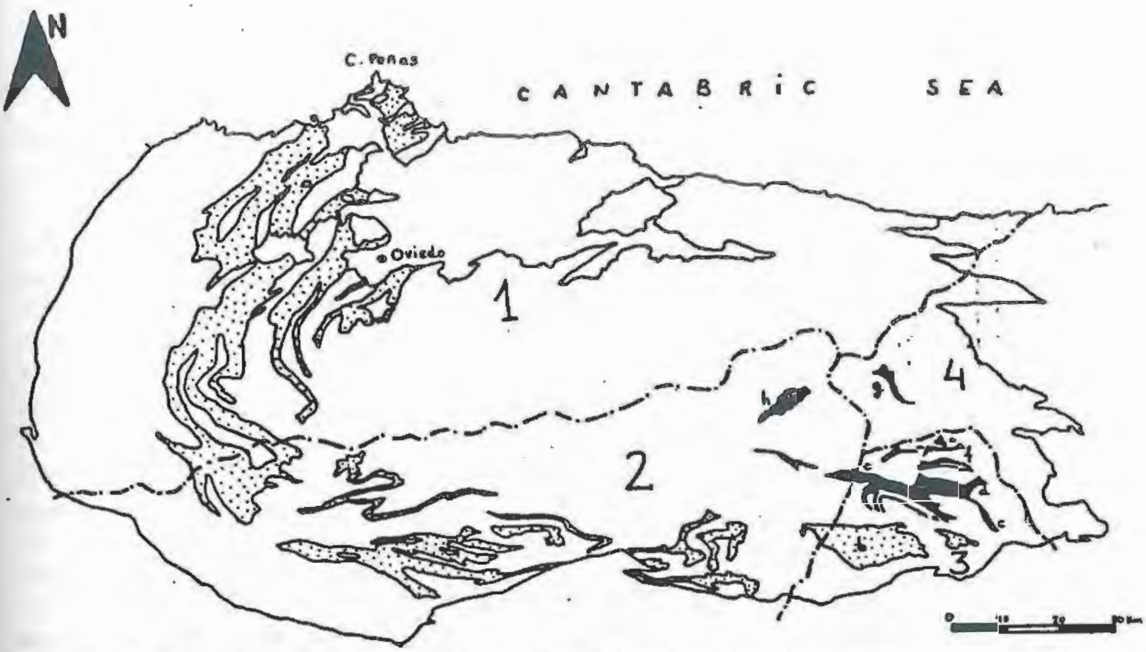
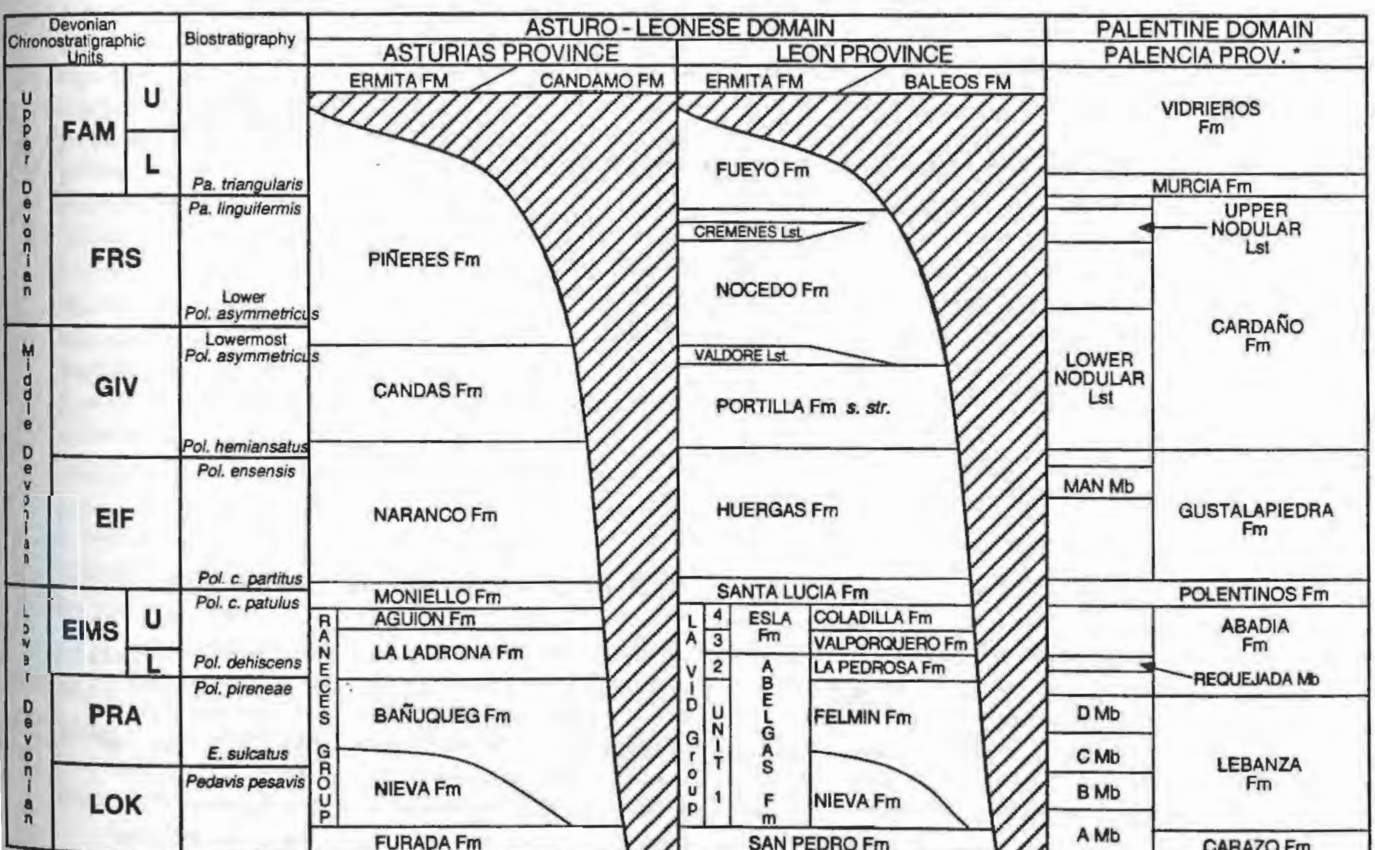


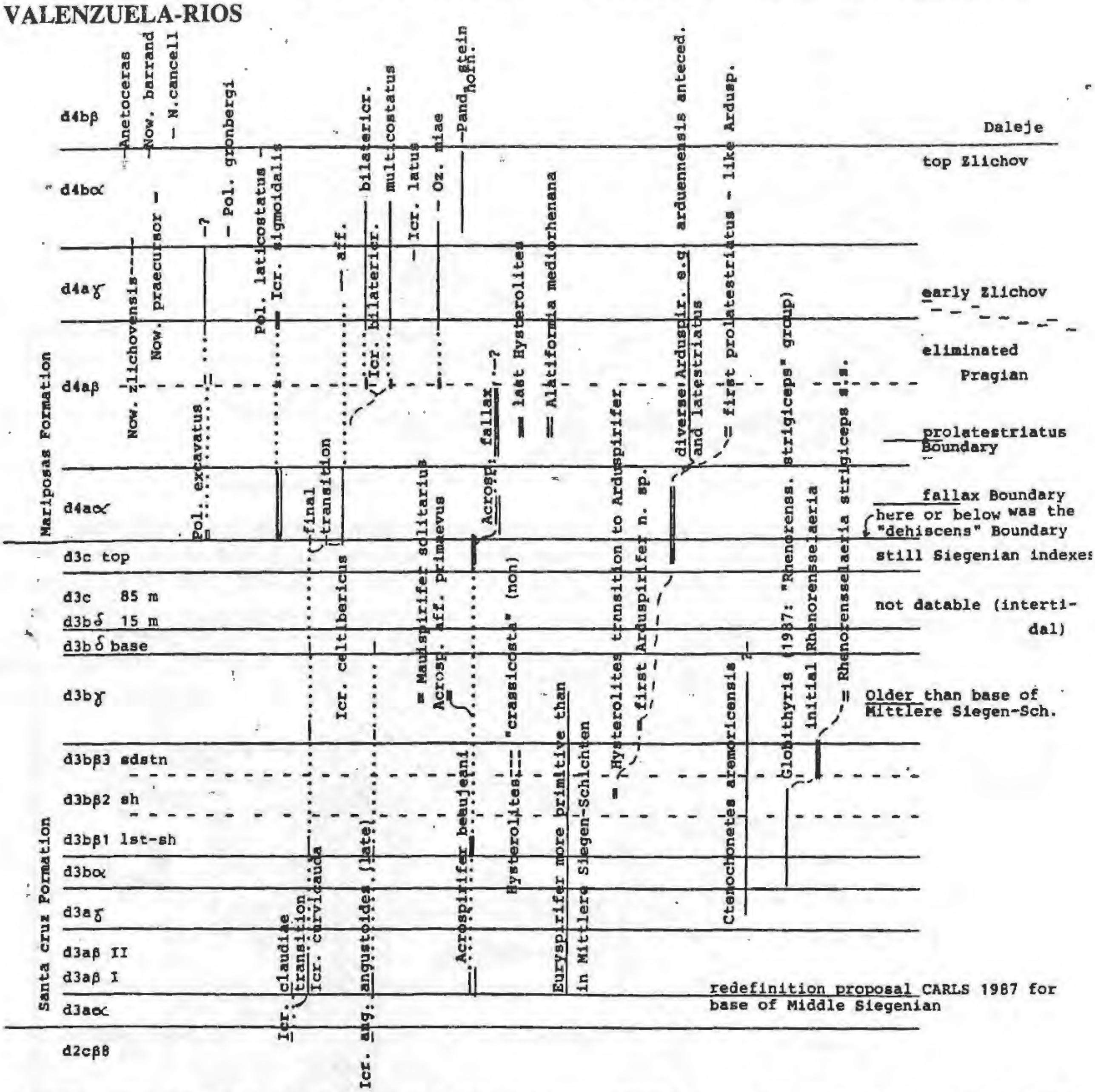
Figure 2 - Devonian outcrops of the Cantabrian Mountains. Dots: Asturo-Leonese Domain; Black, Palentine Domain; 1, Asturias Province; 2, León Province; 3, Palencia Province; 4, Santander Province; a, Santa Maria del Mar area; b, Valsurvio Dome area; c, Barruelo area; d, Lebanza area; e, Cardaño area; f, Arauz area; g, Liébana area; h, Gildar-Montó area.



*Mainly Palencia Prov. but also Leon and Santander Prov.

Figure 3 - Devonian stratigraphy of the Cantabrian Mts. Correlation chart between the lithostratigraphic units of the Asturo-Leonese and Palentine Domains. Diagonal ruled: Pre-Upper Famennian stratigraphic gap.

MATERIALS NEAR THE REDEFINED BASE OF THE EMSIAN STAGE — P. CARLS & J.I. VALENZUELA-RIOS



Materials near the redefined base of the Emsian Stage. P. CARLS & J.I. VALENZUELA-RIOS. Eastern Iberian Cordillera (Nogueras and Nigüella areas). From manuscript in preparation 1993.

The "dehiscens" boundary practised in Nevada and elsewhere is based on Pol. excavata CARLS & GANDL 1969. The redefined boundary in the Zinzilban Gorge is older but can not be detected in Celtiberia due to lack of suitable facies. The middle of unit d3bγ has Spiriferacea slightly more primitive than the Mittlere Siegen-Schichten at the Rhine, where Rhenorensselaeria strigiceps is known from the base of the latter. As the Ardenno-Rhenan Lower Siegenian is deltaic and barren of marine shelly faunas, the traditional concept of "Siegenian" (pre-Emsian) was founded on the Mittlere and Obere Siegen-Schichten (which differ little in indexes). It can not be excluded that the new Emsian base is deep within them or even below them. Several errors of CARLS concerning the age of d3bδ faunas since 1965 are revised. The traditional Emsian base is near prolatestriatus or fallax Boundary which could not be discriminated by means of conodonts. The "monster" fauna of western Armorica is top d3c. The traditional Belgian concept of the upper Siegenian was so as to include the "Ulmen-Gruppe" of SOLLE, which lies above the fallax/prolatestriatus band. The new boundary will be disliked by the geologists working in the traditional areas of the Ardenno-Rhenan regions, as it converts the most important parts of the Siegnian into Emsian. The boundary is now even deeper in the Pragian than had been warned bv CARLS 1987.

MIDDLE AND UPPER DEVONIAN STAGE BOUNDARIES IN THE SOUTHERN POLAND CARBONATE SHELF SUCCESSION — GRZEGORZ RACKI

The Holy Cross Mts are the principal reference area for study of the Devonian epicontinental succession in Poland.

This is the main field of the present discussion on the current state of correlation in the light of SDS stage definitions, with some additional data from the CracowSilesian sections (Fig. 1).

Tomczykowa (1991) discussed present biostratigraphical questions related with the base of the Devonian system in the northern Holy Cross Mts and Lublin area, but subdivision of the Lower Devonian terrigenous strata is generally unsuccessful (with possible exception of the trilobite-based Lochkov and Prag boundary), due to lack of the guide fossils in the largely continental succession. The significant data are supplied by palinological studies of the Holy Cross and Silesian profiles, and the Emsian age of sandstone complex is well evidenced (E. Turnau, oral comm.). Not very abundant icriodontid conodonts also indicate the late Emsian assignment of the basal Grzegorzowice and Dabrowa Beds, whilst the Lower-Middle Devonian series boundary runs within the units. For example, the series boundary is near the base of the unit VIII of Pajchlowa (1957) in the well-known Grzegorzowice-Skaly section, characterizing the Lysogory (northern) facies region (Malec in Sarnecka 1988; Malec 1992). The fossiliferous, mostly carbonate diachronous deposits record the Ic transgrssive pulse in the eustatic cycle framework of Johnson et al. (1985).

The Eifelian-Givetian boundary is recognized only in the open shelf Lysogory succession: conodont faunas indicate its placements just below the bottom of the unit XX (sensu Pajchlowa 1957) of the Skaly Beds, i.e. ca. 120 m above the shaly set with Nowakia otomari corresponding to the If deepening event (Malec 1984). The stage boundary is speculatively proposed for the thick and widely distributed stromatoporoid-coral limestone sequence of the Kowala Formation (Narkiewicz et al. 1990); the main basis are the transgressive event correlation between Lysogory basin and Kielce carbonate platform, and macrofaunal data, in first order entry of oldest Stringocephalus (Jurkowice-Budy section; Racki 1993).

The Middle-Upper Devonian series boundary position is based on biostratigraphically significant conodonts, largely Ancyrodella, in several sections from the transitional area between the Kielce and Lysogory domains (Kostomloty zone and northern Kielce subregion; Racki 1985, 1993; Racki & Bultynck 1993), with the Wietrznia sections in main role. This boundary occurs within the argillaceous Szydlowek Beds and calcareous (organodetrital) Wietrznia Beds, but the accurate correlation with the global stratotype (Montagne Noire) point have been found as somewhat ambiguous due to weakness of the reference succession. This series boundary more crudely established within the biostromal Kowala Formation in regard of scarce conodonts (impoverished polygnathid biofacies), and equivocal macrofaunal evidences (brachiopods, corals). Neverheless, upward-shallowing cycles, referred largely to 3rd order eustasy in scheme of Vail et al. (1991), forms framework for regional correlation of the late Givetian and early Frasnian bank to reef complex (Racki 1993). The series boundary is located just below less or more distinctive drowning unconformity (= the base of the unit IIb/c of Racki 1993 within the transitans Zone) in the Holy Cross Mts. Such event pattern is also supposed for the Cracow area (Narkiewicz & Racki 1987).

The Frasnian-Famennian boundary is realatively easily recognized in regard of rich conodont data, and paired with variable hiatuses in many sections (Narkiewicz 1988, Szulczewski 1989, Racki 1990). This is record of prominent eutatic fall in the latest linguiformis Zone (see Sandberg et al. 1989), coupled with global carbonate ecosystem crisis. In consequence, also the basal Famennian Early triangularis Zone is at least reduced even in the most complete sections (Psie Gorki, Kowala; Racki 1990, Racki in Racki et al. 1993).

Similarly, the "natural" aspect of the Devonian- Carboniferous boundary is expressed in the area under discussion in widespread gaps and condensation phenomena (e.g. Szulczewski 1973, 1978). The best studied exception is the continuous(?) basin succession at Kowala in the southern Kielce subregion, where the system boundary is preliminarily documented within the fossiliferous calcareous Radlin Beds (Malec in Racki et al. 1993).

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CORRELATION CHART OF THE MIDDLE-UPPER DEVONIAN IN SOUTHERN POLAND

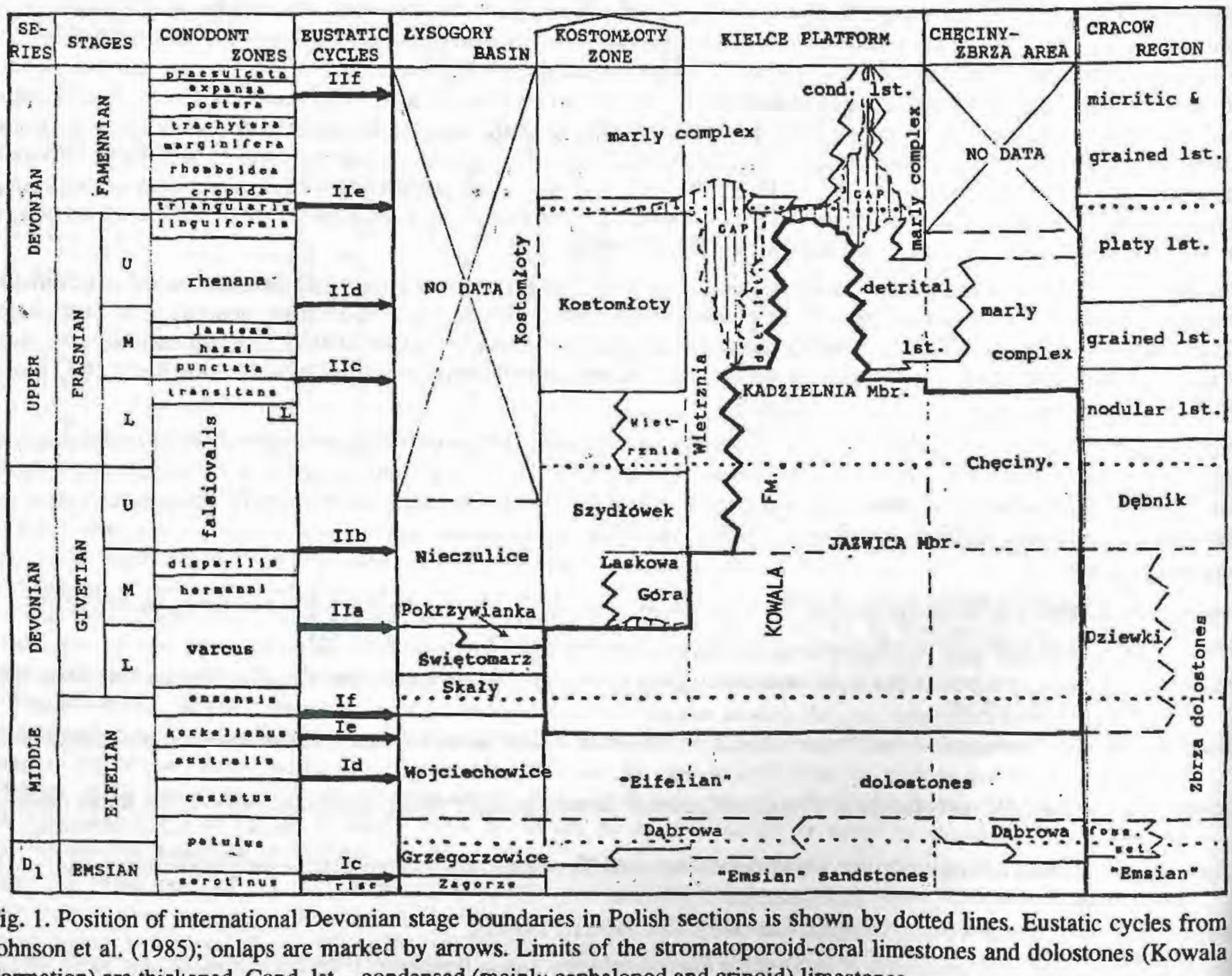


Fig. 1. Position of international Devonian stage boundaries in Polish sections is shown by dotted lines. Eustatic cycles from Johnson et al. (1985); onlaps are marked by arrows. Limits of the stromatoporoid-coral limestones and dolostones (Kowala Formation) are thickened. Cond. lst. - condensed (mainly cephalopod and crinoid) limestones.

SUMMARY OF THE STATE OF CORRELATION AND TERMINOLOGY IN THE DEVONIAN OF THE ARDENNES RESULTING FROM THE DECISION OF THE S.D.S. — P. BULTYNCK

The present state of correlation is indicated in seven figures. Three schematic diagrams show facies development within the Lower, Middle and Upper Devonian Series, the present lithostratigraphic terminology and the position of the stages as defined by the S.D.S in relation to the previous local stage boundaries. Four diagrams give more detailed information on positioning the base of the Eifelian. Givetian, Frasnian and Famennian.

In our review a series of points will be emphasized.

1. The correlation of a stage with the G.S.S.P. is carried out using a succession on the south side of the Dinant Synclinorium, the "classic area" of three Devonian stages and still the reference area for correlation within the Ardennes .
2. Correlation with the G.S.S.P. is, as far as possible, attempted primarily on the basis of either the index conodont species that was used in the fixing of the "golden spike" or another conodont taxon recorded from the boundary stratotype section.
3. A selection of macrofossils, mainly brachiopods, that confirm the correlation, are useful for regional correlation, or were used in defining the old boundaries .
4. Biostratigraphic information on selected microfossil groups (acritarchs, spores and ostracodes) at the boundary level.
5. Global or regional events close to the boundary level.

LOWER DEVONIAN

The Lower Devonian, a clastic sequence more than 3000 m thick, was originally subdivided into Gedinnian, Siegenian and Emsian using lithologic criteria and brachiopod faunas.

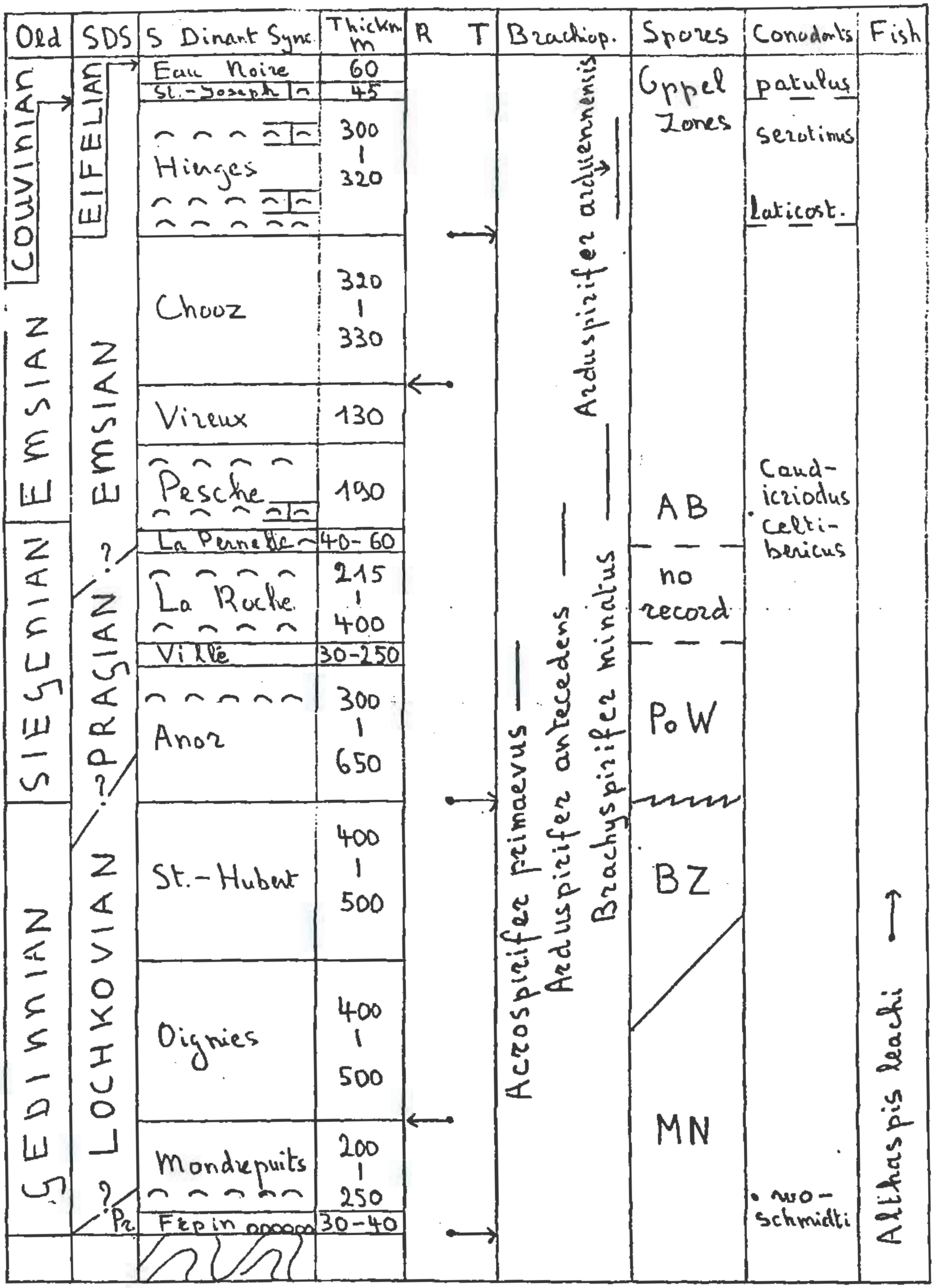
It corresponds to a major transgressive sequence, interrupted by two important regressions, demonstrated by red shales and sandstones with emersion indicators, during the upper Gedinnian and the middle of the Emsian. Neither the base of the Lochkovian nor the base of the Pragian or Emsian can be directly correlated with the stratotype sections. As a consequence of the clastic facies, conodont data are extremely scarce: the *woschmidti* Zone (uppermost Pridolian, lower Lochkovian) has been identified a few meters above the base of the Gedinnian; conodont taxa restricted to the *laticostatus* Zone and/or *serotinus* Zone, occur in the lower and middle parts of the Hierges Fm; the uppermost Emsian *patulus* Zone is recognized with confidence in the St. Joseph Fm and the lower part of the Eau Noire Fm, previously assigned to the Middle Devonian. The approximate positioning of the base of the Lochkovian, Pragian and Emsian is based on the spore zonation established by STEEMANS (1989) in the Lower Devonian of the southern Ardennes. The spore zones can be correlated, by way of Brittany, with chitinozoan zones that are recognized in Bohemia. STEEMANS concluded that, at least at some localities, the base of the Gedinnian is younger than the base of the Lochkovian. The base of the Pragian may be slightly older or younger than the top of the Gedinnian in the type area and is certainly below the earliest occurrence of *Acrospirifer primaevus* in the Ardennes (GODEFROID & STAINIER, 1982). The Pragian/ Emsian boundary is below the traditional base of the Emsian in the southern Ardennes, characterized by the earliest occurrence of *Brachyspirifer minatus*, according to GODEFROID & STAINIER (1982). This level corresponds to the base of the Emsian in its type area (SOLLE, 1971).

MIDDLE DEVONIAN

The Eifelian of the southern part of the Dinant Synclinorium is characterized by a mixed siliciclastic-carbonate sequence, about 700 m thick, with local development of biostromal formations. In the northern part, the Eifelian consists of a 50 m thick, mainly clastic succession overlying red conglomerates. The stage corresponds to a major transgressive sequence. During Givetian time, sea-level conditions were relatively stable. Shallow water platform carbonates, 450 m thick, with coral and stromatoporoid biostromes and back-reef deposits, prevail in the southern Ardennes. Two minor deepening events occur, one between the Trois-Fontaines Fm and the Mont d'Haurs Fm and a second at the base of the Fromelennes Fm. In the northern part, thickness of Givetian sediments is reduced to about 130 m; the succession consists of mixed siliciclastic-carbonate deposits.

The Middle Devonian of the Ardennes was initially subdivided into Couvinian and Givetian stages (see BULTYNCK, COEN-AUBERT, DEJONGHE, GODEFROID, HANCE, LACROIX, PREAT, STAINIER, STEEMANS, STREEL & TOURNEUR, 1991, for references and proposals to standarize the subdivision into formations). The base of the Eifelian corresponds to a level at about 94 m above the base of the Couvinian. Correlation with the G.S.S.P. is based on the first occurrence of *Icriodus retrodepressus*, within an evolutionary lineage and a uniform lithologic sequence. The stratigraphic distribution of several conodont taxa is similar to their ranges in the Eifel stratotype section. However, it should be mentioned that *Polygnathus costatus partitus* is known from only one locality. *Arduspirifer intermedius* appears just below the boundary level.

The base of the Givetian in the type area originally corresponded to the base of the Givet Limestone. Correlation with the Givetian G.S.S.P., on the basis of the earliest occurrence of *Polygnathus hemiansatus* and *Icriodus obliquimarginatus*, permits an approximate boundary positioning about 42 m below the base of the Givet Lmst. However, it should be stressed that, as a consequence of the shallow water facies, *P. hemiansatus* is rare and *I. obliquimarsinatus* is the most valuable boundary marker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EIFELIAN
EMSIAN
PRAGIAN
LOCHKOVIAN
Eau Noire
St.-Joseph
Hinges
Chooz
Vireux
Pesche
La Pernelle
La Roche
Villé
Anor
St.-Hubert
Oignies
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Arduspirifer arduennensis
Acrospirifer primaevus
Arduspirifer antecedens
Brachyspirifer mirabilis
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no record
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patulus
serotinus
laticost.
Caud-icriodus celti-bericus
wo-schmidti
Althaspis leachi

Fig. 1

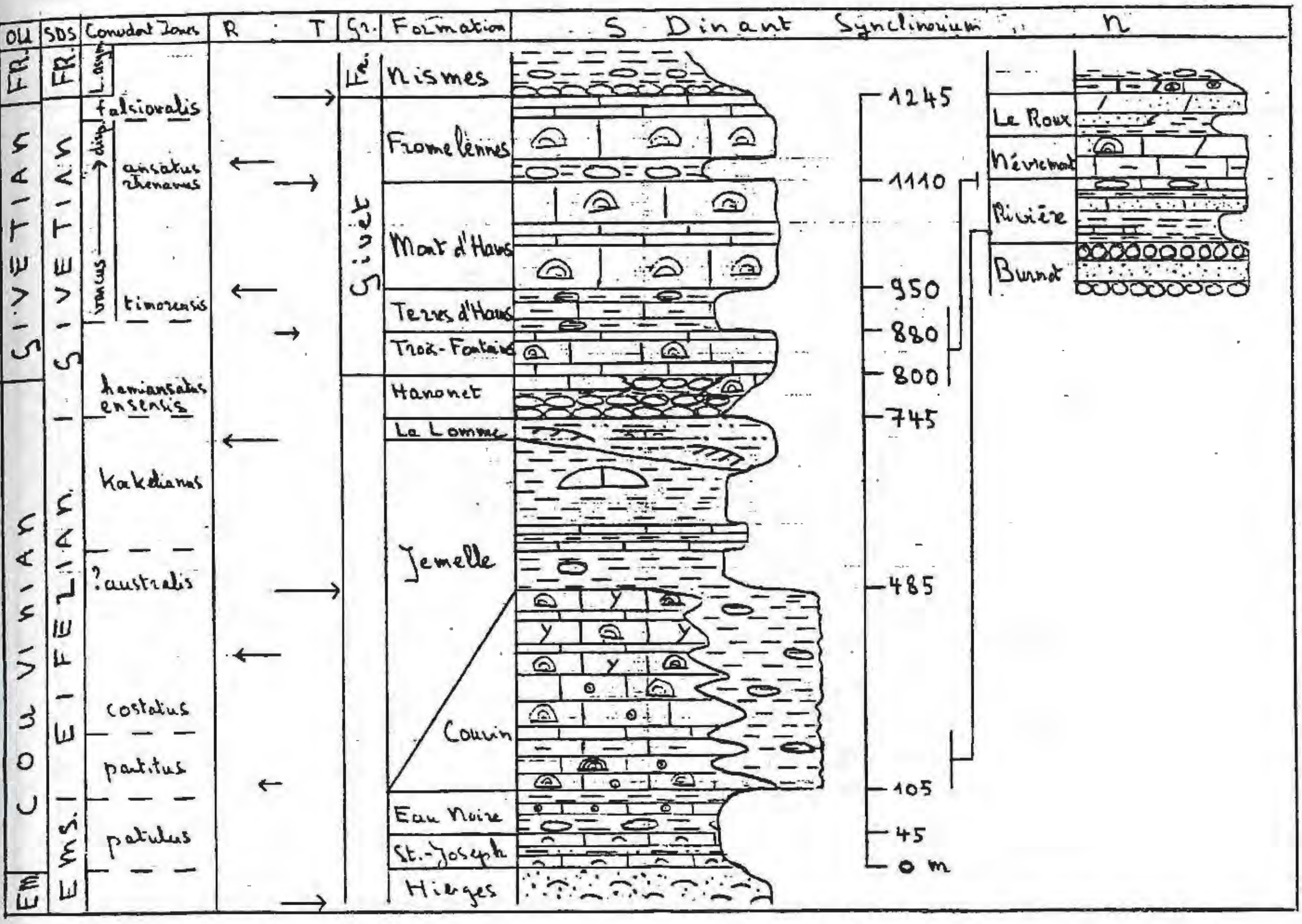

Fig. 2

for regional correlation. *Invertrypa kelusiana* occurs just below and above the boundary level and the first record of *Stringocephalus* is 58 m higher.

A relatively important regressive phase, shown by sandstones and siltstones with cross-bedding, occurs 20 m below the base of the Givetian.

UPPER DEVONIAN (pars)

The Nismes Fm at the base of the Frasnes Group corresponds to a major transgressive phase recognized in the southern and northern parts of the Dinant Synclinorium. In the type area the overlying formations comprise two marked bedded limestone bars, shales with nodules and limestone beds and biohermal lenses. Three phases of bioherms/mudmounds can be recognized in the southern part of the Dinant Synclinorium.

The bioherm/mudmounds of the two lower phases correspond to biostromal formations in the Philippeville Massif and the northern part of the Synclinorium. The red mudmounds of the third phase occur within the Neuville Fm and the Valisette Fm, exposed in the southern part and the Philippeville Massif. In both areas the top of the Frasnes Group consists of mostly dark shales, the Matagne Mbr, considered either as a deepening or anoxic event. They are overlain by greenish shales with nodules and mostly nodular limestone beds, belonging to the base of the Famenne Group.

The base of the Frasnian in the auxiliary boundary stratotype for neritic facies at Nismes (BULTYNCK, CASIER, COEN, COEN-AUBERT, GODEFROID, JACOBS, LOBOZIAK, SARTENAER & STREEL, 1987) is above the base of the Frasnes Gr. Correlation with the G.S.S.P. is based on the earliest occurrence of "*Ancyrodella rotundiloba*" within an evolutionary lineage. Positioning of the boundary is not affected by the discussion on taxonomy of early *Ancyrodella* species. The boundary beds contain rich atrypid and spiriferid faunas (SARTENAER, 1982 and GODEFROID & JACOBS, 1986) that are very useful for correlation. At Nismes and Wellin the Frasnian boundary is within the *Polvzygia beckmanni beckmanni* ostracod Zone (COEN, 1982 and CASIER, 1987). Spores are not known from the auxiliary stratotype; however in the nearby Boulonnais area, the Givetian/ Frasnian boundary is within the TCo Zone (STREEL, HIGGS, LOBOZIAK, RIEGEL & STEEMANS, 1987).

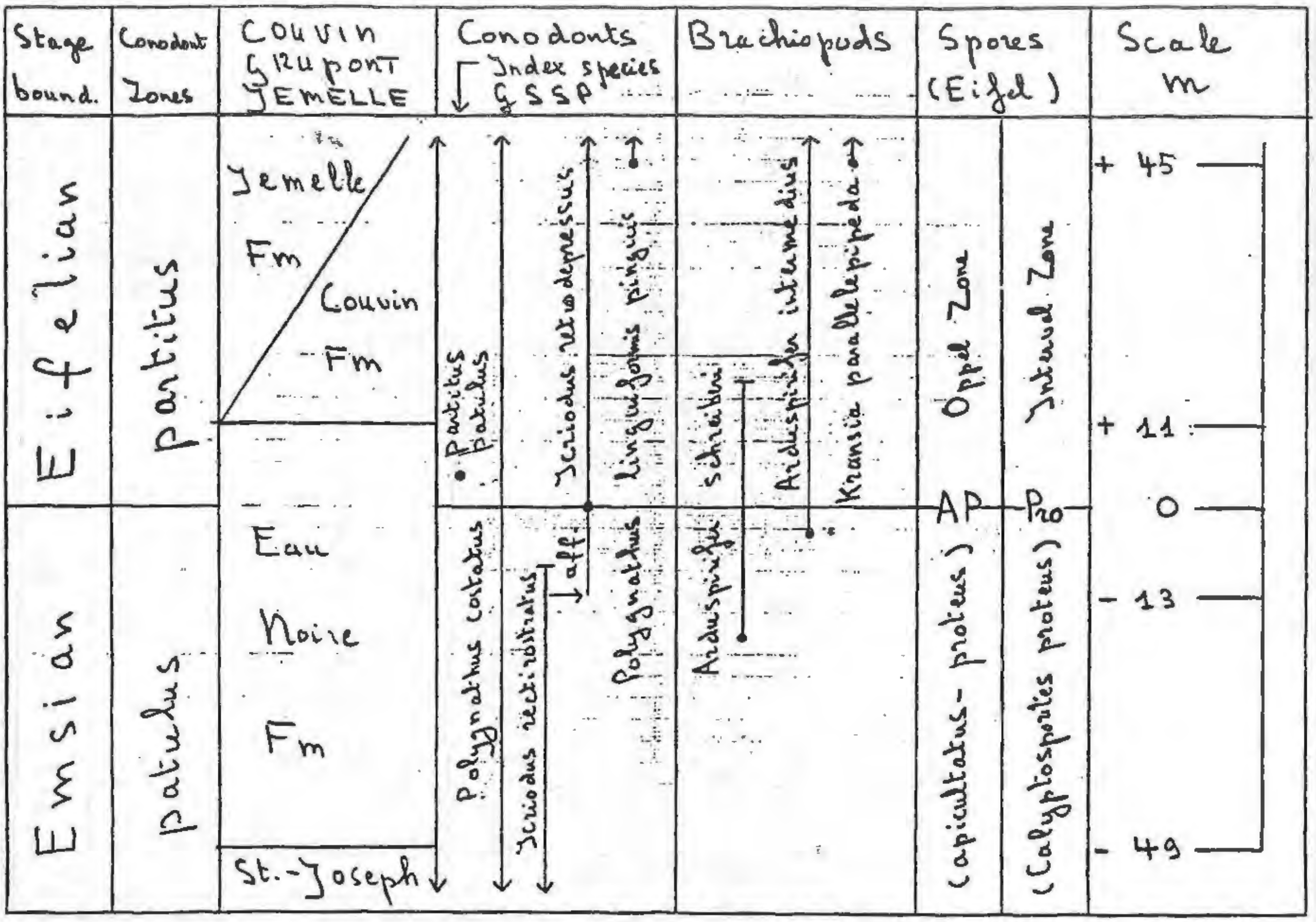

Fig. 3

The early *Palmatolopis triangularis* Zone has been well documented from three sections in the Famenne type area: Hony and Sinsin (SANDBERG, ZIEGLER, DREESEN & BUDLER, 1988) and Senzeilles (BULTYNCK, 1988). In these localities the earliest occurrence of *P. triangularis* is above a shaly interval (1.35 m at Hony, 0.15 m at Sinsin and about 9 m at Senzeilles) without conodonts. The interval belongs to the lowest part of the Senzeilles Fm and the Matagne Mbr. According to new conodont information at Senzeilles, *P. triangularis* occurs, together with *P. prae-triangularis*, 0.7 m above the historical boundary of GOSSELET (1877). *P. triangularis* morphotypes from this level are identical to the morphotypes in the lower 3 cm of bed 32a of the G.S.S.P. in the Montagne Noire (KLAPPER, 1990) and in bed 100 of the sequence at Steinbruch Schmidt in the Kellerwald area (SANDBERG, SCHINDLER, WALLISER & ZIEGLER, 1990).

At Senzeilles the Frasnian/Famennian boundary beds are characterised by rich rhynchonellid faunas (SARTENAER, 1960 and 1983). The *Pampoecilorhynchus lecomptei* Zone occurs just above the boundary. Two acritarch taxa have their earliest occurrence not far below the entrance of *P. triangularis* (MARTIN, in press). According to new data from Hony, the base of the Famennian is within the Vg acritarch Zone (STREEL and VANGUESTAINE, 1989).

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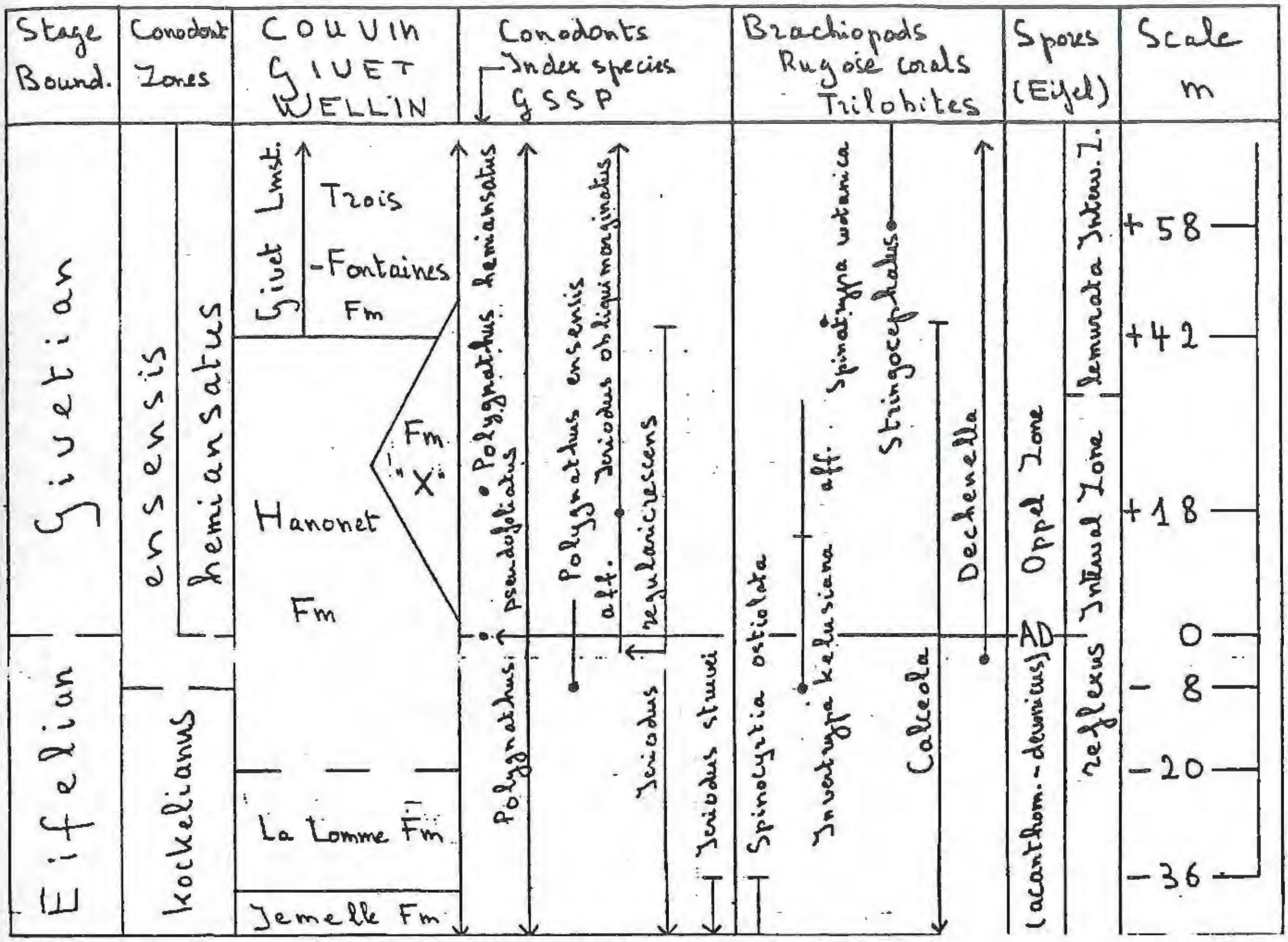

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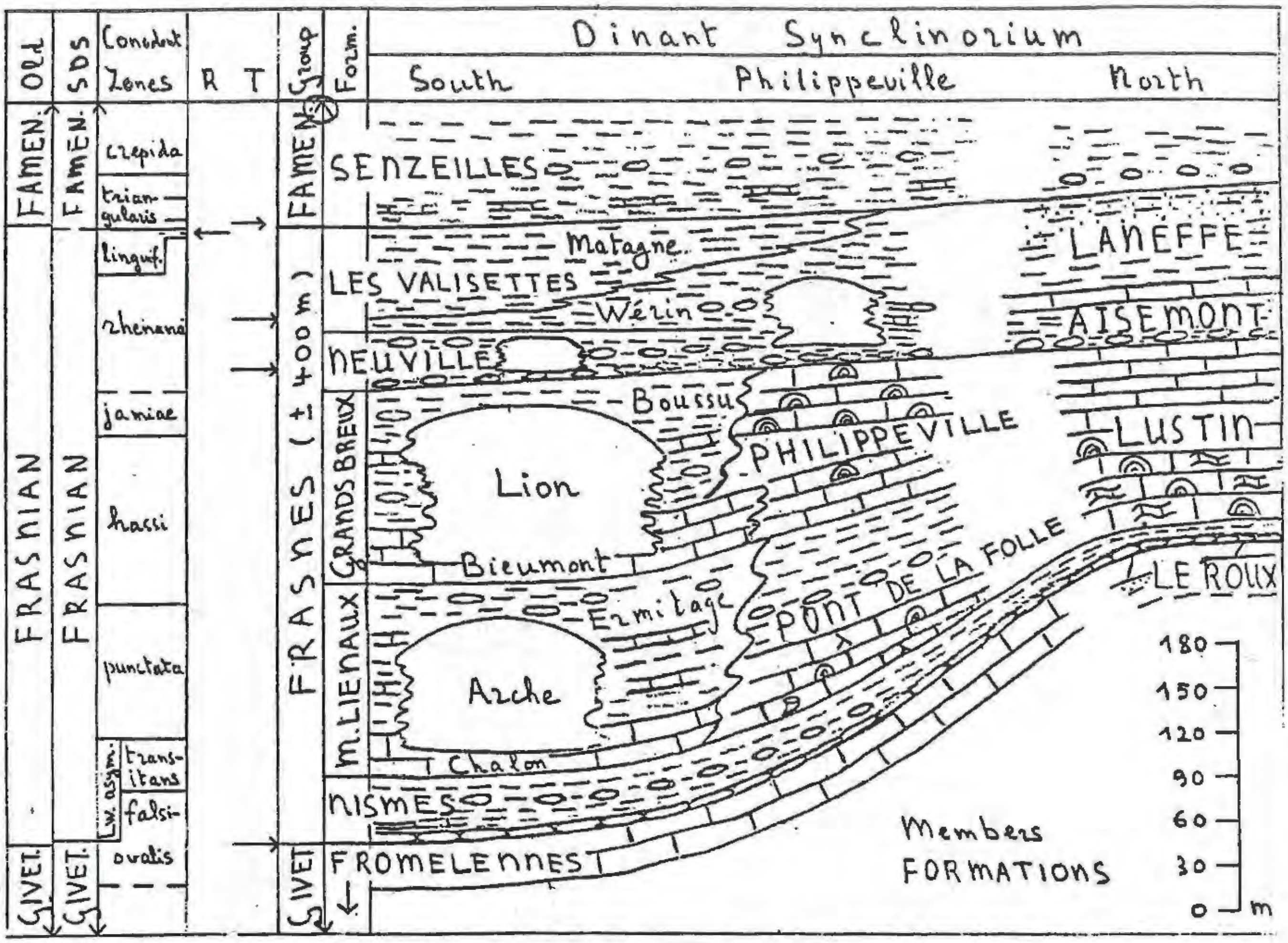

Fig. 5

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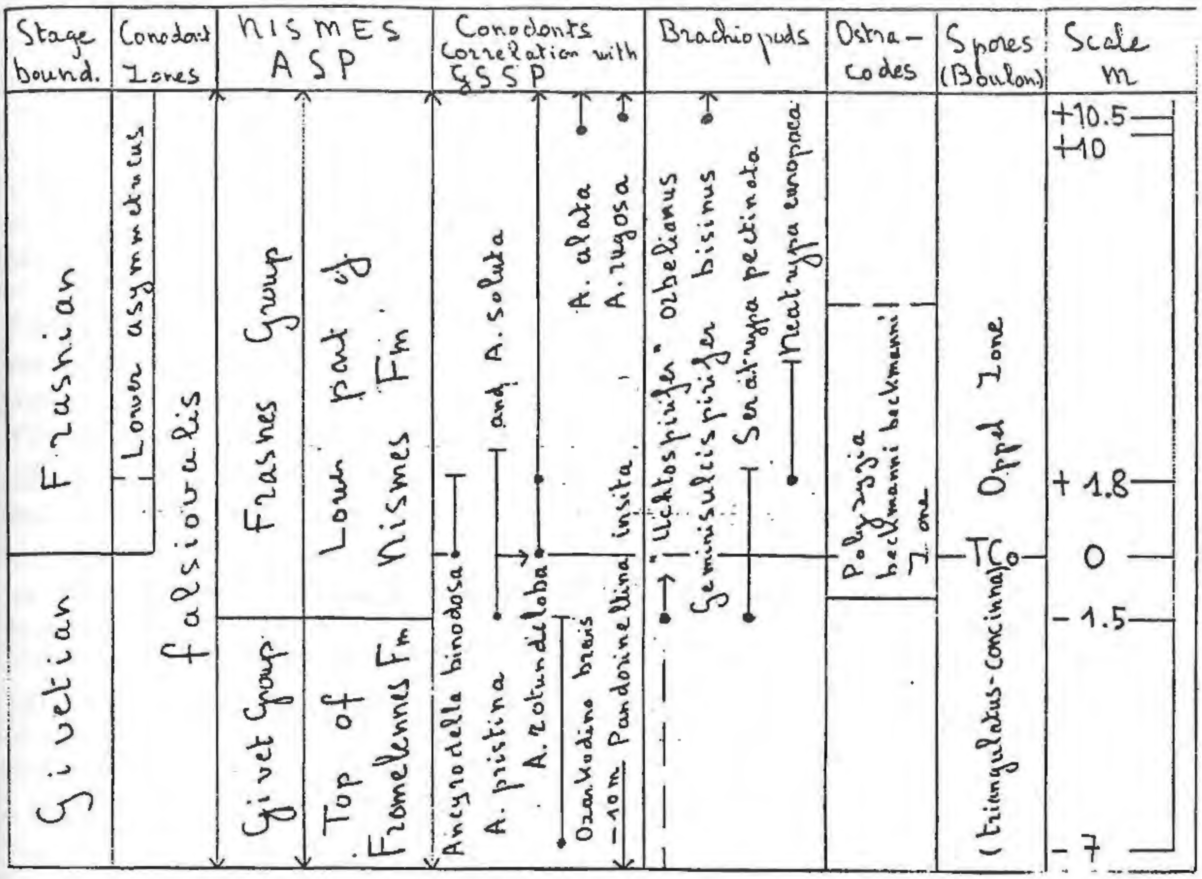
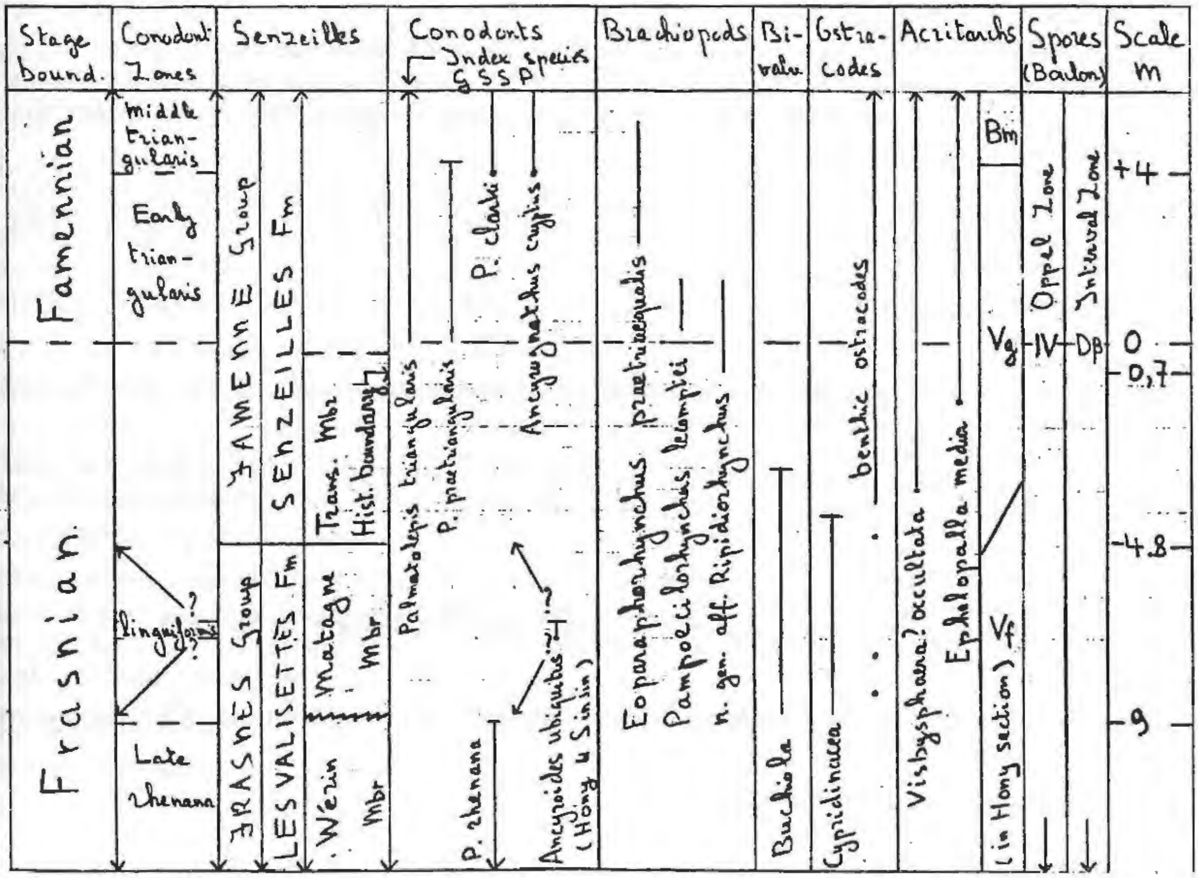


Stage bound.
Conodont Zones
NISMES ASP
Conodonts Correlation with GSSP
Brachiopods
Ostracodes
Spores (Boulon)
Scale m
Frasnian
Givetian
Lower asymmetricus
falsiovalis
Frasnes Group
Givet Group
Lower part of Nismes Fm
Top of Fromelennes Fm
Ancyrodella binodosa
A. pristina and A. soluta
A. rotundiloba
A. alata
A. rugosa
Ozarkodina brevis
Pandorinellina insita
−10 m
"Uchtospirifer" orbelianus
Geminisulcispirifer bisinus
Seratrypa pectinata
Neatrypa europaea
Polyzygia beckmanni beckmanni Zone
Oppel Zone
(triangulatus-concinna)
TCo
+10.5
+10
+1.8
0
−1.5
−7

Fig. 6



Stage Bound.
Conodont Zones
Senzeilles
Conodonts
Index species GSSP
Brachiopods
Bivalv.
Ostracodes
Acritarchs
Spores (Boulon)
Scale m
Famennian
Frasnian
middle triangularis
Early triangularis
linguiformis
Late rhenana
FAMENNE Group
SENZEILLES Fm
Trans. Mbr
Hist. Boundary
FRASNES Group
LES VALISETTES Fm
Matagne Mbr
Wérin Mbr
Palmatolepis triangularis
P. praetriangularis
P. clarki
Ancyrognathus cryptus
P. rhenana
Ancyroides ubiquitus (Hony & Sinsin)
Eoparaphorhynchus praetriquetralis
Pampoecilorhynchus lecomptei
n. gen. aff. Ripidiorhynchus
Buchiola
Cypridinacea
benthic ostracodes
Visbysphaera? occultata
Ephelopalla media
(in Hony section)
Bm
Vg
Vf
IV
DP
Oppel Zone
Interval Zone
+4
0
−0,7
−4.8
−9

Fig. 7

SUBCOMMISSION ON DEVONIAN STRATIGRAPHY

MINUTES BUSINESS MEETING, GÖTTINGEN, GERMANY (AUGUST, 5TH, 1993)

Meeting held at the Institut und Museum für Geologie und Paläontologie, Göttingen, Germany, on the occasion of the Gross Symposium.

PRESENT. Titular Members: P. Bultynck, R. Feist, M. House, W. Kirchgasser, J. Richardson, M. Streel, W. Ziegler. Corresponding Members: A. Blieck, D. Brice, P. Carls, W.A. Oliver Jr, G. Racki, P. Sartenaer, V. Talimaa, S. Turner, Wang Nian-Zhong, K. Weddige, D. Weyer, G.C. Young. Guests: M. Gintner, W. Riegel, E. Schindler, J. Schuelke.

1. INTRODUCTION

The Chairman, M. House, opened the meeting at 2 pm by welcoming members, especially CMs G. Racki and Wang Nian-Zhong present for the first time, and guests. He reported with deep regret the death of Dr. H. Jaeger and the meeting stood in silence in memory of this colleague.

Apologies for absence were recorded from TMs Chlupac, Garcia-Alcalde, Hou Hong-Fei, Klapper, Morzadec, Pedder, Sandberg, Talent, Turnau, Yolkin, Yu Chang Min and from CMs Crick, Dineley, Hladil, Mawson, McGregor, Racheboeuf, Truyols-Massoni, Xian Si-Yuan.

2. MINUTES OF THE GUILIN MEETING 1992

The Chairman commented that SDS had received 1300 $ not 1400 $ from the IUGS for 1992 (under 7 d. Finance). The Minutes of the Guilin Meeting were approved.

3. CHAIRMAN'S BUSINESS

The Chairman thanks Prof. O.H. Walliser for the organisation of the meeting and K. Bartzsch, H. Blumenstengel and D. Weyer for leading the excellent field trip to the Palaeozoic of Thuringia.

He announced the publication of the first issue of "Silurian Times" (1993). Copies can be obtained from:

Dr. Godfrey S. Nowlan
Geological Survey of Canada
Institute of Sedimentary and Petroleum Geology
3303-33rd Street N.W.
Calgary, Alberta, Canada, T2L, 2A7

He reported that he had received a letter from J. Remane and K.H. Gohrbandt (Chairman and Secretary General ICS) recommending that the subcommissions of the ICS should become actively involved in sequence stratigraphy. In the discussion that followed it was agreed that sequence stratigraphy is an interesting facet of stratigraphy and should receive especial attention. It was agreed that the chairman should answer the letter.

The Chairman reported that a letter had been received from TM Yolkin to say that a book is in press on the section in Zinzilban Gorge in the Kitab National Park (Uzbekhistan) where the basal Emsian GSSP is located. It contains descriptions of different faunal groups from the Pragian-Lower Emsian.

4. REVIEW OF WORK SINCE GUILIN MEETING

a. Base of the Givetian

The proposal for the basal Givetian GSSP at Mech Irdane, near Erfoud (Morocco), has been approved by ICS, who will recommend it for ratification to the IUGS.

The Chairman mentioned a letter from Prof. G.S. Odin (Université P. et M. Curie, Paris) stating that the proposal is not valid because geochronometrical data are not available. It was agreed that the SDS should ask him for collaboration in the field of geochronology.

b. Base of the Famennian

The basal GSSP at Coumiac, Montagne Noire (France) has been approved by the ICS and ratified by the IUGS.

c. Base of the Emsian

The final version of the proposal for the basal GSSP in Zinzilban Gorge (Uzbekistan) has been submitted to ICS but has not yet been approved by them.

See also item 3, letter TM Yolkin, book on Zinzilban Gorge.

5. INTERNATIONAL DEVONIAN CORRELATION REVIEW

Following the suggestion of CM Crick (Guilin meeting 1992), the Subcommission discussed form and matter of a publication on regional Devonian correlation to show how these are affected by the SDS decisions on the boundaries of Devonian series and stages.

CMs Oliver and Young and most members thought that in the book emphasis should be put on the position of the boundaries in different areas of the world and not on detailed regional correlation charts. CM Blieck however commented that correlation of the stage boundaries is relatively well established but that it is difficult to correlate in between these boundaries. CM Carls argued that taxonomy of the boundary defining taxa is very important. He mentioned the case of the base of the Emsian for which the critical figured conodont specimen, defining the position of the boundary in the Zinzilban section, is not Polygnathus dehiscens, as was decided by the SDS, but may belong to P. excavatus.

TM Ziegler replied that in selecting a boundary criterion we should refer to a figured specimen; the taxonomy of this specimen may change in the future. CM Oliver added that the emphasis lays on the position of the boundary in the GSSP, conodont taxonomy is a matter for specialists.

CM Sartenaer was in favor of a book as published on the Silurian/Devonian boundary with emphasis on the application of the boundary in different regions. TM Ziegler generously agreed to publish the contributions in a special Courier volume.

In conclusion it was agreed that the papers in the volume will focus on the Devonian series and stage boundaries the SDS agreed on and on the position of these boundaries in the major Devonian areas of the world. The Chairman added that there should be an introduction on different fossil groups, as was the case in the book on the Silurian/Devonian boundary. The SDS Officers and TM Ziegler will take a decision on the form of the contributions.

The hand-outs of the talks on Devonian regional correlation resulting from new GSSP definitions, presented by SDS members during the Gross Symposium will be mailed by the Secretary to CM Crick for publication in the next Newsletter. The final versions should be sent to the Secretary before October.

6. DEVONIAN MARINE - NON-MARINE CORRELATION

CM Blieck has submitted a report for 1993 (Document A appended to the Minutes).

CM Turner proposed a joint meeting with the IGCP 328 Devonian Group and the Geological Society of London in 1994. The Chairman thought that such a meeting should be organized later because of the next SDS meeting in Moscow and the joint field trip to Timan in July 1994.

The final meeting for the IGCP 328 project will be held in Paris (4-9 September 1995), on the occasion of the International Congress "Premiers Vertébrés-Vertébrés Inférieurs". The working group would much appreciate support from the SDS for a publication on Devonian Microvertebrates.

7. DOCUMENTATION OF DEVONIAN BIOEVENTS

In discussion it was stated by CM Carls and the Chairman that this is not a task of first priority for the SDS. The Chairman stated that, the primary task of boundary definition having now been completed by SDS, it was appropriate to move on to other Devonian problems. Following the suggestion of TM Ziegler it was agreed that the matter should be reconsidered after the publication of a book on "Global Bioevents" (IGCP 216) edited by CM Walliser.

8. DEVONIAN GLOBAL SEA LEVEL CHANGES

The Chairman said that he had received a letter from TM Menner and Dr. Yatskov that they will organize a symposium on "Devonian Sea Level Changes" during the SDS meeting in Moscow (1994). The Russian and CIS participants will bring contributions on NE Russia, Siberia, Middle Asia, the Urals and the East-European Platform. It was agreed that there should be a call for talks to SDS members. Titles and abstracts should be remitted before the meeting.

9. DEVONIAN SUBSTAGES

CM Carls drew attention to the fact that especially "older" geologists want information on the meaning of chronostratigraphical terms such as lower Lochkovian, upper Lochkovian etc. The Chairman thought that we should wait to discuss this matter until all stage boundaries have been approved by the ICS and ratified by the IUGS. However, meanwhile any document on this topic will be welcomed by the SDS.

10. FUTURE TASKS

See items 5, 6 and 8.

11. MEMBERSHIP

a. Withdrawals from Membership

The Chairman received a letter from TM Pedder stating that he wishes to resign from SDS membership. He will be asked to continue as Corresponding Member. CM Kaljo stated in a letter that he did not wish to continue as member of the SDS.

b. Election of new CMs

Six nominations for election as Corresponding Member had been received. There were:

1. Dr. Mohammed Dastanpour, University of Kerman (Iran), Devonian brachiopods, nominated by CM Dineley and the Chairman;
2. Dr. Michal Ginter, Institute of Geology, Warsaw University, Warsawa (Poland), Devonian microvertebrates, nominated by CM Turner and the Chairman;
3. Dr. Hervé Lelièvre, Muséum National d'Histoire Naturelle, Paris (France), Devonian fish taxonomy and biostratigraphy, nominated by CMs Oliver and Turner;
4. Dr. Ervin Luksevics, Latvian Museum of Natural History, Riga (Latvia), Devonian microvertebrates, nominated by CMs Blieck and Turner;
5. Dr. Juozas Valiukevicius, Institute of Geology, Vilnius (Lithuania), Devonian microvertebrates, nominated by CMs Blieck and Turner;
6. Dr. S.V. Yatskov, Paleontological Institute of the Russian Academy of Sciences, Moscow (Russia), Devonian goniatites, nominated by the Chairman and TM Kirchgasser.

After a vote the six nominees were elected Corresponding Members of the SDS.

c. Election of new TMs

Dr. K. Weddige, Forschungsinstitut Senckenberg, Frankfurt/Main (Germany), has been proposed for Titular Membership by CM Walliser and TM Ziegler. Dr. K. Weddige has contributed much to the activities of the SDS and he is an outstanding expert of Lower and Middle Devonian conodonts. His nomination was unanimously accepted by TMs present.

12. REPORTS

a. Marine/Non-Marine correlation

See item 6. of the Minutes.

b. SDS Newsletter.

Edition and distribution of Newsletter n°9 in May 1993 by CM Crick has been made possible through the generosity of the Department of Geology, University of Texas at Arlington. The Newsletter has been received with enthusiasm. TM Streel thought that it would be useful to circulate the Newsletter also among non-SDS members.

c. South American Activities

The Vice-Chairman received a letter from CM Racheboeuf that he is starting a new project on the Malvinocaffric Silurian-Devonian, focusing on the Silurian-Devonian boundary and the Devonian stage boundaries in Bolivia and Argentina. The project is supported by the "Institut français d'études andines" making annually 3 to 4 grants available for field-work in Bolivia and Argentina.

Persons interested in should contact CM Racheboeuf.

A report from John Marshall on Devonian spores from the Falkland Islands was mentioned.

d. Financial report

Income	
Subvention received from IUGS for 1992	1430 US $
Amounts are alloted as follows:	
Newsletters	250 US $
Attendance Support	800 US $
General Expenses	380 US $

13. FUTURE MEETINGS

a. SDS meeting in Moscow and Timan field-trip, 11-26 July 1994.

The chairman reported on the programme proposed by TM Menner and on the costs for the stay in Moscow and for the field-trip

July 11:	arrival in Moscow.
July 12:	orientation day and study of collections.
July 13-14:	Symposium "Devonian sea level changes" and SDS Business Meeting.
July 15:	flight from Moscow to Ukhta.
July 16-22:	introduction on regional geology of Timan and field-trip, Frasnian sections close to Ukhta.
July 23:	flight from Ukhta to Moscow.
July 24-25:	departure from Moscow.

There is also possibility to participate in a field-trip to Vezha-Vohz Creek (July 23-25) with return to Moscow on July 26.

Costs in Moscow are expected to be 100 US $ per day + 100 $ for registration. Approximate cost of the flight Moscow/Ukhta/ Moscow is 240 US $ and costs for the field-trip, 1000 US $. The additional flight cost to Vezha-Vozh is 120 US $.

In the discussion that followed it was stated by different members that costs are high, however the programme was very welcomed and unanimously accepted. Further details will be circulated later.

b. Joint meeting with Palaeozoic Microvertebrate Correlation Working Group, IGCP 328.

It is proposed to hold the meeting in 1995 at the Paris Congress (4-9 September) on lower vertebrates or in London. John Marshall had offered to organize a field-trip to the Old Red of Scotland.

c. Meeting and field-trip Siberia, 1996.

In a letter to the Chairman, TM Yolkin proposed to organize (after 1995) a SDS meeting in Siberia to show non-marine sections in the Minusa depression, transitional non-marine/marine and marine sections in the Kuznetsk Basin, Salair and? Altai.

It was noted that the next International Geological Congress would be held in Beijing in 1995.

14. ANY OTHER BUSINESS

The letters of J. Remane and K.H. Gohrbandt on sequence stratigraphy and from Prof. Odin on missing geochronometrical data for the Givetian GSSP were discussed (see items 3 and 4a).

There being no other business the Chairman thanked members and guests for their attendance and closed the meeting.

P. Bultynck, Secretary, November 1993.

COMMENT AND REPLY

DEVONIAN CONODONT ZONES: A COMMENT — J. G. JOHNSON

Prof. M. R. House, Chairman, Subcommission on Devonian Stratigraphy, in the October 1993 announcement to members, provided general information about the SDS Program, 1994.

Regarding items 2 (Moscow Symposium contributions requested for regional reviews of Devonian sea-level changes), and 3 (a proposed Courier volume on international review of Devonian correlations) the intention was stated to use a common stratigraphic scale ("the standard zonal scale of Ziegler and others"). A version of that scale was printed on the back of the announcement page (*and reprinted here — ed.*).

Several problems arise from this proposal because the scale provided includes a list of conodont zones:

1. The scale, as drawn, implies an official stamp of approval by the Subcommission for a particular scheme of biostratigraphic zones when the purpose of the Subcommission activities is to set chronostratigraphic boundaries. The stamp of approval is emphasized by heading the list "Standard Conodont Scale."

   I do realize the pragmatic value, and perhaps need, to provide a common basis for contributions, but what is proposed is going too far.

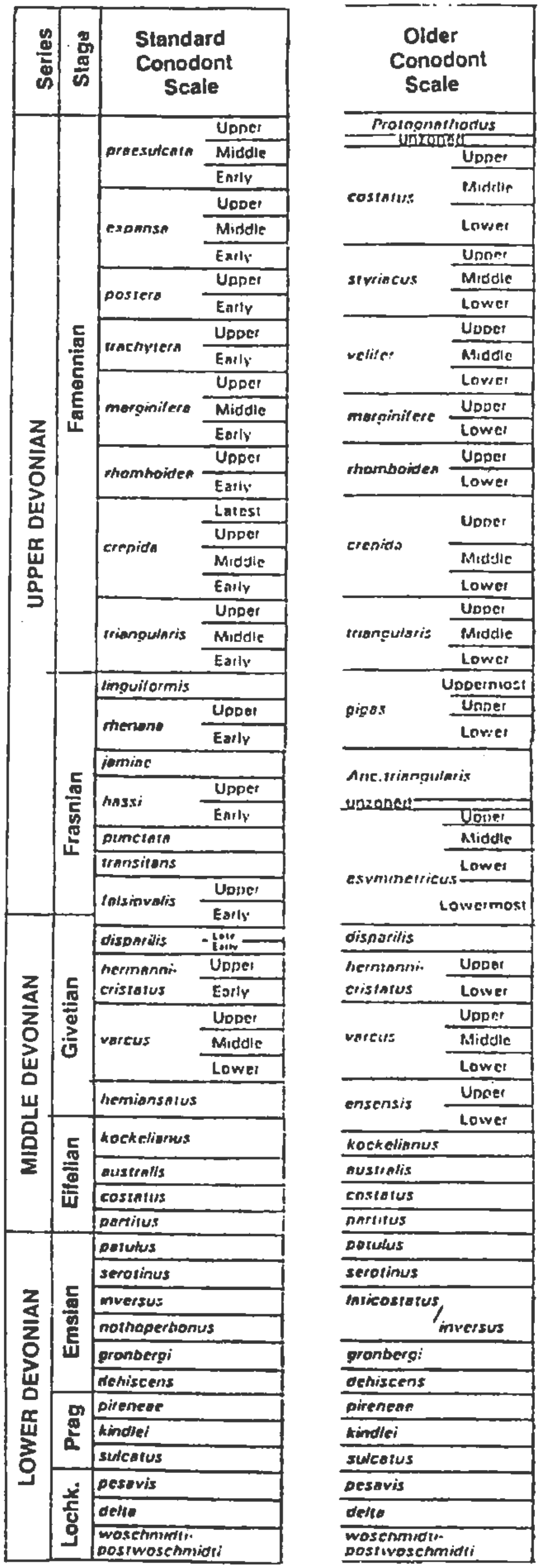
   First, the term "Standard" implies a level of acceptance that does not exist. This mode of expression, employing the term "Standard," has become commonplace in the absence of critical review, the very thing that could validate its use. A more appropriate heading for this zonal scale might be "Offshore Conodont Zones" or just "Conodont Zones."

2. Supposing that an appropriate heading of the zonal scale could be agreed upon, there remain problems with the zonal scale itself. The most significant of these is the representation of some Upper Devonian zones as time units (implied by the use of words like "Early" and "Latest"). Conodont zones are not time units, a concept addressed in a recent paper by me (Newsletters on Stratigraphy, v. 26, p. 41-48, 1992).

   Further, the mix of time and rock adjectives (as "Early" and "Upper") for zones is, in itself, objectionable.

Lesser criticisms include failure to consider the renaming of the *hermanni-cristatus* Zone as the *hermanni* Zone, or the naming of the *norrisi* Zone, or of difficulties with the *falsiovalis* Zone (Klapper and Johnson, 1990, in Journal of Paleontology, v. 64, p. 934-936).

And lastly, the existence of an alternate Frasnian zonation, documented in three papers by Klapper (Klapper, 1989, Canadian Soc. Petrol. Geol. Mem. 14, v. 3, p. 449-468; Klapper, 1990, Jour. Paleontology, v. 64, p. 998-1025; Klapper and Foster, 1993, Paleontol. Soc. Mem. 32), calls into question the utility of the listed Frasnian zones.



REPLY BY M.R. HOUSE TO NOTE FROM J.G. JOHNSON

It will be understood by members of the SDS, I am sure, that the Officers can only work within the framework of instructions and information largely provided by its members. It is in that light that I reply to the comments made.

(1) Members were asked to provide for the Göttingen meeting in August 1994 correlation charts showing the correlative positioning of agreed GSSP's in the areas for which they had a special responsibility. Our German colleagues, under the chairmanship of Dr Weddige, did this and provided a useful table of zones against which their evidence was assembled. Nothing at ail was submitted for western North America.

(2) The German table was the most detailed presented. In seeking to publish in the *Courier* an international statement of the positioning of newly defined stage boundaries, the SDS meeting in August agreed that a detailed scale was essential (not merely of "pragmatic value"), and that something like the submitted German scale was appropriate. Hence its circulation to all member, especially those unable to attend the Göttingen meeting. This was the "draft" scale circulated, and a note was given that it would be superseded.

(3) To my mind every nation, if they wish, has the right to call or to speak of such a scale, as assembled and produced by the national formal body, as a "standard" in the same way as is commonplace for many aspects of national life and culture. I would not wish to deny the right for them to be even more pompous if they wish. Fortunately, in my view, the International Commission no longer discusses the international standardization of chronostratigraphic zones, except insofar as it is necessary for GSSP's. I take it the SDS will use what most of its members regard as the most useful.

(4) There were, in fact, several typographical errors in the German chart submitted. I hope they will not be criticized for such matters when it is recalled that they kindly present things in a language not their own. Perhaps the chart submitted in this *Newsletter* will have corrected these. The main error was that in the subdivision of zones in the standard column the upper name was incorrect. I corrected this with "Upper" because it could easily be done in the same style with scissors and paste: so I personally am to blame for the inconsistency.

(5) With Jes Johnson I also take the view that "Upper", "Middle" and "Lower" are the appropriate terms, hallowed for what we would now call chronostratigraphic subdivision in this way for a century and a half, if only formally accepted a century ago. Indecd, I would go farther and say that formal time divisions in the form of adjectival proper noun couplets, such as "Early Devonian" and "Late Devonian", are not needed, since one can speak of "Upper Devonian time" so easily if needed. Furthermore the adjectival common noun couplets including "early" and "late", for example, are especially useful as rather vaguer terms when precision is not implied and this useful attribute is prejudiced by needless phonetic synonyms.

(6) I hope the Bureau will produce a correlation chart showing various zonations in parallel columns, not merely for conodonts, but for other groups too. This is particularly needed for colleagues working in non-marine areas, and neritic facies, where conodonts are rarely helpful.

(7) I hope also that the new Frasnian zonation of Klapper will be embraced in this way. Having worked with the greatest pleasure with Gil Klapper on Frasnian problems in New York, the Montagne Noire, North Africa and Western Australia, I have in recent joint publications used the Klapper scale myself. But this was because the conodont zonation was done authoritatively by him. Such an agreeable luxury is so far available for few areas of the world. In the UK, for example, the earlier Ziegler scale is the only one available to a compiler using published material. It would be particularly helpful to have the Adorf section correlated with the Klapper scale and perhaps also the more recent graphic correlation scale for the Frasnian if that were to be standardized to one hundred units.

Michael House, Chairman November 1993

NEWS, REPORTS, ETC.

DR. R. THOMAS BECKER, BERLIN

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In the last two years a number of papers have been published which may have missed the attention of SDS members since some of them were published in our institute journal (Berlinger geowissenschaftliche Beiträge, series E) or in books on broader subjects. My rather voluminous Ph.D. thesis finally appeared as a volume (no. 155) of the Courier Forschungs-Institut Senckenberg. A list of Devonian papers and abstracts is given below. Research continued on ammonoid biostratigraphy, paleobiogeography, Devonian events and sealevel changes. Work in Morocco, the Montagne Noire, northern Rhenish Slate Mountains and the Canning Basin will be continued - if a grant application with the Deutsche Forschungsgemeinschaft is succesful or if any other research position turns up. Future emphasize is planned to lie on global environmental change and evolutionary ecology of Upper Devonian ammonoids. Two joint papers with Michael House will include a new, very detailed international goniatite zonation of the Emsian to Givetian and an updated model of the causation of the Frasnian/Famennian mass extinction. The probable significance of short-term climatic overheating episodes for the generation of other Devonian hypoxic events was already outlined in a paper on the *Annulata* Event (BECKER, 1992a). In the near future new results on the F-F-boundary in the Canning Basin will be presented under the lead of Phil Playford. Other current research deals with new Upper Devonian bojobactritids, new late Frasnian goniatites from the Eifel Mountains, a still undescribed, placoderm bearing Kellwasser locality of the Attendorn-Else Syncline and the *Annulata* Event in Morocco.

1992

BECKER, R. T.: Zur Kenntnis der Hemberg-Schichten und *Annulata*-Schiefer im Nordsauerland (Oberdevon, GK 4611 Hohenlimburg). - *Berl. geowiss. Abh.*, E, **3**: 3-41.

BECKER, R. T.: Regional developments of the global hypoxic *Annulata* Event (Middle Famennian). - In: *Phanerozoic Global Bio-Events and Event-Stratigraphy* (WALLISER, O.H., Ed.), Abstracts: 13-14., Göttingen.

BECKER, R.T & HOUSE, M.R.: Refined Devonian ammonoid biostratigraphy. - *Internat. Symp. Dev. System and its Economic Oil and Min. Resour., Guilin, Guangxi 1992, Abstract vol.*: 22-23.

1993

BECKER, R. T., HOUSE, M.R. & KIRCHGASSER, W.T.: Devonian goniatite biostratigraphy and timing of facies movements in the Frasnian of the Canning Basin, Western Australia. - *Geol. Soc. London, Spec. Publ.*, **70**: 291-318.

BECKER, R.T.: Stratigraphische Gliederung und Ammonoideen-Faunen im Nehdenium (Oberdevon II) von Europa und Nord-Afrika. - *Cour. Forsch.-Inst. Senck.*, **155**, 405 p.

BECKER, R.T.: Anoxia, eustatic changes and Upper Devonian to lowermost Carboniferous global ammonoid diversity. In: The Ammonoidea. Evolution and Environmental Change (HOUSE, M. R., Ed.). *Syst. Assoc. Spec. Vol.*, **47**: 105-164.

BECKER, R.T.: Analysis of ammonoid palaeobiogeography in relation to the global Hangenberg (terminal Devonian) and Lower Alum Shale (Middle Tournaisian) Events. - *Ann. Soc. geol. Belg.*, **115** (2): 459-473.

KÜRSCHNER, W., BECKER, R.T., BUHL, D. & VEIZER, J.: Strontium isotopes of conodonts from the Devonian-Carboniferous transition of the Northern Rhenish Slate Mountains. - *Ann. Soc. geol. Belg.*, **115** (2): 595-621.

BLESS, J. M., BECKER, R. T., HIGGS, K., PAPROTH, E. & STREEL, M.: Eustatic cycles around the Devonian-Carboniferous boundary and the sedimentary and fossil record in Sauerland (Federal Republic of Germany). - *Ann. Soc. geol. Belge.*, **115** (2): 689-702.

BECKER, R. T.& PAPROTH, E..: Auxiliary stratotype sections for the Global Stratotype Section and Point (GSSP) for the Devonian-Carboniferous Boundary: Hasselbachtal. - *Ann. Soc. geol. Belg.*, **115** (2): 703-706,.

BECKER, R. T., KORN, D., PAPROTH, E. & STREEL, M.: Beds near the Devonian-Carboniferous Boundary in the Rhenish Massif, Germany. - *IUGS, Subcom. Carb. Strat., Exc. Guidebook, Liege 1993*, 85 p.

BECKER, R. T. & HOUSE; M. R.: New early Upper Devonian (Frasnian) goniatite genera and the evolution of the "Gephuroceratacea". - *Berl. geowiss. Abh.*, E, **9**: 111-133.

BECKER, R. T.: Kellwasser Events (Upper Frasnian, Upper Devonian) in the Middle Atlas (Morocco). - Implications for plate tectonics and anoxic event generation. - In: *Global Boundary Events. An interdisciplinary Conference, Kielce, September 1993, Abstr.*: 9.

in press

BECKER, R.T. & HOUSE, M.R.: International Emsian to Mid-Givetian (Devonian) goniatite zonation with new records from Morocco. - *Cour. Forsch.-Inst. Senckenberg.*

BECKER, R. T. & HOUSE, M. R.: Kellwasser Events and goniatite successions in the Devonian of the Montagne Noire with comments on possible causations. - *Cour. Forsch.-Inst. Senck.*

PROF. A. EL HASSANI, RABAT

Institut Scientifique, Département de Géologie, B.P. 703 Rabat-Agdal , Morocco

Under the agreement (DFG/CNR) a cooperation program with Prof. Walliser, after 4 years of works, we published:

1. EL HASSANI, A. ; TAHIRI, A. & WALLISER, O.H. (1991).- Etude comparée du Dévonien de la Meseta marocaine occidentale et des massifs hercyniens allemands. *Bull. Inst. Sci. Rabat,* N°15.
2. WALLISER, O.H. ; EL HASSANI, A. & TAHIRI, A. - Le Dévonien de la Meseta marocaine occidentale, Comparaisons avec le Dévonien allemand et événements globaux. *to be published in The Courier Forsch. Inst. Senckenberg, Frankfurt.*

   Comparative investigation on Paleozoic development, especially Devonian, in the Moroccan Meseta, the Anti-Atlas and central Europe (Germany and Bohemia). Reasons of this research are: 1) common points analysis from different Paleogeographic and paleotectonic situations, 2) time specific facies, and 3) presence and importance of bio-events in the Moroccan Paleozoic (using the biostratigraphy).
3. EL KAMEL, F. & EL HASSANI; A. (1992).- Présence d'une tectonique synsédimentaire dans le Dévonien inférieur des Rehamna septentrionaux (Meseta marocaine occidentale). *Bull. Inst. Sci., Rabat, N° 16.*

   Mapping of Ain el Melah area (SE of Northern Rehamna) and the lithostratigraphic sections studied show a synsedimentry instability in the Early Devonian. Late Silurian layers were dislocated and glided in the Early Devonian basin after an extensional phase. The latter created a sole on which glided olistoliths or a sedimentary klippes

During the last 14th Regional Meeting of Sedimentology IAS, Marrakesh April 27-29, 1993.

My research group have presented results of our Devonian studies in the Western Meseta. It's stratigraphical, sedimentological and structural studies (Prof. El Hassani Coordinator).

1. BEN BOUZIANE A. , JAUTEE, E. , EL HASSANI, A. , FEDAN, B. & TAHIRI, A. .- Evolution diagenètique deS CARBONATES DEVONIENS DES forages du bassin de Doukkala (Maroc OCCIDENTAL), *14th Meeting IAS, Abstracts* p:54-55
2. BENBOUZIANE, A., EL HASSANI, A., FEDAN, B. & TAHIRI, A..- Effets de la dolomitisation, de l'enfouissement et de la tectonique sur l'évolution de la porosité dans les formations dévoniennes des Rehamna Nord, Meseta Marocaine Occidentale. *14th Meeting IAS, Abstracts* p: 53
3. EL KAMEL, F. & EL HASSANI, A..- Tectonique synsédimentaire dans le Dévonien inférieur des Réhamna septentrionaux, (Meseta Marocaine Occidentale). *14th Meeting IAS, Abstracts* p: 139
4. EL MDARI, K. , EL KAMEL, F. & EL HASSANI, A.. - Les récifs dévonien moyen dans les Rehamna septentrionaux (Meseta marocaine occidentale). *14th Meeting IAS, Abstracts* p: 141

SILURIAN-DEVONIAN FORMATIONS OF OULAD ABBOU AND MECHRA BEN ABBOU, REHAMNA (MOROCCAN MESETA).

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The western domain of the Moroccan Meseta is limited (fig. 1): to the North by the Rif domain, to the South by the High Atlas, to the East by the Middle Atlas and to the West by the Atlantic ocean. Paleozoic rocks crop out in Central massif, Rehamna and Jebilet. They establish the Caledonian and Hercynian basement covered by Mesozoic and Cenozoic sedimentary rocks which are still horizontal and unfaulted. Mechra Ben Abbou and Oulad Abbou areas where the present field trip has been focused, are located in the Rehamna massif. Several aspects, sedimentological, tectonical and metamorphical, are shown in the Rehamna outcrops. The Hercynian metamorphism is intense to the South of Rehamna (mesozone).

By contrast, to the North, the outcropping Paleozoic sediments of Mechra Ben Abbou and Oulad Abbou are not significantly metamorphosed. For this reason we have chosen those areas to study Paleozoic formations, particularly Devonian.

STRATIGRAPHICAL AND SEDIMENTOLOGICAL SKETCH

SILURIAN

Silurian outcrops are poor. It is represented by graptolitic black shales containing carbonate lenses and green-gray pelites with bioclastic limestones layers. Silurian deposits were deposited in an anoxic environment (shallow marine), demonstrating an eustatic raise related to Late Ordovician inlandsis melting.

Paleogeographic change is marked by the presence of sandstones and quartzitic block, which were deposited at Silurian-Devonian boundary.

The quartzitic olistoliths in the Silurian-Devonian sandstones matrix should represent synsedimentary tectonic events and probably should be related to graben opening.

The Silurian of Oulad Abbou (140m) is represented by a marine volcanoclastic formation including bioclastic limestones, silty limestones, silt stones and silty pelites.

This formation, dated from the Early Telechian to Gorstian-Late Ludfordian, includes several intrusive occurrences and lydites.

DEVONIAN

Lower Devonian

The transition between Silurian and Devonian deposits in the Eastern Rehamna is progressive. The Lower Devonian pile begins by coarse clastic deposits: conglomerates and red sandstones containing vegetal traces, which testify the vicinity of an uplifted area considered as a source of this detrital sediments. This is overlain by shales including bioclastic limestones and red sandstones. From the Lochkovian to Praguian, sediments are accumulated under conditions of shallow marine in the Western part near a terrestrial area to open marine environments in the Eastern part, toward Mechra Ben Abbou "basin".

The Western ridge of this "basin" shows several traces of a synsedimentary tectonic activity: presence of quartzitic, sandstones and limestones blocks in a shale matrix, and synsedimentary faults. This ridge is also characterized by terrigenous sediments, aerial and torrential.

Middle Devonian

During Late Emsian, depositional environment changed. Detrital deposits of Lower Paleozoic are overlain essentially by carbonates sediments. During the Late Emsian-Givetian, marine basement uplift or/and diminution of eustatism allow development of a carbonate platform. This reefal ecosystem started at Oulad Abbou during Emsian and extended to the Doukkala area. It is organized on reef ridges including fringing reefs, reefs barrier, surrounding terrigenous marginal basin. This paleogeographical pattern is completed by the presence of an emergent land (shoal): "môle d'Imfout" which acted as a detrital source for the marginal basin. Mechra Ben Abbou platform carbonate was probably bordered to the West by a reefal complex presently eroded.

At the end of the Givetian and beginning of the Frasnian, reefal migration to the East occurred, particularly in the Mechra Ben Abbou "basin". Carbonates of this area are represented by Eifelian-Givetian reefal limestones, equivalent of the Foum El Mejez limestones attributed to Givetian-Early Frasnien.

This reef migration from the West to the East is also recorded in an other Mesetian area (oued Cherrat). It was the result of a marine basement uplift probably associated to the diminution of eustatism. It is attested by the increasing surface of the "môle d'Imfout" (emergent). In the same time sea withdrawal to the East. These events are related to the general emersion of Western Rehamna during the Late Frasnian and probably the Early Famennian.

Upper Devonian

The Rehamna massif, emergent from Late Frasnian to Early Famennian, was covered by the Famennian sea. The Foum El Mejez graben, developed in the Western part of the Rehamna, received deltaic deposits.

They are followed by fine shaly facies in the northern extension at Sidi Bettache basin.

Coarse clastic facies located at the top of the Famennian formation are the result of the progradation to the North of deltaic system. Neritic conditions developed during the Strunian. After this lateral accretion, shoals bordering the Famennian basin were partially submerged. The Foum El Mejez basin, where the sedimentation rate were more important than subsidence, was filled. At the same period, the Sidi Bettache basin was still subsiding and received chaotic material and volcano-clastics at its border, whereas fine detrital sediments were deposited in the center.

The Late Devonian, in the Oulad Abbou area, is represented by shaly and pelitic facies with fauna characteristics of an open marine environment.

In the Western Rehamna, the Foum El Mejez formation is 300m thick. It is represented by sandstones and silts including quartzitic thick layers containing *Buchiola* and *Cyrtospirifer verneuilli*. This formation is overlain by Late Famennian/Tournaisian sandstone carbonates which are disconformable on Middle Devonian karstic limestones in the Nahilat area. Progressive unconformity by Strunian sandstones and Late Famennian pelitic sandstones of Foum El Mejez is related to block tilting.

Toward the North-West, chaotic and channeled Bled Mris formation containing quartzitic blocks is attributed to the Late Devonian. Characteristic sequences from these deposits are developed in the western margin of Sidi Bettache basin. Instead of Foum El Mejez formation should probably be equivalent of Cherrat formation. However, sediments are folded and metamorphised in central Rehamna. making correlations difficult between the two areas.

THE NORTHERN BORDER OF HERCYNIAN BELT IN MOROCCO: RABAT-TIFLET AREA

Ahmed EL HASSANI

The Rabat-Tiflet area is constituted by two main units: the Sehoul metamorphic zone and the Bou Regreg sedimentary zone. These two areas are separated by a roughly east-west trending thrust.

The Sehoul zone is characterized by a clastic sequence, several hundred meters thick, that is interpreted as a deltaic sequence. It is paleontologicaly dated from Cambrian time. The rocks affected by a low grade metamorphism, are deformed by folds. This are east-northeast trending (N50-70°E), often isoclinal, with a vergence toward south southeast. They are associated with a flow cleavage. This deformation was followed by the emplacement of a calc-alkaline granite. Its contact metamorphism developed andalousite, cordierite, biotite and chlorite. The syn-kinematic development of the andalousite crystals suggests that the granite emplacement occurred during the last stages of the sehoulian phase. This phase is dated, on the other hand, from Late Ordovician to Early Silurian by fact that the Upper Silurian strata rest unconformably upon the sehoulian structures.

Dating of the cleavage and metamorphism development of the Sehoul zone by K/Ar isotopic method indicate a Late Ordovician age (-450 Ma) for the folding phase. This distinguishes this zone from the other areas of the Moroccan Hercynian belt. The sehoulian phase, therefore, developed after the Early Paleozoic deformation of Kabylia. It was more or less contemporaneous with the Taconic orogeny of the Appalachians.

The Bou Regreg zone is constituted by a sedimentary sequence. Generally, the sedimentary facies display strong similarities with the sequences of the Moroccan Meseta (i.e. in central Morocco). However, several particularities are noteworthy:

- the Ordovician is represented here only by the Arenig/Llanvirn and it comprises calc-alkaline volcanic rocks.

- the absence of Upper Ordovician and Lower Silurian strata is attributed to the compressive events that occurred in the North ("Caledonian" phase of Sehoul).

- the first evidences of a synsedimentary extensive regime are noted since Early Devonian time. The crustal extension became obvious during Late Devonian time, when the Sidi Bettache basin opened.

The Sehoul and the Bou Regreg zones were progressively brought together by a polyphase thrust. A first episode, "Late Silurian", is represented by southward directed thrusts, that are proven to predate Late Silurian in the Eastern part of the Rabat-Tiflet area. A second episode, "Hercynian", created a mylonitic zone, roughly east-west trending, where deformed and brecciated Middle Devonian limestones and Late Devonian conglomerates are squeezed.

Apart of this Hercynian thrust, the Hercynian deformation was relatively mild, with open folds and diagenetic to very low grade metamorphic intensity.

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Publication list (1992-1993):

*Hladil, J., Cejchan, P. & Berousek, P. (1992): Rebuilding of the shallow water dwellers: otomari-Kacak and Kellwasser events. - Global Bioevents, Abstr., Gottingen 1992, 50-51. Gottingen.

(1992): Are there turbidites in the Silurian /Devonian Boundary Stratotype ? (Klonk near Suchomasty, Barrandian, Czechoslovakia). - Facies, 26, 35-54. Erlangen.

(1992): Svrchnodevonsti konodonti z vrbenske skupiny od Rymarova. [Upper Devonian conodonts from the Vrbno Group at Rymarov]. - Zpr. geol. Vyzk., R. 1990, Ces. geol. Ust., p. 56. Praha.

(1992): Celechovicke vapence v deformacnich strukturach na v. okraji Boskovicke brazdy. [Celechovice Limestone within the deformation structures of the eastern margin of the Boskovice Furrow]. - Zpr. geol. Vyzk. R. 1990, Ces. geol. Ust., p. 55. Praha.

*—, Krejci, Z., Kalvoda, J., Ginter, M., Galle, A. & Berousek, P. (1992): Carbonate ramp environment of Kellwasser time-interval (Lesni lom, Moravia, Czechoslovakia). - Bull. Soc. belg. Geol., 100/1-2 [1991], 57-119. Bruxelles.

(1992): Zonality in the Devonian Carbonate Sediments in Moravia. - Proceedings of the 1st International Conference on the Bohemian Massif, Prague, 1988, 121-126. Praha.

& *Chlupac, I. (1992): New Devonian occurrences in the Jested Mts., North Bohemia. - Cas. Mineral. Geol., 37(3), 185-191. Praha.

*— & Berousek, P. (1992): Taphonomy and primary biotic associations of the Silurian-Devonian boundary stratotype (Klonk, Central Bohemia). - Scripta, Geology (Univ. Brno), 22, 87-96. Brno.

(1993): Posloupnost diagenetickych zmen ve vapencich na hranicnim stratotypu silur/devon, Klonk u Suchomast. [Sequence of diagenetic changes in the limestones of the Silurian/Devonian boundary stratotype, Klonk near Suchomasty]. Zpr. geol. Vyzk. v r. 1991, 51-53. Praha.

*—, Berousek, P. & Lukes, P. (1993): Temne vapencove vrstvy pri stropu akantopygovych vapencu u Koneprus - otomari-Kacak event. [Dark

limestone layers at the roof of the Acanthopyge limestone near Koneprusy - Otomari-Kacak event]. - Zpr. geol. Vyzk. v r. 1991, 53-55. Praha.

(1993): Tabulatomorphs and stromatoporoids below and above the upper boundary of the Acanthopyge Limestone (Eifelian/Givetian transitional interval, Central Bohemia). Vest. Ces. geol. ust., 68(2), 27-42. Praha.

(1993): Strange squamulate coral from the Eifelian Acanthopyge Limestone (Koneprusy, Central Bohemia). - Vest. Ces. geol. ust., 68(2), 43-44. Praha.

*— & Kalvoda,J. (1993): Devonian boundary intervals of Bohemia and Moravia. - In: M.Narkiewicz, ed., Global Boundary Events, Excursion Guidebook, 29-50. Kielce. & *Hladikova,J. (1993): Facies against the global isotope control. - Global Boundary Events, Kielce 1993; Abstracts, p. 21. Kielce.

*— & Kalvoda,J. (1993): Life strategies during the extinction and recovery at Eifelian-Givetian and Frasnian-Famennian boundaries in Bohemia and Moravia. - Global Boundary Events, Kielce 1993; Abstracts, p.22. Kielce.

*) the senior (first) author of the publication

[ ] Translated headline when the paper is written in Czech

Note these publications of colleagues:

Chlupac, I. (1992): Middle Devonian trilobites from Celechovice in Moravia (Czechoslovakia). - Sbor. geol. Ved, Paleontologie, 32, 123-161. Praha.

Galle, A. (1993): Middle Devonian Rugosa from Horni Benesov (Moravia, Czech Republic). - Journal of the Czech Geological Society, 38(1-2), 59-70. Praha.

Kalvoda, J. (1992): The youngest conodont fauna of the Barrandian. - Scripta, Geology, 22, 61-63. Brno.

What was done here since the last newsletter:

1. It seems that both the Kacak event and Upper Kellwasser event are accompanied by strong sea-level falls at their bases. First common reactions of biota are observed and compared in the bio-events. Crisis development depends on systagenesis (sensu O.Walliser), selected life strategies of organisms as well as on a complicated interplay of many other factors including small random imputs. The biological reasons may affect the medium-long-term changes of biota much more than usually considered on the background of still favourized terrestrial or extraterrestrial catastrophes of physical nature (J. Hladil & J. Kalvoda).
2. Data on the Eifelian-Givetian interval were collected from individual terranes within and around Bohemian Massif. Summary and interpretation of the data are prepared for publication (A. Galle, J. Hladil & P. Isaacson).

Which projects are started now or newly proposed for 1993/1994:

1. Block configuration before the coming Variscan Orogeny (Emsian-Eifelian fauna of Bohemia and Moravia). Grant Agency of Czech Republic, 1993-1995, J. Hladil, A. Galle, I. Chlupac, V. Havlicek, J. Kalvoda ...
2. A more intensive search of any clue to bio-crisis scenarios. State, academician and private grant agencies apply more sofisticated and utilizable approaches (see attached pleading of Grant Agency Vltava-Recovery). P. Berousek, J. Hladil, P. Cejchan ...

With the best regards to Devonian stratigraphers

Yours sincerely Jindra Hladil

APPENDIX:

PRIVATE GRANT AGENCY "VLTAVA" (RECOVERY) is established: aim is an activated scientific research of biotic recovery during or after the mass extinction of organisms

<u>Call for the projects and opinions</u>

A few words to outline the objectives

Are you feeling that some of your projects which aim to solve the causes of biotic crises have unsuficient financial sources? We are feeling the same. Our suggestion is to pursue sponsorship by private companies directly, i.e. without the common state-budget filter, so that some promissing topics among recovery studies may be initiated and accomplished faster than they are now.

The Private Czech Grant Agency "RECOVERY" is only born. The first steps have been made but the real face of the Agency will be formed during the next months. Three activities have to proceed simultaneously: Sponsor activation, Agency-supported management activation and activation of scientific contacts as well as relevant creative suggestions. The Agency aims to form a small body within prevailingly but not only Mid-European regions. We hope that the Agency may contribute in a new way to the general effort of the International Geological Correlation Program No.335 "BIOTIC RECOVERIES FROM MASS EXTINCTIONS".

As generally accepted, the interplay of human activities and the rebuilding of contemporaneous biota represents one of the main problems of human civilization. Although this problem seems to be hidden in the noise of other problems such as wars, nutrition of the population, displacement or activation of capital, it must be realized that this problem can have fatal consequences of first order significance.

Contemporaneous ecological activities, as seen from all possible angles, look likc chaotic interventions by firemen or like an insufficiently decelerated process which leads to collapse. Many times it is difficult to say whether individual intervention which looks good is really good or not.

Environmental pollution, biotope changes and extinctions have be come threatening processes. We assume that these changes develop more quickly than we can understand them. There are several puzzling but essential questions: Which parts of the biota are activated when other parts of the biota are extinct? What is "still natural or acceptable" rebuilding and what is the "uninvited" fatal collapse? Can we deal with new situations or are the new situations triggered by so many random factors that they can hardly be controlled?

Serious recent evaluations by many experts speak about a lack of any clues how the biota can be activated under extreme pressure. Our strategies should be dictated by moral values and economic considerations.

The Czech Private Grant Agency "RECOVERY" calls for new as well as brain-storming projects. New directions as well as those they have been the objectives of IGCP 216 "GLOBAL BIO-EVENTS" and IGCP 293 "GEOCHEMICAL EVENT MARKERS" are welcome.

Basic orientation of projects

A. Suggested studies will be devoted to major crises in Earth history, or they will be devoted to behavior of organisms in terms of the recent crisis.

B. The preference should be given to strong and clear approaches, i.e. to advanced interpretative studies as well as to primary studies are based on new and strong hypotheses. These studies must appeal to private sponsorship. A sponsor knows that science is complicated but he needs at the same time some guarantees or indications that the study or project has sound and realizable objectives.

C. There is a priority on projects addressing changes of the ecosystem and their causes. Please, note that possible detailed case studies should possess some reasonable chance how can results be generally utilized.

Examples of possible investigations

1. Framework of life strategies and crisis conditions.
2. Small refugia, adsorbing and releasing of organisms.
3. Lazarus populations and clades.
4. Effective detection and protection of refuges: their capacity and prospect.
5. Perspectives and limiting factors: clades in steady state (a "stasis"), in radiation, in survival.
6. Phylogenetic evolution of individual groups (a "systagenesis") and internal anticipation; non-adequate reactions in the same conditions.
7. Ultra-small populations, Adam & Eva starting points.
8. Guild reactions; possible structures; their stabilization and decay.
9. Internal oscillations of ecological systems and chaotic inputs: an interplay.
10. Alternative models and documentation of multiple interference of "biotic" and "non-biotic" inputs; the interfering pattern; probability of fatal drops.
11. Inertia of crisis; internal and external factors; perspectives of rare survivors; temporal versus successful salvage excursions.
12. Types of intraclade variability and their significance as evolution markers.
13. More sophisticated, multi-parametre models of geochemical and physical environments.
14. Theoretical system analysis; stable and labil configurations.
15. Any other field of investigation you have in mind. There is only the restriction that they should roughly correspond with the major ideas of the working group.

We have asked the IGCP-project leaders for recommendations:

> I would certainly encourage you to organize a working group under Project 335 (keeping us informed, of course) and to seek additional funding to support the research aims of that group.
>
> It sounds like an excellent idea!

Douglas H. Erwin, Co-leader and secretary, IGCP Project 335

I hope you can convience private companies and government agencies to cooperate with you in the establishment of your proposed research group. You have my strong recommendation and I fully support your effort.

Helmut H.J. Geldsetzer, Co-leader and secretary, IGCP Project 293

Call for projects and opinions

We hope that you agree with the objectives of our activity. This type of fund-raising has not been pursued in bio-event investigations. The start of the Agency will probably not be free of complications and problems.

However, we believe that direct communication of the private grant agency with private companies are the proper method for the next years.

We look forward to your comments, suggestions, and grant applications. We hope you will examinate this uncommon method with us.

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DEVONIAN SUBSTAGES, BIO-EVENTS AND SEA LEVEL CHANGES: A CALL FOR INTEGRATED APPROACH — GRZEGORZ RACKI

As shown by the recent Göttingen meeting, Devonian substages, biological events, sea level fluctuations, as well as the Devonian sequence stratigraphy are among the current tasks of the SDS. I think it is good occasion and virtual need for joint discussion of these interrelated problems.

Devonian substages are commonly used (see several papers in "Devonian of the World", Canadian Society of Petroleum Geologists, Memoir 14, 1988) but remain undefined and of variable meaning. On the other hand, recognition of the worldwide transgressive-regressive (T-R) cycles by Johnson et al. (1985) presents a convenient framework for "natural" stratigraphic subdivision (sensu Walliser 1985), and sequence analysis. Major lithological changes, recording the global sea-level movements and frequently anoxic events, are manifested within the Devonian system mainly in drowning uncorformities (Schlager 1989) characterized by black shale markers (e.g. in the New York succession), condensed lag horizons, submarine erosion surfaces etc. Such rapid facies changes typically coincide with diversity of biotic (both evolutionary and migration) responses, e.g. in result of simple "species-area effect" (see e.g. House 1985, Becker 1993, Racki 1993). The well established NATURAL BOUNDARIES are involved with easy applicability because they are recognizable already during field works. This concept is the best realized by the SDS in the Frasnian-Famennian boundary re-definition.

In fact, Johnson and Klapper (1992) in the recent discussion of the North American T-R cycles clumped the eustatic pattern with intra-stage units. Similarly, a substage (subage) scheme was proposed by me for the Givetian and Frasnian (Racki 1993), with an attempt of their integration with the global bio-events of House (1985) and Walliser (1985, 1992). The prominent Taghanic flooding (= Taghanic Event, T-R Cycle IIa) in the Middle varcus Zone is a good natural base of the Middle (or Upper?) Givetian. The following deepening pulse (IIb) near the beginning of the falsiovalis Zone would then define the Upper (or Uppermost?), post-*Stringocephalus* Givetian; the biotic consequence of the transgression is called "Mesotaxis Event" (as an alternative of "asymmetricus Event"). The Middle Frasnian is viewed as coinciding with the T-R Cycle IIc, whilst the *Manticoceras* (= Frasne) Event is arbitrarily assigned to the slightly earlier transgression, initiating the sustained Frasnian eustatic rise in the transitans Zone already (Subcycle IIb/c in Racki 1993). The Upper Frasnian is regarded as an equivalent of the complex T-R Cycle IId, and the event-rich Kellwasser interval.

Despite several hindrances, this is hoped that such integrated approach (already achieved in several points by the IGCP Project 216) refines subdivision of Devonian segments, and easily enables their consideration in terms of sequence stratigraphy, focused primarily on sedimentary record of different-scale sea level changes in various facies realms.

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NEW CONTRIBUTION TO THE DEVONIAN STRATIGRAPHY

Thematic issue of ACTA PALAEONTOLOGICA POLONICA, vol. 37 (1992), no. 2-4, entitled "Devonian reefs of Poland", has been published May 1993. The volume includes ten papers (one more in the next issue) documenting stratigraphic and paleoecologic characters of different groups of fossils (from algae to ichtyofaunas) within the Givetian and Frasnian stromatoporoid-coral limestones of southern Poland. Control significance of sea level cyclic changes for sedimentary development and biotas (conodont including) of the bank to reef complex is emphasized. This collective effort is thought as a regional ecostratigraphic synthesis, shared in the IGCP Project 53, as outlined by A.J. Boucot in the "Preface".

Content of ACTA PALAEONTOLOGICA POLONICA 37 (2-4):

Racki G.: Evolution of the to reef complex in the Devonian of the Holy Cross Mts, p. 87-182.

Nowinski A.: Tabulate corals from the Givetian and Frasnian of the Holy Cross Mountains and Silesian Upland, p. 183-216.

Wrzolek T.: Rugose corals from the Devonian Kowala Formation of the Holy Cross Mountains, p. 217-254.

Racki G. & Sobon-Podgorska J.: Givetian and Frasnian calcareous microbiotas of the Holy Cross Mountains, p. 255-289.

Hurcewicz H.: Middle and Late Devonian sponge spicules of the Holy Cross Mountains and Silesian Upland, p. 291-296.

Racki G.: Brachiopod assemblages in the Devonian Kowala Formation of the Holy Cross Moufntains, p. 297-357.

Malec J. & Racki G.: Givetian and Frasnian ostracod associations from the Holy Cross Mountains, p. 359-384.

Hajlasz B.: Tentaculites from the Givetian and Frasnian of the Holy Cross Mountains, p. 385-394.

Chlupac I.: Trilobites from the Givetian and Frasnian of the Holy Cross Mountains, p. 395-406.

Liszkowski J. & Racki G.: Ichthyoliths and deepening events in the Devonian carbonate platform of the Holy Cross Mountains, p. 407-426.

Following paper:

Gluchowski E. 1993: Crinoid assemblages in the Polish Givetian and Frasnian. Acta Palaeontologica Polonica 38 (1-2), 35-92.

Supplement:

Racki G. & Bultynck P. 1993: Conodont biostratigraphy of the Middle to Upper boundary beds in the Kielce area of the Holy Cross Mts. Acta Geologica Polonica 43 (1-2), 1-26.

IGCP 328 DEVONIAN GROUP AND SDS MARINE/NON-MARINE CORRELATION WORKING GROUP REPORT 1993 — ALAIN BLIECK

Preliminary remarks

I had asked through *Ichthyolith Issues* news and views from Devonian fish experts (to be sent to me or G.C. Young) to try establishing a first synthesis for the Devonian. But nothing came! So I use here published or nearly published data for the Lower Devonian (see Blieck's abstract in The Gross Symposium). Anybody who wants to collaborate on that tentative correlation is welcome. I indeed consider that all the IGCP 328 contributions on Devonian ichthyofaunas are also contributions to this SDS working group on marine/non-marine correlations. The recent book edited by J. A. Long (1993, Belhaven Press) can be considered a major, elaborated report on those subjects.

I don't know if time has already come to establish global correlation charts for the Devonian; it is partially made in Long's (ed.

1993) book by Young and Turner for eastern Gondwana, Wang Shitao and Long for China, Blieck, Janvier, Dineley and Loeffler for various places of the Old Red Continent and Siberia, but not yet done for western Gondwana. The only essay to correlate to conodont zones is by Young with his 15 macrofaunal assemblages of eastern Gondwana (Emsian to Tournaisian) but lots of problems still exist!

1 - LOWER DEVONIAN

Consider my oral communication on the correlation of the Early Devonian of the Old Red Continent as a general report.

It is based on recent papers by Mark-Kurik (1991) on Emsian placoderm correlation, Ilyès & Elliott (in press) on supposed Emsian new pteraspid localities of the USA, and a re-appraisal of previous; correlations (Blieck, 1984). To correlate vertebrate-bearing Early Devonian sequences with the conodont standard-sequence is not easy at all!

2 - MIDDLE AND UPPER DEVONIAN

a. See G C. Young's report.

b See Mark-Kurik's abstracts in The Gross Symposium and in the IInd Baltic Stratigraphy Conference (Vilnius, May 1993) on the Givetian/Frasnian boundary. There is a project of correlation between several Givetian-Frasnian vertebrate-bearing sequences of the Baltic States, eastern Quebec (Escuminac Fm.) and northern France (Boulonnais), using spores, vertebrates, invertebrates (E. Mark-Kurik, R. Cloutier, D. Vézina, S. Loboziak, C. Derycke,...).

c A new Famennian locality is reported by J.N. Theron (S. Africa Geol. Surv.) from the upper units of the Witteberg Gp. in the eastern Cape (SDS Newsletter n° 9: 3), but it is not the first record of Famennian fish in W. Gondwana as proclaimed: Famennian fish localities are well-known from Ma'der and Tafilalt, Morocco, south of the South-Atlasic fault zone, i.e., on W. Gondwana. See H. LELIEVRE for more info!

3 - DEVONIAN / CARBONIFEROUS BOUNDARY

These are recent data coming from the Early Carboniferous Stratigraphy Meeting (SCCS-CIMP joint meet.) held in Liege, Belgium, last June (M. Streel ed., 1993, abstracts). We heard four oral communications of Drs. L. Hance, E. Poty, P. Steemans and P. Muchez on the Chinese-Belgian cooperative program (with Fang Xiao-si, Xu Shao-chun. Inst. Geol., Beijing) on sections of Hunan, SW China, with corals, spores, foraminifers... and vertebrates in a mixed siliciclastic facies (the microverts have been sent to H. Lelièvre). These sections may thus be considered good candidates for correlation between W-European and Chinese ORS vertebrate-bearing localities (see tabl.).

N. France - S.Belgium	China	
Ardenne	Hunan	other provinces
Famennian-Tournaisian type series	mixed silicicastic facies Menggongao and Malanbian Fms	ORS facies
with marine invertebrate, vertebrates, and spores	with marine invertebrates, spores, microvertebrates	with vertebrates, spores
Tourneur, Hance, Poty Steemans, Streel, Muchez, Thorez, etc. Derycke	Tourneur et al., Fang Xiao-si, Xu Shao-chun et al. Lelièvre	Chang, Zhang, Liu, Wang, Pan, etc.

C. A. SANDBERG, DENVER, COLORADO

C. A. SANDBERG, in collaboration with Nancy Hasenmueller and Carl Rexroad has in press a paper dealing with the conodont biochronology, biostratigraphy, and biofacies of the upper part of the New Albany Shale, Indiana. Conodonts recovered from cores, in contrast to those that occur in outcrop sections, exhibit virtually no reworking and document the utility of the global standard Late Devonian conodont zonation. Eleven of 18 standard zones between the early Frasnian (early Late Devonian) *transitans* Zone and early Famennian (late Late Devonian) Early *marginifera* Zone are recognized and suggest nearly continuous deposition of the lower four members of the New Albany. Changes in conodont biofacies are shown to have occurred in response to downwarping of the Illinois basin in synchroneity with downwarping of the Michigan basin, to eustatic sea-level changes, and to the late Frasnian mass extinction.

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REPORT TO THE SUBCOMMISSION FOR THE DEVONIAN SYSTEM — SUSAN TURNER, QUEENSLAND MUSEUM

Following the Studies on Early Vertebrates symposium in China in 1987, a group of vertebrate palaeontologists decided we must plan a co-ordinated effort to investigate the use of vertebrates microfossils in biostratigraphy; in the first instance this was intended to cover Palaeozoic fishes on which most of us worked. This arose from our field session in east Yunnan, South China, walking the famous Cuifengshan section. Preliminary work by Wang Nian-zhong (IVPP, China, 1984) had brought the presence of microremains in this classic section to the fore and it was clear from our traverse that there were at least over 20 bonebeds in the sections; a bed-by-bed sampling was necessary to understand this supposedly non-marine section which has such a endemic macrovertebrate fauna and which promised a microfauna more useful to biostratigraphy which cosmopolitan taxa, at least at generic level.

In 1988 we produced the first *Ichthyolith Issues* with the aim of co-ordinating our work into an International Working Group. This has been followed by 12 issues to date. In 1989 at the Tallinn Mid Palaeozoic fish colloquium we decided to try to gain an IGCP project on Palaeozoic Microvertebrates to investigate further their role in biostratigraphy and their importance in providing correlative potential for "difficult" facies to enable marine/"non-marine" correlation. We achieved that objective in 1991 and now we are at midterm for IGCP 328 having held a successful joint meeting, The Gross Symposium and field excursion to Thuringia with SDS .

What else have we achieved? One of our main aims is to dessiminate information about Palaeozoic microvertebrate studies. This is achieved by *Ichthyolith Issues* and by personal persuasion though the medium of workshops and if possible direct teaching in university courses. In March this year in Australia we held a very successful 3-day Workshop at Macquarie University palaeobiology Unit with about 30 students in attendance. I hope all participants in IGCP 328 will use opportunities to encourage interest in microvertebrates, especially in the micropalaeontology world which sadly usually neglects to teach vertebrate studies. In the next few years a textbook on microvertebrates is planned which should encourage greater coverage of microfossils in university courses.

Another central concern is to reach concensus on correlation schemes for Palaeozoic rocks using microvertebrates. At the Gross meeting we hoped for, but did not achieve a Devonian synthesis that will enable us to put forward a microvertebrate zonation of the System to complement palynological data and work already in hand on macorvertebrate zonation. Our aim is to do this at our Final meeting at the Museum of Natural History in Paris in September 1995 (details in *I.I.* 12 or from co-leaders Blieck and Turner).

I thought I would take a brief historical look at our work and then see where we are now. In the last century Devonian fish figured prominently in early works on stratigraphy as pioneer geologists tried to make sense of the northern hemisphere successions. Murchison in Britain and Russia and Pander in the Baltic all used fish fossils (macro and micro) in the main thrust of their arguments for subdivisions of what is now Late Silurian and Devonian Somewhat later in the USA Newberry attacked similar problems and was using fish to correlate rocks across the States. Early taxonomic work including palaeohistology by Agassiz (for Murchison), Pander, Newberry and Worthen, and Rohon later in Russia all of which underpinned the stratigraphical conclusions. Sadly, by the end of the 19th century and for most of the 20th in North America this work has languished. Even when conodont studies took off in the thirties and fish were found alongside them, the fish workers never materialised. In the intervening years only one or two people in the States seemed to attack the problems; first there was the masterly work of John W. Wells who began to tackle the mid-west bonebeds and whose work is still insightful today (tragically he was put off fish work by his elders and betters who told him that such work was not important - that was great for corals but bad for us!). Then there was R.H. Denison who mirrored Gross's synthetic work reviewing distribution of fish in space, time and facies; much of his microvertebrate work remains unpublished. Only in recent times have more people in the States returned to the problems of understanding isolated (micro)vertebrate remains.

Fortunately, the combined taxonomic and stratigraphical approach continued in Europe and by mid century, Walter Gross became a leading exponent in the use of histological techniques and the unravelling of microvertebrate remains. His work became the basis for the first major success in the use of microvertebrate remains to tackle Palaeozoic biostratigraphical problems. The Siluro-Devonian boundary had long been a contentious issue just because of the historical precedent of Murchison choosing the Welsh Borderlands as the type area for one of the two major systems. Errol White promoted the use of pteraspids to zone these "non-marine" sections where only fish and plant remains were common. Gross, however, examined microremains from marine material in Europe and later formulated a simple zonation based on thelodont and acanthodian scales. This work has been followed up in Europe and the Welsh Borderlands by Karatajute-Talimaa, Ørvig, Mark-Kurik and Märss, Blieck and Goujet, and Turner for thelodonts, and K-T, Valiukevicius and Märss for acanthodians. Now we have a very useful zonation based on microvertebrate for the Silurian and Early Devonian, especially in the Baltic region, on which we can continue to build. Karatajute-Talimaa extended her work across the former Soviet Union; Turner and Goujet amongst others attempted to deal with other parts of the Western world. By emigrating to Australia Turner began to discover thelodonts and other microvertebrates across the southern hemisphere and to try and make sense of those.

These early studies are on a par with conodont studies of the thirties. Now we are moving rapidly into a more advanced stage where we are beginning to employ multielement taxomnomy and an understanding of the environmental and other factors which affected the fish. Our aim is to interpret the microremains so hopefully we can produce better zonation schemes. Now we are beginning to finetune - for instance in 1973 I proposed that the incoming of *Turinia pagei* should mark the S-D boundary in the Welsh Borderland - a position formalized now in Europe at least. But recent work is ashowing that other species of *Turinia* appeared much earlier in later Silurian times in Arctic Canda (Ludlow, Thorsteinsson coll.), Greenland (Turner & Peel 1987) and probably Irian Jaya (Vergoossen/Turner pers. obs) and Iran (Young coll, pers. obs).

Since our international effort began in 1988/89 work on Devonian microvertebrate studies has blossomed. The only blot on the horizon is the continued downspiralling of funding for our sort of science which restricts our possibilities to have students and pass on knowledge to the next generation. Fortunately, there are new students and work on fish microfossils since late 80s/early 90s investigating all the major groups of fishes for their biostratigraphic potential. Countries and regions with Devonian fish remains being studied include Australia, the Baltic, Brazil, Bolivia, Burma, Canada, China; Czech Republic and Moravia, France/ Belgium, Germany , Latvia, Libya, Lithuania, Morocco, Algeria, Poland, Russia incl Timan-Pechora, Kazakhstan, Uzbekistan, Saudi Arabia, Spitsbergen, U.K. esp. South Wales and Scotland, U.S.A. esp. Nevada, New York, Venezuela.

One example of success is the recognition of the use of phoebodontiform and xenacanthoid teeth in stratigraphy in mid to late Devonian and into early Carboniferous. Even the preliminary work shows the ability of phoebodonts to complement conodonts in deeper water marine successions. Recent work by Ginter and Ivanov (e.g., 1992, 1993) has prompted a relook at the older material to clarify the potential of these forms. Already there appears to be a correlation between the relatively rapid radiation of phoebodontiform/ xenacanthiform sharks and the Taghanic Event of North America (and possibly elsewhere).

Newberry (1889, p.31) put our aim into words over 100 years ago - speaking of the great Corniferous Limestone fish-beds (the "kjokkenmöddings") of accumulated fish remains several inches in thickness over all the sea bottom, he said they (the fish-beds) "deserve more careful consideration than they have yet received, and it is to be hoped that some one who is favourably located will make them the objects of careful and prolonged study. In no other way can the immense mass of animal remains they include be properly investigated, and it is quite certain that the results would justify the devotion of considerable time to the task". Whether it was Newberry or Wells in the Americas or Pander and Gross in Europe our IGCP is attempting to build on their findings and to bring that wish to fruition.

IGCP328: SOME RECENT AND IMPORTANT PUBLICATIONS RELEVANT TO D/C AND EARLY CARBONIFEROUS MICROVERTEBRATE STUDIES

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e-mail: t.wright@uow.edu.au; fax: 61.42.214.250; phone: 61.42.213329 (work), 61.42.297129 (home).

My research (where time allows) is mostly on Devonian themes in the Lachlan Fold Belt in New South Wales, focussing on faunal studies, local geology and regional biostratigraphy. Numerous distractions include early Palaeozoic faunas of east-central Iran and lingering studies of New Zealand faunas. While on study leave in the first half of this year I worked with Barrie Rickards at Cambridge on a large fauna of Silurian graptolites from central NSW, and the final version (hopefully) of the Mount Patriarch, NZ Cambro-Ordovician trilobite story has been submitted for publication. In the near future, taxonomic studies of corals and shelly faunas from the Mudgee district are of high priority.

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IGCP 328 AND SDS MARINE/NON-MARINE CORRELATION WORKING GROUP REPORT: MARINE/NON-MARINE CORRELATION USING VERTEBRATES: SUMMARY OF RECENT STUDIES IN AUSTRALIA AND ANTARCTICA — G.C.YOUNG, AUSTRALIAN GEOLOGICAL SURVEY, CANBERRA

1. METHODS

Establishing marine-nonmarine correlations can be achieved by several means:

A. **micro- and macrovertebrate studies from marine horizons dated by conodonts or other marine invertebrates.** This work is proceeding for the Devonian of eastern Australia mainly at Macquarie University Centre for Ecostratigraphy and Palaeobiology (MUCEP), and at Queensland Museum. At MUCEP conodont work is done by R. Mawson and J. Talent, and A. De Pomeroy and others are analyzing microvertebrate samples. In Brisbane microvertebrate samples come mostly from J.Pickett's (NSWGS) conodont work (E. Devonian of NSW), the Broken River area of Queensland, and elsewhere. Current work includes studies by S. Turner (sharks and thelodonts), and C. Burrow (placoderms, palaeoniscids), See Turner (1993) and Gross Symposium abstracts for summaries of this work, also represented on a revision of Young's (1989) Devonian biostratigraphic chart for Australia, currently in progress.

Establishing correlations with non-marine deposits (containing mainly macrovertebrate faunas) depends on finding the same or closely related vertebrate taxa in non-marine facies. Alternatively we can rely on external data from integration of conodont and miospore zonations, but for much of Australia the deep weathering profile means the latter information is only available in the subsurface.

B. **Isotopic dating techniques.** Using the SHRIMP ion microprobe to give numbers for volcanic ash deposits in both marine and nonmarine sections may provide sufficient precision to establish a broad correlation framework. Recent work on the D/C boundary (e.g. Claoue-Long et *al.* 1992) indicates the potential for this work, but as yet no vertebrate horizons have been dated in eastern Australia using the SHRIMP.

C. **Event stratigraphy.** Detailed analysis of eustatic sea-level change (e.g. work of Becker and House in Canning Basin), and utilisation of sequence stratigraphic analysis using seismic data and good subsurface palaeontological age control, should provide a better understanding of effects of sea-level change in non-marine depositional systems, with the potential for correlating events on a global or at least regional scale. At the gross level (degree of inundation of eastern Australian margin during Late Devonian), this has been utilised in age control of macrovertebrate faunas of east Gondwana (see Young 1993). Utilisation of geochemical signatures is still in the future.

2. EAST GONDWANA CORRELATIONS

Except for the Emsian of the Ohio Range (considered to be in the Malvinokaffric Province) the vertebrate-bearing Antarctic Devonian succession is entirely non-marine. In Australia the major difficulty at present in attempting correlation of non-marine and marine Devonian rocks is to assess the age of various fish faunas of assumed post-Emsian age in widespread non-marine sequences in eastern and central Australia which overlie Lower Devonian marine strata. The problem concerns closing the gap between faunas considered to be of Emsian-Eifelian age on the one hand, and those of Givetian-Frasnian age on the other (see discussion in Young 1993). Some systematic work indicates that the vertebrate faunas in these two categories are less dissimilar than previously thought. A major impediment is lack of detailed taxonomy of microvertebrate assemblages to establish a microvertebrate succession.

Emsian-Eifelian faunas. Turiniid thelodont assemblages occur over large parts of Australia (from E-W, the Darling, Georgina, Officer, Amadeus and Canning Basins) in marginal/nonmarine deposits (e.g. Gross 1971; Turner et. al. 1981; Young et al. 1987; Long et al. 1988). There is a tentative correlation with the *Wuttagoonaspis* fauna of western NSW (Ritchie 1973), a very diverse placoderm assemblage, still largely undescribed, in which *Turinia* is also abundant (Turner et al. 1981). The macrofauna (*Wuttagoonaspis* etc.) is also well represented in the Georgina Basin (Cravens Peak Beds and lower Dulcie Sandstone), where a marine interval of short duration has been suggested on the evidence of associated ostracods and eridostracans in a basal limestone unit of the Cravens Peak Beds (conformably overlain by sandstones containing the *Wuttagoonaspis* fauna). If correct this is the only marine Devonian occurrence in central Australia, which might indicate a short-lived transgression at or near the Emsian-Eifelian boundary, In 1991 new deposits were discovered in IGCP **328 field work in** the western Amadeus Basin (Mount Winter) in a thick calcareous succession, this time overlying sandstones containing *Wuttagoonaspis.* The Mount Winter assemblage includes abundant thelodont and acanthodian scales, osteolepids, dipnoans, shark spines, groenlandaspids, etc., but so far no antiarchs. The Cravens Peak assemblage includes antiarchs (Young 1984), dipnoan scales, onychodontids, the shark *Mcmurdodus* (Turner & Young 1987), etc.

Givetian-Frasnian faunas. Apart from the presence of *Mcmurdodus* just mentioned, the Antarctic Aztec fish fauna is important in being the only known assemblage in which *Turinia* scales are associated with the antiarch placoderm *Bothriolepis.* The Aztec fauna apparently represents a transition from the youngest non-marine turiniids in East Gondwana (associated with perhaps the oldest *Bothriolepis)* at the base, ranging up to the first appearance of phyllolepids at the top (Young 1988, 19933.

Phyllolepid placoderms are common in southeastern Australia (e.g. Long 1984; Ritchie 1984), where they are at least as old as early Frasnian. *Austrophyllolepis has* **now been identified in** Antarctica (J. Long pers. comm.), with phyllolepid remains going down further in the succession than previously thought by Young (1988). Except for the Hatchery Creek fauna, which like the lower Aztec contains both bothriolepids and turiniids (Young & Gorter 1981), and the *Grenfellaspis* fauna (Ritchie et al. 1992) interpreted as latest Famennian, all other presumed non-marine post-Emsian fish faunas of south eastern Australia contain phyllolepids. New discoveries of significance include the definite determination of the phyllolepid from the Harajica fish fauna in the Amadeus Basin as Ritchie's genus *Placolepis*, which suggests perhaps that Young's 1993 fauna 11 (Nettleton's Creek) may be misplaced in the macrovertebrate zonation. In the Lachlan Fold Belt in NSW a new phyllolepid (associated with Bunga Beds type plants) has been discovered in a sinter deposit enclosed within the Dulladerry Rhyolite (dated elsewhere as Early Devonian!), and a superb new locality with hundreds of complete phyllolepids of all growth stages has been collected by Alex Ritchie from near the Canowindra fish bed (and slightly lower in the sequence). Together with undescribed material from the far south coast of NSW (e.g. Fergusson et al. 1979; Young 1982, 1983, 1988b, 1989), Queensland, and elsewhere (but not so far in western Australia), we have enough phyllolepid material awaiting description to keep several Ph.D.'s busy. The Dulladerry Rhyolite occurrence can potentially be dated using the SHRIMP, to compare with the numerical age obtained for Victorian faunas interbedded with isotopically dated volcanics (Williams et al. 1982). Description of the NSW south coast material is significant because the late Frasnian marine transgression is assumed to be represented in this sequence by the Bellbird Creek Formation (based on conodonts of the *gigas* Zone found to the north at Ettrema; Pickett 1972).

3. SOME CURRENT PROBLEMS

a. **Is the *Wuttagoonaspis* fauna the same age wherever it occurs?** (Note that the agnathan *Pituriaspis* occurs in the Georgina, and there are other differences to Ritchie's Mulga Downs Group fauna). Detailed description of elements common to both (e.g. various actinolepid and groenlandaspid arthrodires) would help resolve this.

b. **What is the age of this fauna (or faunas) from conodont evidence?** A maximum age for occurrences in the Darling Basin (and perhaps Georgina and Amadeus) is provided by underlying marine beds of the Cobar Supergroup in the Darling Basin which contain pre-Emsian conodonts, as discussed by Young (1993), but J. Pickett (pers. comm. 1993) thinks it could be even older (placoderm remains from underlying Winduck Group need to be determined - the same or an older assemblage; L. Sherwin pers comm. 1993).

c. **What is its younger age limit?** Contrary to the evidence above, the shark *Mcmurdodus* in the Cravens Peak fauna (Turner & Young 1987) suggests a younger age, since this form is otherwise only known from the Aztec Siltstone fauna of southern Victoria Land, Antarctica (Young 198'8; Turner & Young 1992).

4. CURRENT RESEARCH PROGRAM

Systematic description of the faunas is urgently needed, but there are few researchers to do the work. Compared to Europe, with over 150 years of systematic research, we still have many significant faunas which are largely undescribed. These contain groups which can test preliminary biostratigraphic schemes, and provide broader empirical support for a Devonian vertebrate zonation for East Gondwana. However the faunas have a significant endemic component, or show associations not known from the northern hemisphere, so the need for a local vertebrate succession is very evident.

5. REFERENCES

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VALENTINA TALIMAA — INSTITUTE OF GEOLOGY, 2600 VILNIUS, REPUBLIC OF LITHUANIA

Information of activities with Devonian of Lithuania and beyond its boundaries. The 2nd Baltic Stratigraphic Conference was held in Vilnius on May 9-14, 1993. Eleven reports concerning Devonian stratigraphy were read at this conference. Reference to abstracts of these reports will be added to the SDS data base of publications and reports.

Dr. J. Valiukevicius read the report "Acanthodian biostratigraphy of Lower and Middle Devonian in Lithuania, Latvia, Estonia and Byelorussia" at W. Gross Symposium, Göttingen.

PAN JIANG — GEOLOGICAL MUSEUM OF CHINA, XISI, BEIJING 100034, CHINA

Pan Jiang, 1992, New galeaspids (agnatha) from the Silurian and Devonian of China. Geological Publishing House, Beijing. 86 pp.

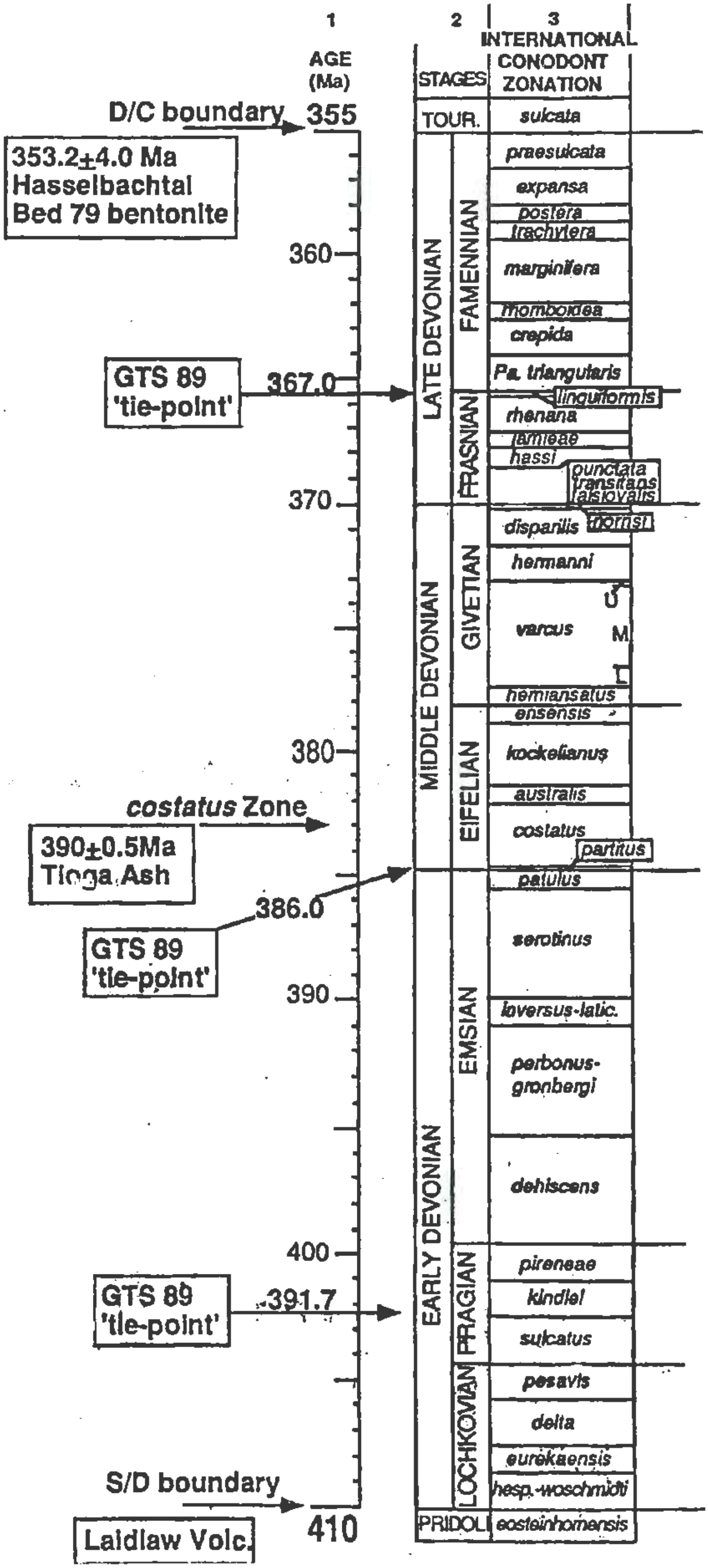
Pan Jiang & Ji Shu'an, 1993, First discovery of Middle Devonian galeaspids in China. Vertebr. PalAsiat. 31(4):304-307.

LUTZ HERMANN KREUTZER — GEOLOGISCHE BUNDESANSTALT, VIENNA

Kreutzer, L.H., 1992, Palinspastische Entzerrung und Neugliederung des Devons in den Zentralkarnischen Alpen aufgrund von neuen Untersuchungen. Jb. Geol. B.-A., 135:261-272.

Kreutzer, L.H., 1992, Photoatlas zu den variszischen Karbonat-Gesteinen der Karnischen Alpen (Österreich/Italien). Abh. Geol. B.-A., 47:1-129.

Also news that Dr. H.P. Schönlaub is now Director, Geologische Bundesanstalt, Wien.


1
AGE (Ma)
2
STAGES
3
INTERNATIONAL CONODONT ZONATION
D/C boundary
355
353.2±4.0 Ma
Hasselbachtal
Bed 79 bentonite
360
GTS 89 'tie-point'
367.0
370
380
costatus Zone
390±0.5Ma
Tioga Ash
386.0
GTS 89 'tie-point'
390
400
GTS 89 'tie-point'
391.7
S/D boundary
Laidlaw Volc.
410
TOUR.
LATE DEVONIAN
FAMENNIAN
FRASNIAN
MIDDLE DEVONIAN
GIVETIAN
EIFELIAN
EARLY DEVONIAN
EMSIAN
PRAGIAN
LOCHKOVIAN
PRIDOLI
sulcata
praesulcata
expansa
postera
trachytera
marginifera
rhomboidea
crepida
Pa. triangularis
linguiformis
rhenana
jamieae
hassi
punctata
transitans
falsiovalis
disparilis
norrisi
hermanni
varcus
U
M
L
hemiansatus
ensensis
kockelianus
australis
costatus
partitus
patulus
serotinus
inversus-latic.
perbonus-gronbergi
dehiscens
pireneae
kindlei
sulcatus
pesavis
delta
eurekaensis
hesp.-woschmidti
eosteinhornensis

CATALOGUE OF MARINE ISOTOPIC EVENTS IN THE PHANEROZOIC – W.T. HOLSER, M. MAGARITZ AND R.L. RIPPERDAN

A principal objective of IGCP Project 293 "Geochemical Event Markers in the Phanerozoic" is to establish a stratigraphic framework based upon geochemical signatures for the whole Phanerozoic. A major step in that direction is a catalogue of 13C, 18O, 34S and 87Sr data documenting "Marine isotopic events in the Phanerozoic" prepared by W.T. Holser, M. Magaritz and R.L. Ripperdan.

A draft model of such a catalogue was presented at the February 1992 Meeting of IGCP Project 216 "Global Biological Events in Earth History" in Göttingen and was presented again at the SDS Meeting in Göttingen. The quality of the photocopy of the model received by the editor was such that it could not be reproduced here.

The authors invite everyone who undertakes geochemical research on Phanerozoic events to submit such data to W.T. Holser, Cornell University, Department of Geological Sciences, Snee Hall, Ithaca, New York 14950, U.S.A. Include full information such as reprint of published paper, citation of same, preprint or informal statement. Full credit will be given.

DR. E. A. YOLKIN, NOVOSIBIRISK

My plan for the next year is to visit SDS session in Moscow. We hope to finish next year a preparation of the book with descriptions of conodonts (Yolkin, Weddige, Izokh, Erina), tentaculates (Walliser, Kim), tabulate corals (Kim), rugose corals (Erina), crinoids (Stukalina, Rakhmanov); microvertebrate (V'ushkova) from the Emsian Stratotype. Another important topic of our studies is biotic changes through the Silurian and Devonian.

With best regards, Zhenya

DR. K. ZAGORA – GRIMMEN, GERMANY

Zagora, K., 1993, Sedimentationsablauf und Speicherentwicklung im Oberdevon der Insel Rügen. Geologisches Jahrbuch, A 131:389-399.

Zagora, I., 1993, Zur Teufenabhängigkeit der Nutzporosität mitteldevonischer Sandsteine von Rügen/Vorpommern. Geologisches Jahrbuch, A 131:402-406.

PROF. EM. M.A. MURPHY – DAVIS, CALIFORNIA

The *Pandorinellina ? boucoti* lineage (Lochkovian, Devonian, conodonts). Jour. Paleontology, 67:869-874.

Punctuated stasis and collateral evolution in the Devonian graptolite lineage of *Monograptus hercynicus* Perner. Lethaia (in press – with K.B. Springer).

DR. WM. A. (BILL) OLIVER, JR., RESTON, VIRGINIA

Bill Oliver has formally retired after 36 years with the U.S. Geological Survey but isn't leaving. He expects to continue his researches on Devonian rugose corals as Scientist Emeritus with the Survey and Research Associate in the Department of Paleobiology, U.S. National Museum of Natural History. Address, phone and fax numbers remain the same.

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES
(IUGS)
INTERNATIONAL COMMISSION ON STRATIGRAPHY

Subcommission on Devonian Stratigraphy

Chairman:	*Vice-Chairman:*	*Secretary:*
Prof. Michael R. House	*Dr. Raimund Feist*	*Dr. Pierre Bultynck*
Department of Geology	*Inst. Sci. de l'Evolution*	*KBIN/IRScNB*
University of Southampton	*Université Montpellier II*	*Rue Vautier Straat*
Hants, SO9 5NH	*F-34095 Montpellier-Cedex 05*	*B-1042 Brussels*
ENGLAND, UK	*FRANCE*	*BELGIUM*
Fax: 44-703-593052	*Fax: 33-67-042032*	*Fax: 32-2-6464433*

elected August 1992]

CONCERNING: Proposal for the Global Stratotype Section and Point (GSSP) for the **Pragian - Emsian boundary.**

FROM: Subcommission on Devonian Stratigraphy

TO: ICS and IUGS for acceptance and ratification June 1993

(1) The Subcommission on Devonian Stratigraphy (SDS) wishes to recommend an horizon and locality for a basal Emsian GSSP at the base of Bed 9/5 in the Zinzalban section of the Kitab National Park in Uzbechistan. The Final Postal Ballot naming tnis localioty and level was concluded on December 1989 . The voting in the final ballot was as follows. Yes votes: Bultynck, Dineley, Hou, House, Klapper, Lardeux, McGregor, Norris, Oliver, Pedder, Rzhonsnitskaya, Schönlaub, Talent, Walliser, Yolkin, Ziegler: vote against; Yu: Abstention; Chlupáč: No replies Bensaïd, Hünicken. The approval by 16 out of the 18 voting TMs (89%) is well in excess of the 60% majority requires by ICS statutes.

(2) Boundaries had been considered in several parts of the world. It had heen agreed that a boundary related to a conodont lineage would be used and the voting took into account that Bed 9/5 corresdonds to the entry of *Polygnathus dehiscens* as illustrated and published by Yolkin *at al.* 1989, *Courier Forschungsinstitut Senckenberg*, 110, 237-246. Following lengthy discussion at a meeting held in Washington in July 1989, the Zinzalban section received majority vote, and the Final postal Ballot followed.

(3) In accordance with the requirements for submission to the ICS of a candidate section, details regarding the motivation and factual data on the locality and horizon are given as Appendices A-C.

M.R. House, Chairman

CONCERNING: Proposal for the Global Stratotype Section and Point (GSSP) for the Pragian - Emsian boundary.

FROM: Subcommission on Devonian Stratigraphy

TO: ICS and IUGS for acceptance and ratification

APPENDICES A and B

Appendix A comprises the statements required under the *Guidelines and Statutes* for submission to ICS of a Global Stratotype Section and Point (GSSP) including maps, stratigraphical column and location details. Appendix B is the paper describing the conodont sequence published by Yolkin *et al.* 1989, *Cour. Forsch.-Inst. Senckenberg*, 110, 237-246.

APPENDIX A

1. Motivation and choice of boundary level

As a result of discussion over a number of years, the Subcommission on Devonian Stratigraphy has agreed that the most useful level for defining the base of the Emsian would be the appearance of *Polygnathus dehiscens* in the lineage *P. pirenaee* Boersma - *P. dehiscens* A serviceable boundary could not be proposed in the original type area because of the absence of pelagic faunas which the SDS regarded as the most useful for international correlation. Although a globally useful GSSP had been proposed for the base of the Pragian in the vicinity of Prague in Bohemia, sequences in that areaabout the Pragian - Emsian boundary had proved unsatisfactory for proposal as a GSSP based on pelagic faunas especially with regard to conodonts which has especial use internationally. Though data and submissions for potential candidate sections for a GSSP for the base of the Emsian were canvassed, only one submission was forthcoming. This clearlythe superior nature of the Zinzilban sections. The type section was vistited by the SDS in 1978 and subsequently by a special party. It was included in field trips of the Inmternational Geologica Congress, Moscow 1984 as Excursion 100, The Middle Palaeozoic of the Southern Tien Shan.

2. Correlation on the global scale

Because of the ensemble of distinctive characters, rapid evolution in the *Polygnathus dehiscens - P. Pireneae* lineage can be traced internationally with ease; the incoming of forms referable tp *Pl. dehiscens* can be readily determined. Both species are quasi-global in distribution, occuring in sequences in Europe, Australia, North America and China as well as in central Asia. The proposed GSSP has a range of other faunal elements in the succession giving the potential for documentation of other groups across the boundary.

The proposed GSSP occurs in a relatively uniform sequence of dark micritic limestones characterizex by lack of significant abrupt faunal change such as would support the view that major diastems are not present. An association of benthic and pelagic facies norted above provides potential for correlation into other facies.

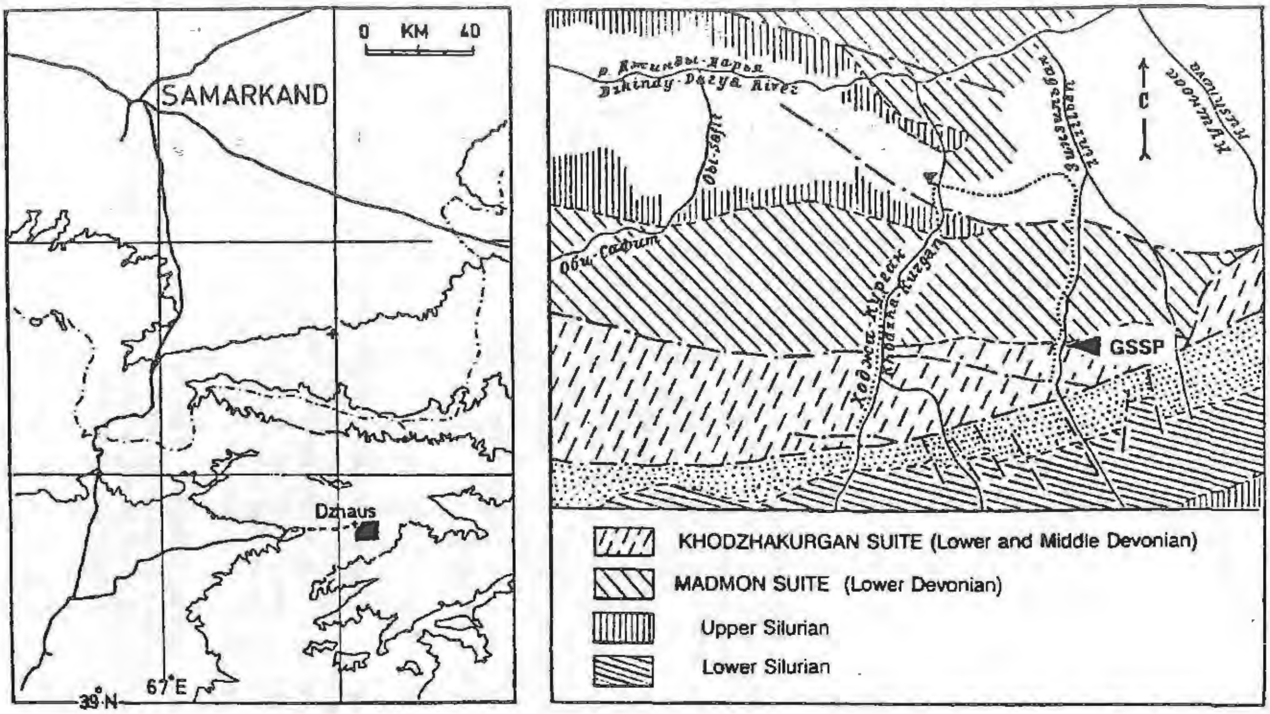


FIGURE 1. Maps showing the position of the Kitab National Park in Uzbechistan (southern Tien Shan) and the position of the GSSP proposed for the base of the Emsian. Geological Map modified from Kim *et al.* 1978.

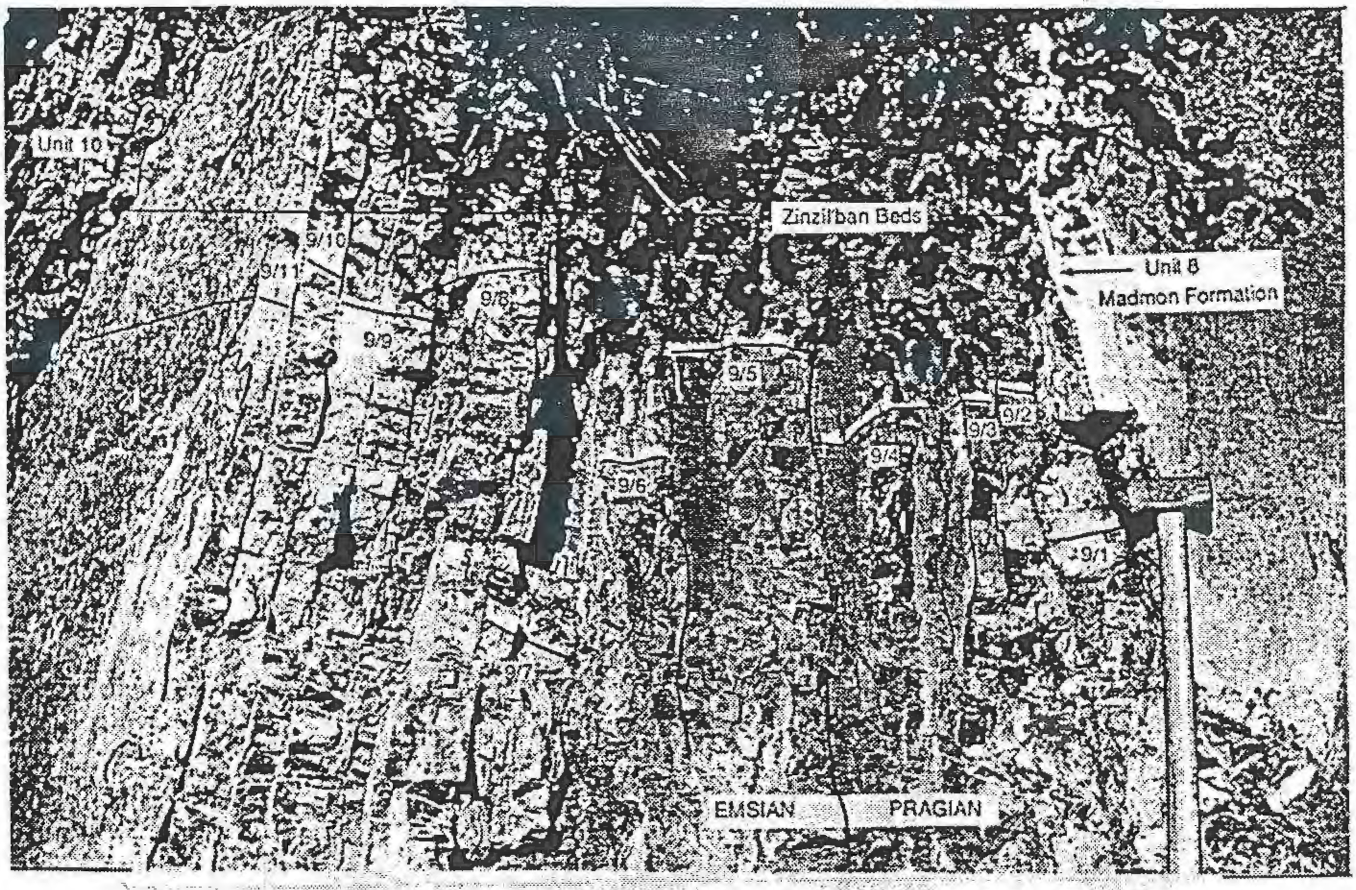


FIGURE 2. Photograph showing the position of the proposed GSSP in the Zinzilban Gorge section between Beds 95/4 and 95/5.

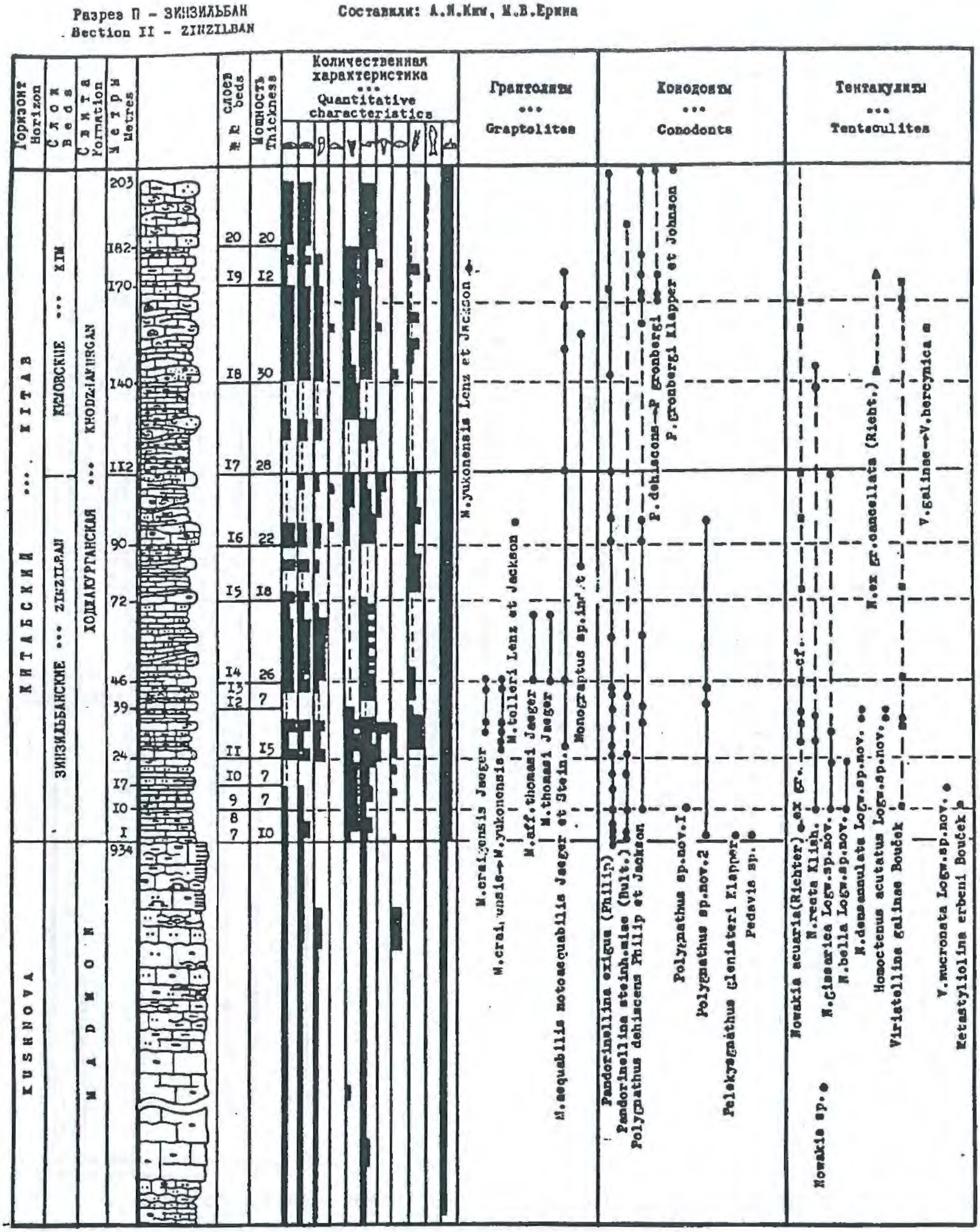


FIGURE 3. Log showing the large-scale section of the Zinzilban Gorge and the record of graptolites, conodonts and tentaculites. Note that in the detailed sequence given in Appendix B the bed numbering has been slightly changed so that Bed 9 goes down to the base of the Zinzil'ban Beds. Modified from Kim *et al.* 1978.

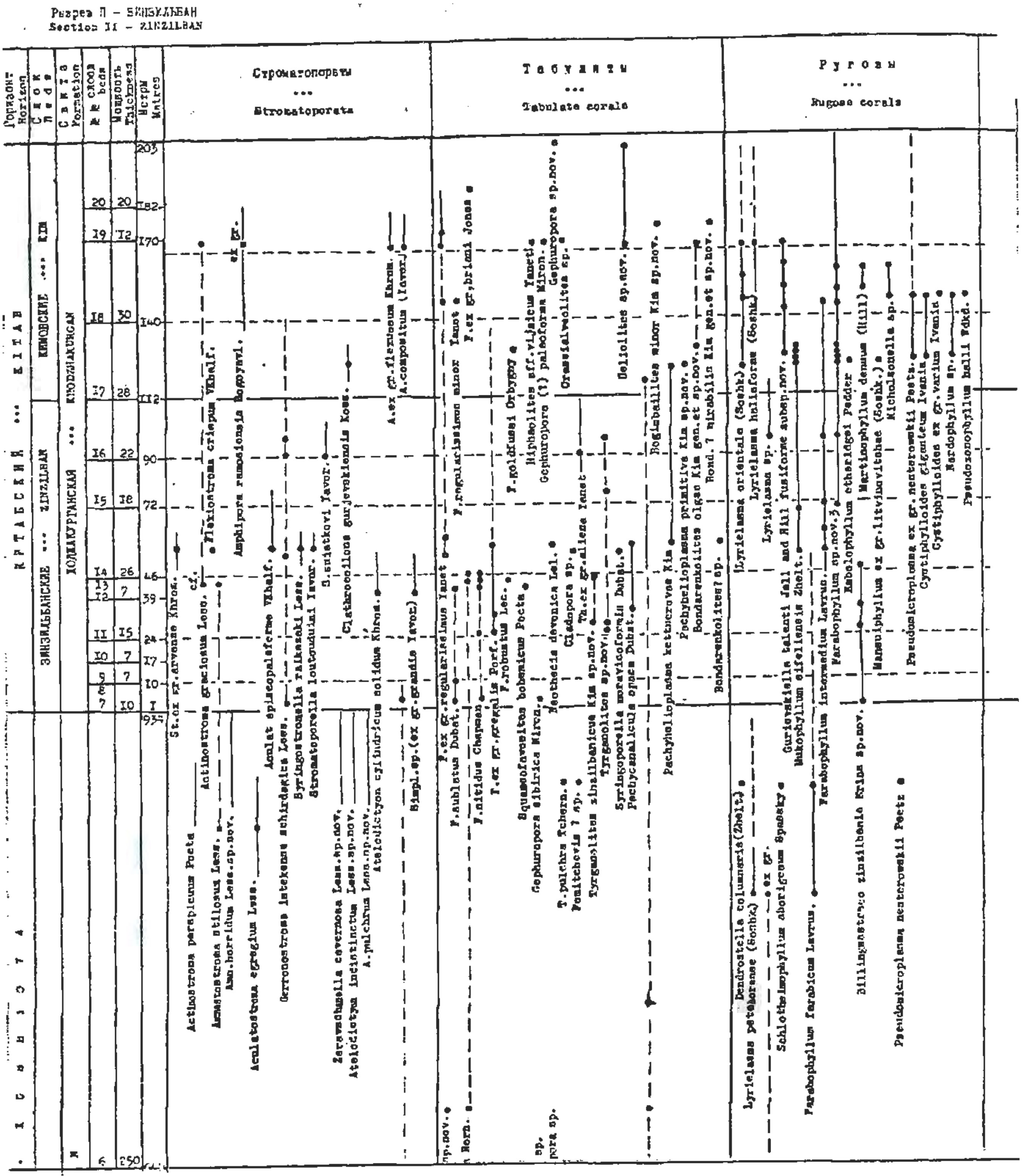
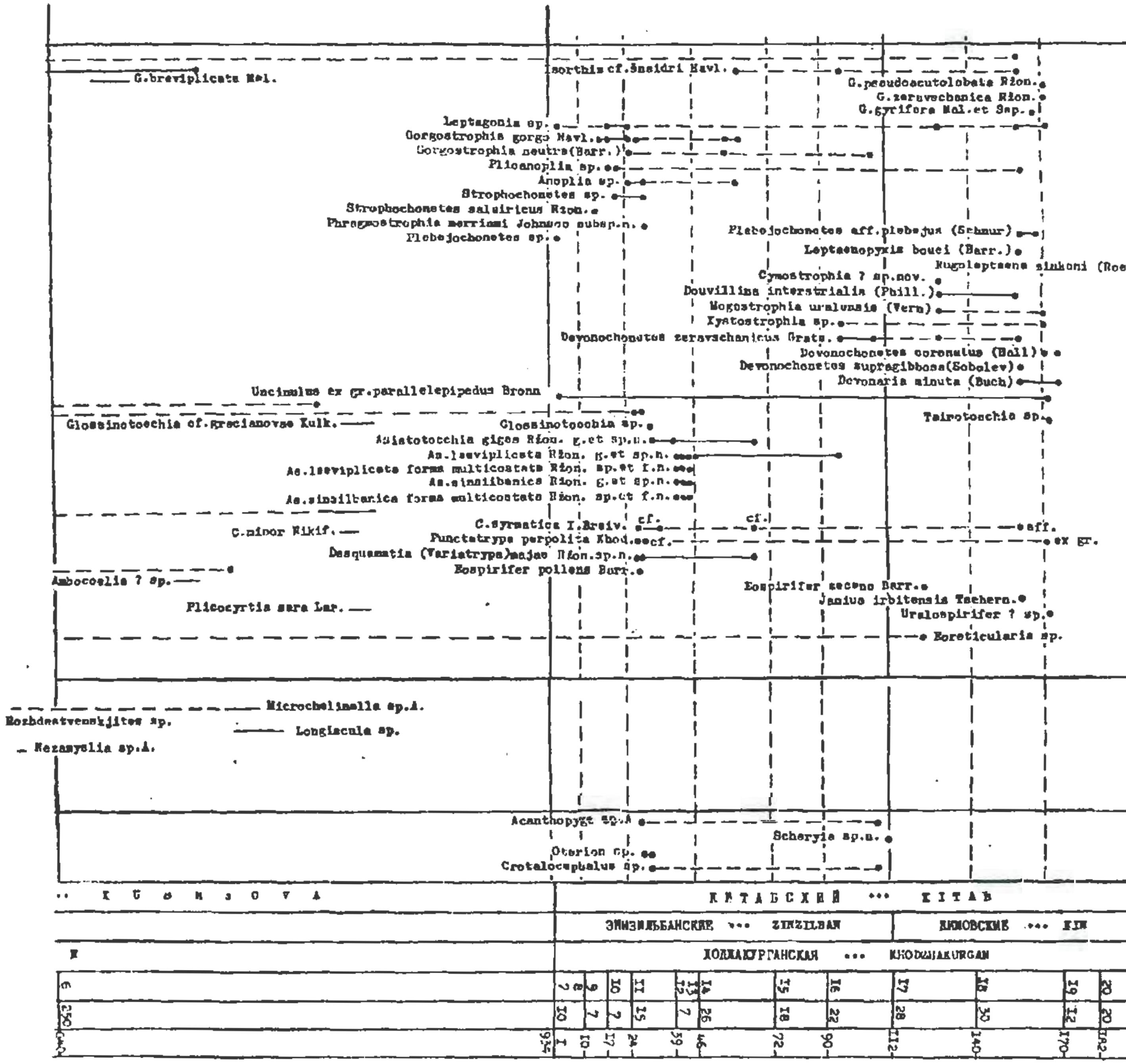


FIGURE 4. Log showing the large-scale section of the Zinzilban Gorge and the record stromatoporoids, tabulate corals, rugose corals, brachiopods, ostracods and trilobites. Note that in the detailed sequence given in Appendix B the bed numbering has been slightly changed so that Bed 9 goes down to the base of the Zinzil'ban Beds. Modified from Kim *et al.* 1978.

6



G.breviplicata Mal.
Isorthis cf.Szajdri Havl.
G.pseudoacutolobata Rzon.
G.zeravschanica Rzon.
G.gyrifera Mal.et Sap.
Leptagonia sp.
Gorgostrophia gorgo Havl.
Gorgostrophia neutra(Barr.)
Plicanoplia sp.
Anoplia sp.
Strophochonetes sp.
Strophochonetes salairicus Rzon.
Phragmostrophia merriami Johnson subsp.n.
Plebejochonetes sp.
Plebejochonetes aff.plebejus (Schnur)
Leptaenopyxis bouei (Barr.)
Rugoleptaena sinkoni (Roe
Cymostrophia ? sp.nov.
Douvillina interstrialis (Phill.)
Mogostrophia uralensis (Vern)
Xystostrophia sp.
Devonochonetes zeravschanicus Grats.
Devonochonetes coronatus (Hall)
Devonochonetes supragibbosa(Sobolev)
Devonaria minuta (Buch)
Uncinulus ex gr.parallelepipedus Bronn
Glossinotoechia cf.grecianovae Kulk.
Glossinotoechia sp.
Tairotoechia sp.
Asiatotoechia gigas Rzon. g.et sp.n.
As.laeviplicata Rzon. g.et sp.n.
As.laeviplicata forma multicostata Rzon. sp.et f.n.
As.sinzilbanica Rzon. g.et sp.n.
As.sinzilbanica forma multicostata Rzon. sp.et f.n.
C.minor Nikif.
C.syrmatica I.Breiv.
cf.
cf.
aff.
Punctatrypa perpolita Khod.
cf.
ex gr.
Desquamatia (Variatrypa)majae Rzon.sp.n.
Eospirifer pollens Barr.
Ambocoelia ? sp.
Eospirifer secans Barr.
Janius irbitensis Tschern.
Plicocyrtia sara Lar.
Uralospirifer ? sp.
Reticularia sp.
Microcheilinella sp.A.
Rozhdestvenskijites sp.
Longiscula sp.
Nezamyslia sp.A.
Acanthopyge sp.A
Scharyia sp.n.
Otarion sp.
Crotalocephalus sp.
... K U G M A Z O V A
КИТАБСКИЙ ... KITAB
ЗИНЗИЛЬБАНСКИЕ ... ZINZILBAN
ДЖИМОВСКИЕ ... DZHIM
H
ХОДЖАКУРГАНСКАЯ ... KHODZHAKURGAN
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250
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7
26
18
22
28
30
12
20
640
934
1
10
17
24
39
46
72
90
112
140
170
182

3. Location of the proposed GSSP

The Zinzilban Gorge is within the 52 km Kitab Natiônal Geological Reserve (Zapovednik) in Uzbechistan. The location of the section is shown on Figure 1. Exposures through the proposed GSSP occur in the continuous face on the western wall of the Zinzilban Gorge.

4. Description of type section

The succession forms part of a virtually continuous outcrop extending through most of the Lower Devonian into the early Middle Devonian. The section is illustrated in Figure 2 and the units are also documented in Appendix B.

Although noticeably thinner-bedded than the underlying Madmon Formation (Figure 2), there is no evidence of dastems within the sequences through the proposed GSSP. The suggested Global Stratotype Horizon at the base of Bed 9/5 is located 80 cm above the top of the Madmon Formation. The change in bedding character at that level is assumed to correspond to the global eustatic rise at the base of Depophase Ib in the terminology of Johnson *et al.* 1985.

Beds through the boundary interval yield a mixture of benthic and pelagic organisms, thus providing potential for correlations to be made into exclusively benthic as well as exclusively pelagic faunas. Conodont data relative to the GSSP has already been published (Yolkin *et al* 1989, reproduced here as Appendix B) and the conodonts occur in relative abundance in almost all beds. Data on distribution of benthic fauna was presented earlier by Kim *etal.* (1978, 1984). This documentation is summarised on Figure 3. Note that the Yolkin *et al.* paper refines the measurements and numbers of the type section. A considerable part of the shelly fauna has been formally documented (Kim *et al.*, FAN book).

There are minor dislocations in the massive Madmon Formation (Figure 2) well below the proposed GSSP, but the section forming the basis for this submission is remarkably free from structural complication. The conodonts, having a CIA index of 5, indicate incipient metamorphism.

Due to the absence of volcanic or ash bands, possibilities for geochronometry are not good at the GSSP, but refined placing of the boundary level in other areas using the proposed conodont boundary give ample opportunity for this elsewhere.

5. Abundance and diversity of fossils

On accompanying diagrams (Fig. 3,4) the wide range of taxa in beds associated with the proposed GSSP are indicated. These should enable precision to be obtained by the study of other groups. It may be noted that graptolites continue a short way only above the boundary, and these may represent the last known occurences of the group. Also coiled goniatites appear a little way above the boundary. Very useful dacryoconarids are associated with the critical beds.

6. Favourable facies for widespread correlation

The SDS has previously remarked in submissions that, for the Devonian, faunas of pelagic sequences offer the best means for internationally precise correlation. Such groups are represented in the proposed sequence and, indeed, the base of the *dehiscens* zone is widely recognised internationally and the new work at Zinzilban is now the standard for boundary faunas. Widespread international correlation seems best facilitated by the recommended horizon and section.

7. Structure and metamorphism

The succession is included in the folded and thrust sequences of the Tien Shan ranges. The beds are steeply inclined. Nevertheless the actual successions are readily demonstratable not only in the Zinzilban Gorge section, which is recommends, but also in the adjacent Khodzha Khurgan Gorge and there are other available sections. Metamorphism is slight and not untypical of that to be expected of Mid-Palaeozoic sequences.

8. Magnetostratigraphy, seismic stratigraphy and geochronometry

Work on these has not been accomplished in the type area and this should be considered a next step. As has been already remarked, the Zinzil'ban Beds are thought to correspond to a global sea-level rise which will be important when seimo-stratigraphic terminology is established in the Devonian. It seems likely, howvere, that for magnetostratigraphy and geochronometry, most advances will come from other successions which can be correlated with the GSSP using the precise biostratigraphic tools provided by the work on the type section.

9. Accessibility and conservation

The proposed GSSP lies in the Kitab National Geological Reserve. In 1979 the area was gazetted by the Uzbeck Government as a reserve for the preservation of its superb geology as well as to encourage scientific research on the geology of the area. Laboratory facilities are available at Zapovednik village for a maximum of about 40 visitors. The situation is thus ideal: blending conservation with a very positive attitude towards research. Access is easy: by plane from Moscow or Tashkent to Shakryshabz or Samarkand, then by a ca. 45 km paved road to the Reserve village, from whence the section can be reached by road and pack-track, a distance of about 4 km.

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Cour. Forsch.-Inst. Senckenberg, 110: 237–246, 1 text-fig., 2 pls. — Frankfurt a. M., 12. 6. 1989

Polygnathid lineages across the Pragian-Emsian Boundary, Zinzilban Gorge, Zerafshan, USSR

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Introduction

The 1981 meeting of the Subcommission on Devonian Stratigraphy (SDS) formally endorsed a 3-stage subdivision of the Lower Devonian: Lochkovian, Pragian and Emsian. Definition of the upper boundary of the Emsian and designation of a global stratotype were accepted by the SDS at its 1982 meeting in Frankfurt and ratified by the International Union of Geosciences in 1984. Since then a lower boundary for the Emsian has been discussed and it has been generally agreed that attention should be concentrated on the interval of overlap of *Polygnathus pireneae* BOERSMA and *P. dehiscens* PHILIP & JACKSON. The 1987 and 1988 SDS meetings therefore called for data on sequences where this overlap can be documented. The section in Zinzilban Gorge in the Kitabskiy Gosudarstvennyy Geologicheskiy Zapovednik (Kitab State Geological Reserve) is one such sequence. It was examined by SDS members in 1978; information on the distribution of taxa of all phyla present was published for this meeting (KIM et al., 1978) and further data was published for Excursion 100 of the XXVII International Geological Congress, held in Moscow (KIM, YOLKIN et al., 1984).

In the summer of 1987 ERINA and KIM re-sampled the Zinzilban section for conodonts. Because of the potential global significance of this section, closer sampling was again undertaken by YOLKIN, IZOKH and KIM in autumn 1987, after the SDS meeting in Calgary. Each sample collected was divided into three parts for independent leaching in laboratories in Novosibirsk (YOLKIN and IZOKH), Tashkent (ERINA) and Kitab (APEKINA). Virtually identical yields were obtained from all three laboratories. From study of the Novosibirsk collections, YOLKIN and IZOKH discriminated early forms of *P. dehiscens* and *P. hindei*; APEKINA and ERINA concurred with this differentiation.

In September 1988, the Zinzilban section was visited by a biostratigraphic group from West Germany and Australia (WALLISER, WEDDIGE, WERNER, TALENT and SCHINDLER). Conodont collections obtained up to that time from the Zinzilban section were examined and discussed, special attention being given to the polygnathids. There was agreement regarding recognizability of the early forms of *P. dehiscens* and *P. hindei* and, consequently, the potential for precise definition of a base for the *dehiscens* Zone.

During preparation of this paper, all polygnathid material obtained in Novosibirsk and Tashkent was once more re-evaluated, including material from ERINA and KIM's 1987 sampling of section PT-51. Section PT-51 was collected parallel to and approximately 20 m downslope from YOLKIN, IZOKH and KIM's 1987 sampling. One of ERINA and KIM's samples (PT-51/935.8 m) from the uppermost Madmon Formation, produced 11 good specimens of *P. pireneae* that facilitated recognition of two forms of this species, hereafter referred to as Form A and Form B.

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Characteristics of late Pragian-early Emsian polygnathids

Forms of the relevant species are differentiated according to morphology of the upper surface of the platform and the basal cavity as follows:

Polygnathus pireneae BOERSMA, 1974

Form A: upper platform surface slightly convex; basal cavity broad, visibly protruding outside the platform margins. Collection consists of 8 specimens. Pl. 1, figs. 1-3.

Form B: upper platform surface flattended; basal cavity broad, reaching the platform margins or somewhat protruding beyond the platform margin. Collection consists of 37 specimens. Pl. 1, figs. 4-6.

Polygnathus hindei MASHKOVA & APEKINA, 1980

Early form: side of upper platform relatively narrow, flattened and having weak notch in its anterior, to the left of the free blade; nodes usually distributed singly or rarely between the carina and the marginal rows of nodes or ribs; outer platform margin with a distinct angulation located posterior to the midlength of the platform; basal cavity moderately broad, with flanges of the basal cavity approximately equal in size. Collection consists of 36 specimens. Pl. 1, figs. 7-8.

Late form: side of upper platform relatively broad, flattened with a distinct notch located in its anterior, to the left of the free blade; nodes numerous on the upper surface; outer platform margin with sharp angulation posterior to midlength of the platform; basal cavity broad with its outer flange wider than its inner flange. The first occurrence of the late form is 23 m above tghe base of the Zinzilban Beds. Collection consists of 5 specimens. Pl. 2, figs. 1-2.

Polygnathus dehiscens PHILIP & JACKSON, 1976

Early form: upper platform surface flattened posteriorly and with weak adcarinal grooves anteriorly; basal cavity broad, reaching the platform margin. Collection consists of 9 specimens. Pl. 2, figs. 3-4.

Late form: adcarinal grooves clearly expressed, shallow, deepening somewhat near the anterior platform margins. The first occurrence of this form is at 58 m above the base of the Zinzilban Beds. Not illustrated herein.

Evolutionary trends

Both forms of *P. pireneae* and the early form of *P. hindei* are found at the beginning of the productive interval (Fig. 1) but their characteristic morphology suggests a trend from *P. pireneae* Form A to *P. pireneae* Form B to *P. hindei* Early form. The characteristic changes from *P. pireneae* Form B to *P. hindei* include the development of obvious angulation of the outer margin of the platform, and the appearance of nodes occurring singly or rarely between the carina and the outer margins of the platform. These features become more pronounced in the late form of *P. hindei* (cf. Pl. 1, figs. 4-6 with Pl. 1, figs. 7-8).

It appears that *P. pireneae* gives rise to two distinct lineages of polygnathids with the incoming of the early forms of *P. hindei* and *P. dehiscens*, the *hindei* lineage commencing slightly earlier than the *dehiscens* lineage that gives rise to the main polygnathid stock. The first *P. dehiscens* occurs in the Zinzilban section 80 cm above the first occurrence of *P. hindei* (Fig. 1).

Proposal of stratotype for the base of the Emsian

As suggested by the SDS, a prerequisite for the stratotype for the base of the Emsian is a section where overlap of *P. pireneae* and *P. dehiscens* can be demonstrated; this condition is admirably satisfied by the Zinzilban section. The section is now well known and well documented (KIM et al., 1978, 1984; KIM, ERINA et al., 1984, 1985; YOLKIN et al., 1985, YOLKIN & KIM, 1988). It has been examined three times on international excursions (1978 SDS meeting; 1984 International Geological Congress Excursion 100; 1988 field visit by a German-Australian group of Devonian biostratigraphers).

Fig. 1 Distribution of conodont taxa in the Zinzilban section on the left flank of the Zinzilban Gorge, Zeraf Shan, USSR. ▶

The section is notable for:

1. The appearance of the early form of the zonal species *P. dehiscens*, permitting unequivocal definition of the base of this zone.

2. The value of the evolutionary sequence in *P. dehiscens* being enhanced by the initiation, just prior to the entry of *P. dehiscens*, of a new polygnathid lineage, namely the lineage arising from the early form of *P. hindei* and extending through to *P. tamarae* (APEKINA, in press).

3. The lack of sharp change in conodont associations through the interval in question. Other conodont forms appearing in the Madmon Formation well below the interval shown in Fig. 1 continue through the higher levels in the Zinzilban Beds. Elsewhere the same forms likewise extend into the *dehiscens* Zone from older zones.

4. The Zinzilban Beds consisting of homogeneous fine-grained, dark, well-bedded limestone with no features suggesting interruption in sedimentation. The early form of *P. dehiscens* appears in the Zinzilban Beds in bed 5 of interval 9 (Fig. 1).

5. The presence of benthic faunas including stromatoporoids, corals, brachiopods and trilobites in addition to pelagic groups, specifically conodonts, dacryoconarids and graptolites (KIM et al., 1978).

6. Being conveniently located in a geological reserve with accommodation for visiting scientists and with research facilities dedicated to biostratigraphic research.

In view of the above, we recommend the Zinzilban section be designated the stratotype for the Pragian-Emsian boundary with the boundary located at the base of Bed 5 interval 9 (Fig. 1).

Acknowledgements

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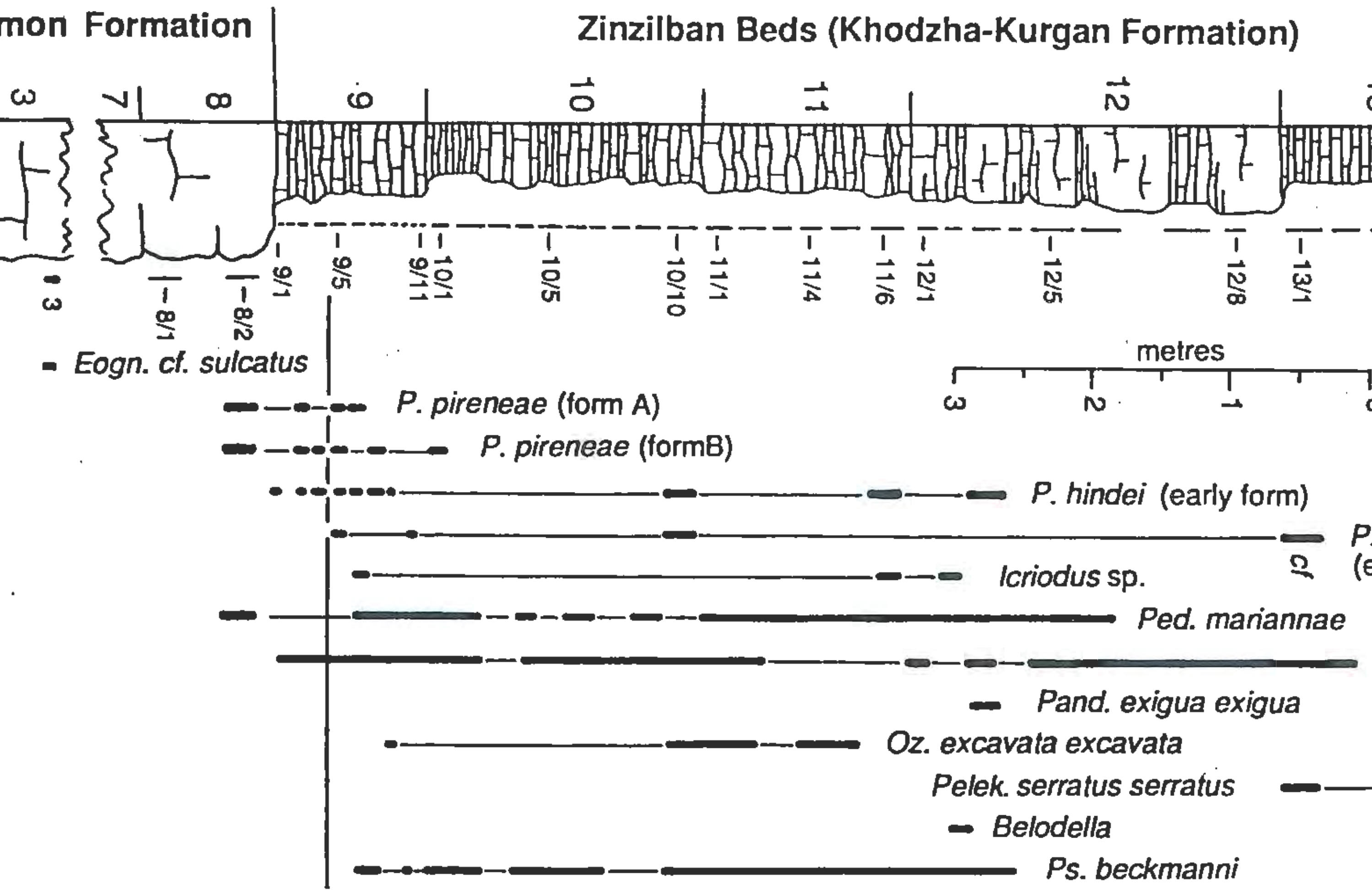
mon Formation
Zinzilban Beds (Khodzha-Kurgan Formation)
3
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8/1
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9/11
10/1
10/5
10/10
11/1
11/4
11/6
12/1
12/5
12/8
13/1
metres
3
2
1
Eogn. cf. sulcatus
P. pireneae (form A)
P. pireneae (formB)
P. hindei (early form)
cf
Icriodus sp.
Ped. mariannae
Pand. exigua exigua
Oz. excavata excavata
Pelek. serratus serratus
Belodella
Ps. beckmanni

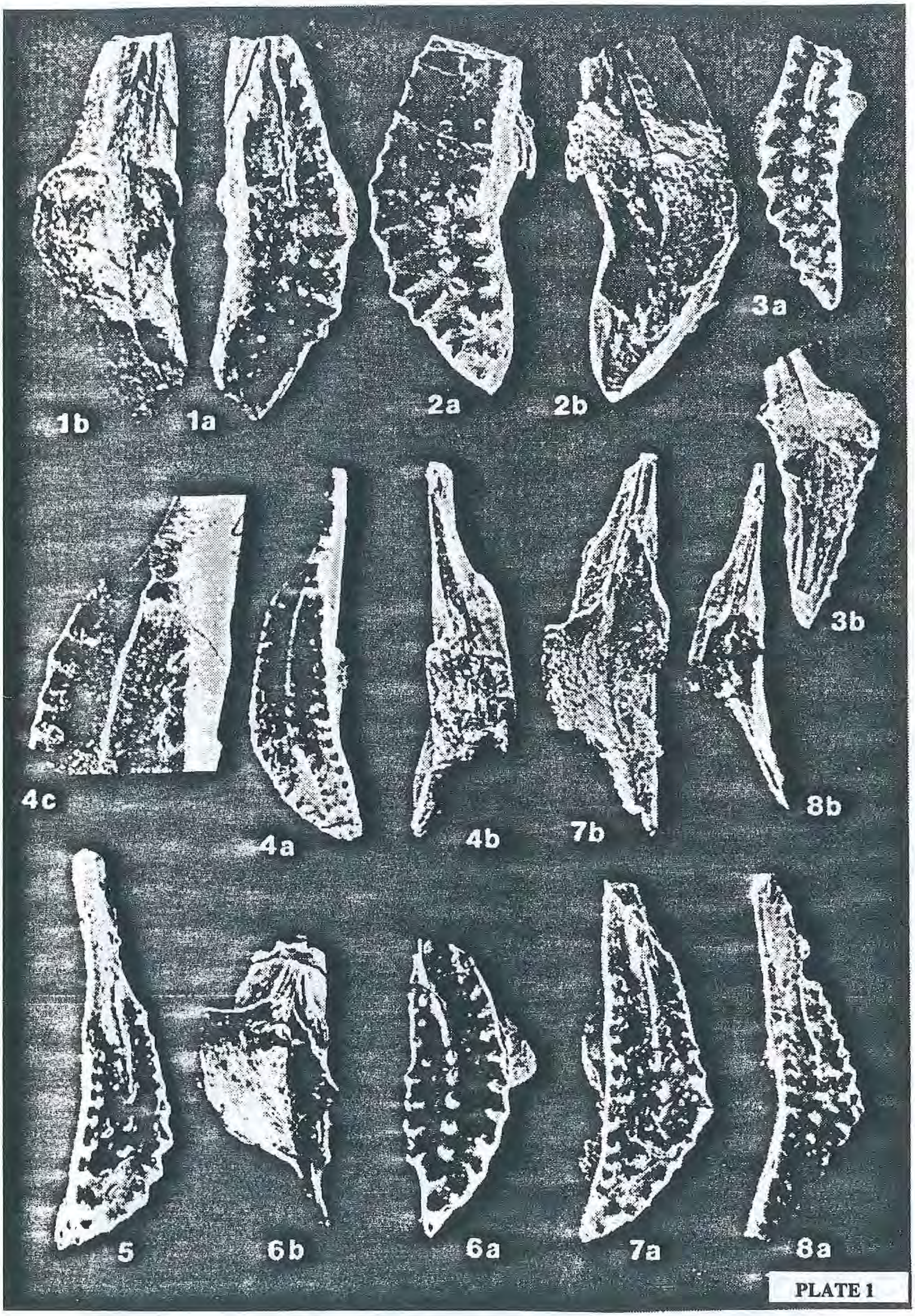

PLATE 1

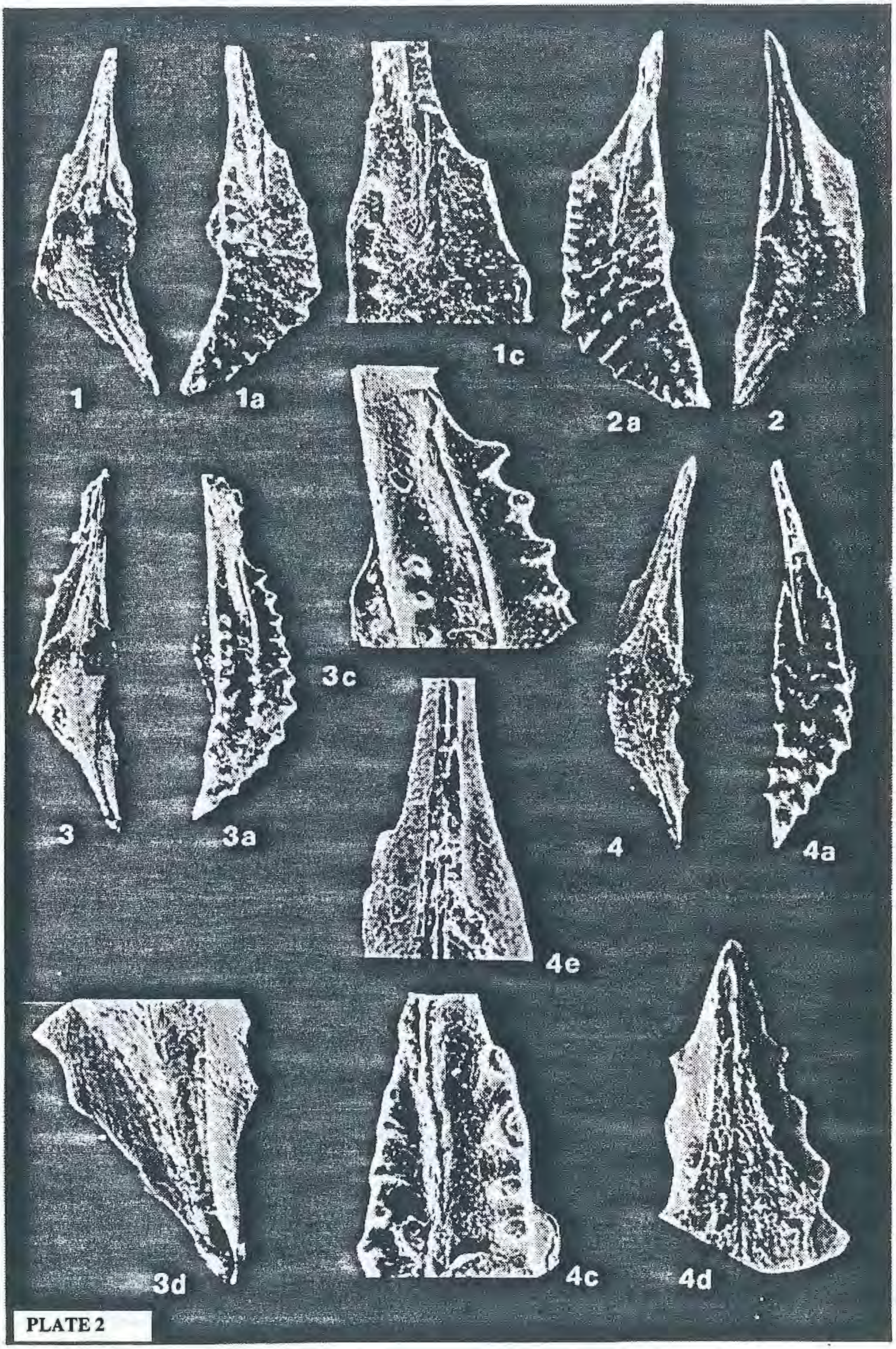

PLATE 2