INTERNATIONAL SYMPOSIUM ON JURASSIC STRATIGRAPHY

Erlangen, September 1 - 8, 1984

Symposium volume I

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JURASSIC STRATIGRAPHY (IUGS)

INTERNATIONAL SYMPOSIUM ON JURASSIC STRATIGRAPHY

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Symposium volume I

Edited by

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PREFACE

These three volumes are the fourth and last of the publications in connection with the International Symposium on Jurassic Stratigraphy, Erlangen 1984. They contain the scientific papers, most of them presented orally during the sessions of the symposium, and the reports from the coordinators of the working groups of the Subcommission on Jurassic Stratigraphy. Earlier in 1984 was published the volume of abstracts of the scientific papers, the list of Jurassic Stratigraphic Workers, and the guide-book for the excursions.

The papers and reports in these volumes concern many aspects of Jurassic stratigraphy: Radiometric methods, magnetostratigraphy, bio- and chronostratigraphy, macro- and micropaleontology, basin analysis, facies pattern, correlation of sedimentary events, regional and multidisciplinary stratigraphy, and datas base management.

Thus, a wide field of Jurassic Stratigraphy is covered by these contributions and we hope a lot of impetus will be given to stimulate further work on the Jurassic system and to initiate fruitful and prosperous cooperative work on the many open problems. The scientific papers of the volumes together with the scientific reports from the coordinators of the working groups present well an informative review about Jurassic stratigraphy today. By traditional reasons papers on bio- and chronostratigraphy are in the majority. They document once more the importance of such studies; the specialist will find papers on ammonites, bivalves, brachiopods, echinoids, gastropods, corals, nannofossils, palynomorphs, acritarchs, ostracods, foraminifera, radiolaria, dinoflagellates, and trace fossils, a wonderful and in no kind old-fashioned bouquet of disciplines. We hope that a first step towards a multidiciplinary stratigraphy and correlation of the Jurassic System has been taken.

Volume I is subdivided into two parts. The first part include short reports given by the coordinators of the working groups and reports on the working group meetings which took place during the symposium. The second part include papers dealing with the Lower Jurassic. Volume

II is subdivided into two parts dealing with Middle and Upper Jurassic respectively. Volume III includes general aspects as regional reviews, biogeographic and faunal problems, and various contributions to Jurassic stratigraphy.

To provide publication of the papers as quickly as possible all papers and reports are printed as received by the editors. Only technical treatment and necessary corrections have been carried out. In the guidelines given to the authors we asked for papers not larger than ten pages and written in English. However, two papers written in French have been accepted as well as several papers of more than ten pages.

The editoral work and the printing have been carried out at the Geological Survey of Denmark. The technical preparation of the volumes has been carried out by Pia Andersen.

Olaf Michelsen

Arnold Zeiss

The meeting and its history

After the International Subcommission on Jurassic Stratigraphy was established in 1978, we first tried to further international cooperation by initiating a joint research project, "Boreal-Mediterranean correlation in the Jurassic system (Jurassic biotic events"), open to all interested Jurassic stratigraphers. This did not prove to be possible however, because we could not get the approval of the IGCP-board in 1980/81, so we decided to try and tackle some of the major problems of Jurassic stratigraphy by establishing smaller working groups, which were to concentrate on only one stage or one fossil group or other stratigraphic disciplines. We discussed the problems with the coordinators of the working groups in Ludwigsburg 1983 after a planned meeting of the subcommission in Copenhagen 1983 failed to materialize due to a lack of interest from our collegues. It was once again evident that only a personal contact among collegues could decide upon the further activity of the working groups.

As the last meeting of Jurassic stratigraphy was held in 1967 it was time to reassemble all Jurassic stratigraphers to give them a possibility to meet, discuss, and make plans for the future work on a cooperative basis. Therefore, we discussed organizing another full meeting of the subcommission, combined with excursions and working group meetings. For organizational reasons, we decided to propose a Symposium on Jurassic Stratigraphy in Erlangen, BRD. Sufficient responses to the first announcement encouraged us to begin with the definitive organisation in late autumn 1983. This was done with the kind assistance of our collegue J. Th. Groiss, the help in the secretariat by Mrs. Scholl, the technical work by Mrs. Sporn and Mr. Günther, and all members of the staff of the department of Palaeontology (Erlangen), and Mrs. Pia Andersen (Geological Survey of Denmark). Mrs. C. Munk, Mr. B. Lang and M. Plückebaum helped to organize excursion A, as did G. Bloos from Stuttgart Museum, who kindly took over the guidance for the first day of this excursion. We also thank the administration of the University of Erlangen-Nürnberg and the directors of the departments of anatomy, geology, palaeontology and zoology, who, free of charge, kindly

put the rooms necessary for our symposium at our disposal. Our cordial thanks are due to the president of the university, who helped to organize a welcoming party at the beginning of symposium and also to the town-major of the city of Erlangen who invited the participants to a reception at the end of the symposium.

The meeting was attended by approximately 160 inscribed participants (only a very small number, mainly those of Africa and Asia were not able to attend), and by 20-30 students and collegues from the geoscience departments of Erlangen. 10 students helped us during the symposium.

Almost all full members of the subcommission were present. Most participants came from Europe. With the exception of the DDR, Yugoslavia, Greece and Turkey all European countries where Jurassic research work is going on were represented (Austria, CSSR, Denmark, Bulgaria, France, BRD, Great Britain, Italy, Luxemburg, Netherlands, Norway, Poland, Portugal, Romania, Sweden, Switzerland, Spain, USSR and Hungary). With much pleasure, we could also welcome guests from Canada, U.S.A., Argentina and China.

Financial assistance was kindly supplied by the following institutions and companies:

International Commission on Stratigraphy
German Academic Exchange Services
International Geological Correlation Program (Project 171)
Kraftwerk-Union A.G.
Heidelberger Portland-Zementwerke A.G.
Aroma-Chemie, G.m.b.H.

From the Kraftwerk-Union and the Raiffeisenbank, we also received other organizational help for the meeting in Erlangen. In addition we were guests for lunch at Sengenthal of the Heidelberger Portland Zementwerke, which is gratefully acknowledged.

Printing of this volume, as well as the abstract volume and the List of Jurassic Workers, was possible only with the kind assistance of the Geological Survey of Denmark to which we express our sincere thanks.

Finally, we thank all colleagues who attended our meeting, especially those who contributed towards the cooperative work in the working groups.
We hope to see you again in Portugal in 1987.

O. Michelsen A. Zeiss

Minutes of the Symposium

1st - 2nd September: Excursion to Northern Franconia (from Coburg to Erlangen, night in Vierzehnheiligen near Staffelstein). - Objects: Triassic/Jurassic Boundary, Lower and Upper Jurassic.

3rd September:

8^{15} Opening of the Symposium (Welcome addresses).

$9\text{-}12^{30}$, $14\text{-}18^{30}$ Scientific lectures (general themes of Jurassic stratigraphy, chronology and stages; first part of reports on regional subjects (Eurasia - Africa).

20^{00} Reception of the President of the University, Erlangen - Nürnberg.

4th September:

$8\text{-}12^{30}$, $14\text{-}18^{30}$ Scientific lectures (Lower, Middle and Upper Jurassic, and second part of reports on regional subjects (USSR and Circumpacific area)).

20^{00} Public lecture by H. Hölder: Das Weltbild der Jurazeit.

5th September: Session of Working Groups

$8\text{-}12^{30}$ Lower Jurassic Working Groups

$14\text{-}17^{30}$ Upper Jurassic Working Groups

6th September: Session of Working Groups; informal and formal meetings.

$8^{30}\text{-}12^{30}$ Middle Jurassic; microfossils; brachiopods; corals.

$14\text{-}17^{30}$ Open informal Meeting with the Circumpacific Jurassic Research Group, followed by the Formal Meeting of the Subcommission on Jurassic Stratigraphy.

20^{00} Reception of the Town Major of the City of Erlangen.

7th - 8th September: Excursion to Southern Franconia (from Erlangen to Neuburg/Donau; night in Eichstätt. Objects: Middle and Upper Jurassic.

Publications of the Symposium

1) Abstract Volume, Copenhagen, August 1984, 75 p.
2) List of Jurassic Workers, Copenhagen, August 1984.
3) Guidebook to Excursions, Erlangen, August 1984, 205 p., 84 figs.
4) Symposium Volume (3 parts), 908 p., Copenhagen 1984.

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5) Program of Symposium, 16 p., Erlangen, August 1984.
6) List of participants, 16 p., Erlangen, August 1984.

VOLUME I

REPORTS OF THE WORKING GROUPS

LOWER JURASSIC AND LOWER-MIDDLE JURASSIC BOUNDARY

REPORTS OF THE WORKING GROUPS

Working groups on the Jurassic Stages, and on various non-ammonite taxa (Microfossils, brachiopods, corals & sponges)

Arnold Zeiss

The reports of the Working Groups are often twofold. The one presents a short review on the activities of the group, and the other deals with the present state of knowledge and/or open problems. The report on the working group meeting in Erlangen is included in the first or the second part, as the coordinator or reporter has found it appropriate.

The meetings of the working groups was one of most important subjects of our symposium. Therefore we reserved one and a half day for this purpose. Only a personal contact between the members concerned could decide in which direction progress could be reached. Each coordinator gave a review of the present status and the open problems, and this was followed by an open discussion between the group members and other interested persons of the symposium.

In the Lower Jurassic working groups the need for further local studies was predominating, and even led to the dissolving of the Toarcian working group. In the Middle and Upper Jurassic working groups the discussion on the already available data and their usefulness was opened. Of course also in these latter working groups basic data are needed, but the results of the discussions seem to be more prosperous for coming to a general agreement about future work and decisions than in the Lower Jurassic. Nevertheless, we hope that also the Lower Jurassic groups will reach some results untill the next meeting in Lissabon. Real problems exist in the uppermost Jurassic stage working group, as basic data of the Upper Tithonian are still under study. This Working Group, whose general coordinator is John Cope will be divided for practical reasons into three branches: Kimmeridgian/Portlandian, Tithonian, and Volgian. Despite of the fact that the collegues from USSR have

now abondoned the term Volgian, the problems of correlation remain! The first branch will be directed by John Cope, the second by Arnold Zeiss, and the third by M. Mesezhnikov.

As the working groups on the Jurassic Stages also handle with the Jurassic ammonites as the most important fossil group for subdivision of this system, we have tried to establish working groups dealing with other fossil groups or other items. At the working group meetings the three following groups met: Micropalaeontology, brachiopods and corals and sponges (see reports). During the meeting for the members of the subcommission it was further proposed to establish a group on magnetostratigraphy, which will be directed by J. Ogg.

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Report of the Triassic-Jurassic Boundary Working Group

R. Mouterde

The meeting of the Triassic-Jurassic boundary working group was held on Wednesday the 5th of September 1984 during the symposium in Erlangen.

Many specialists of the Jurassic took part in the discussions. First, the question "How can we establish the boundary?" was longly debated.

- the juridical boundary is the basis of the 1st zone of the Hettangian (Planorbis zone) or more precisely the basis of the 1st subzone (Planorbis subzone) in the type locality.

- a more efficient decision concerning the boundary and the final choice of the type locality should be based on the knowledge of the evolution of the whole fauna and flora and also on the sedimentology of the beds located at the Trias-Jurassic boundary.

After this, we took an inventory of the possible sections and the important fossil groups. The names of the coordinators proposed for these workings are those underlined below.

A. The following sections were retained:

U.S.A.: New York Canyon (Guex, Smith, Taylor)

Slovakia: 2 continuous sections Rhaetian/Hettangian in the sheet of Križna ("nappe de Križna"). Rakus et al.,....There is a possibility of an excursion in 1986-1987, see P.S.

Chile-Peru: v. Hillebrandt, Prinz

Austrian Alps: Bloos, Krystyn (?)
Great Britain: Donovan.
France (Lorraine): Franiatte, Muller.
(Ardéche): Elmi, Mouterde.

B. For the different groups of fossils, the following names were kept back.

Palynology: Guy-Ohlson, Weiss
Nannofossil: Lord
Ostracodes: Lord, Michelsen, Urlichs
Foraminifera: Copestake, Ruget
Radiolaria: Pessagno, Blome, Kozur
Acritarchia: Dorning
Brachiopoda: Ager, Almeras, Dagis, Delance, Laurin
Gastropoda: ?
Bivalvia: Hayaki, Troedsson
Echinoderma & Crinoida: ?
Ammonites: Bloos, Elmi, Francatti, Guex, v. Hillebrandt, Mouterde, Repin, Tozer
Nautiles: Tintant
Magnetostratigraphy: Ogg?

It is evident that this list is incomplete. Please send us your suggestions. We demand to all the coordinators to write, as far as it is possible, a prereport upon the already known results and the possible/eventual/contingent prospective.

P.S. Composition of the West Carpathian Rhaetian/Hettangian working group which is able to organize an excursion in 1986/87.

Bivalvia: M. KOCHANOVA

Brachiopods: M. MICHALIK
J. PEVNY

Foraminifera: GADZICKY
Ammonite: M. RAKUS
Lithology: M. SYKORA
Coordinator: M. RAKUS

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First meeting, Sept. 5th 1984, at Erlangen

The session was held together with the working group on the Triassic/Jurassic boundary under the convenorship of colleague R. Mouterde.

The present state of ammonite stratigraphy and open problems in Lower Lias stratigraphy are referred to at separate places of this volume and therefore not repeated here. In contrary to other parts of the Jurassic there is still necessary a considerable amount of basic work in Lower Lias stratigraphy. Therefore no definitions of boundaries were proposed or fixed. It was proposed to provide compilations of important profiles, collections, originals and litterature in regional order as base of work in the future.

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G. Bloos

Open problems in stratigraphy exist in every region, and the stratigraphers know the problems of their respective region of work best. Therefore a compilation of open problems is a typical task of a working group. Compilations of a single author will mostly be one-sided more or less.

Problems of ammonite systematics and stratigraphy

These problems are so closely related that they are not separated here.

Questions concerning the lower boundary of the Lias and the preplanorbis beds are here excluded.

The question if Neophyllites appears earlier than Psiloceras is not certainly solved. The limestone blocks with Neophyllites at the type locality Drove were crowded with Neophyllites, but without Psiloceras. Since such an occurrence of Neophyllites above Psiloceras is not known from anywhere it might be concluded that it must be a horizon below Psiloceras. The question of the relation between Neophyllites and Psiloceras in England is still open because of the bad preservation in most cases. In boreholes of NW Germany and in sections of S Germany both genera occur together. A preliminary solution might be to regard the probable horizon of Neophyllites as a part of the planorbis Subzone.

In the planorbis Subzone in some regions Psiloceras planorbis s.l. (Ps. psilonotum, Ps. sampsoni and similar forms) occurs earlier than Psiloceras plicatulum s.l., in others (e.g. Germany) these two groups occur together. It might be that there is an overlap of both groups and the earlier horizon without plicatulum is lacking in some regions. It might also be that plicatulum is still rare in the earlier horizon.

Waehneroceras s.l. is an important group of ammonites, but the systematics is partly too little known for stratigraphical purposes. Probably there can be distinguished Waehneroceras s.str. (=Curviceras BLIND 1963) and other "Waehneroceras" by means of the suture line (DONOVAN & BLOOS, in prep.). Waehneroceras s.str. occurs earlier than other "Waehneroceras" the correct name of which seems to be Kammerkarites BUCKMAN (type species Aegoceras diploptychum WAEHNER).

In Germany Caloceras and Waehneroceras s.str. appear together. In England Caloceras appears earlier, but sometimes also together with Waehneroceras. The systematics of Caloceras should be revised in order to distinguish better different horizons. The revision is necessary especially in S Germany where different species occur which are all determined "johnstoni" thus far.

In Germany within "Waehneroceras" there was distinguished besides Curviceras (= Waehneroceras s.str.) Storthoceras (Megastomoceras) and Saxoceras (LANGE 1941). New studies have shown that there exist transitional forms so that it is nearly impossible to find a good boundary between both groups. Therefore both could be comprised in one genus; this might be, as mentioned, Kammerkarites. LANGE's genera might be preserved as subgenera; Saxoceras has stratigraphical significance because it appears later than Storthoceras, in NW Germany together with Alsatites. The stratigraohical sequence of species of Kammerkarites, especially below Alsatites, should be better known in order to characterize this part of the Hettangian in a better way.

Psilophyllites hagenowi is an important index species, at least in Germany. It occurs before the appearance of Alsatites. The beds between the first appearance of Kammerkarites and the first appearance of Alsatites can be regarded as a separate zone sensu ELMI & MOUTERDE 1965 within which Psilophyllites hagenowi characterizes the upper part.

The first appearance of Alsatites in relation to the sequence of Kammerkarites is not certainly known. There seem to be differences between different regions, e.g. France (Ardèche region) and Germany. Also the sequence of species of Alsatites is not sufficiently known. In the Ardèche region Alsatites laqueus appears earlier than the liasicus group, in Germany it appears later. But sometimes both species occur also together (e.g. in Luxembourg).

In NW Germany Schlotheimia angulata appears earlier than Schlotheimia extranodosa. This was confirmed by BUDWILL who collected more than 2000 specimens bed by bed at the locality of Oldentrup. It is the question if this horizon, called "Zone of Schlotheimia amblygonia" by LANGE, can be recognized in other regions, especially in England.

The horizons of Schlotheimia amblygonia and Schlotheimia extranodosa are absent in South Germany; also the ammonite as-

semblage of Schlotheimia complanata in NW Germany is lacking in South Germany. In South Germany the Angulata Zone begins with an assemblage of extraordinary many species of Schlotheimia which was almost completely unknown thus far. Charateristic are especially forms with very densely ribbed inner whorls (generally determined "Schlotheimia striatissima"). These species are all different from those in NW Germany with a few exceptions: Schlotheimia angulosa s.l., Schlotheimia tenuis, Schlotheimia oxygonia. These few species occur in NW Germany in the complanata Subzone. Characteristic in South Germany is the frequency of early Arietitids in the complanata Subzone. There is no doubt that the fauna of the complanata Subzone in South Germany represents another time than the complanata Subzone of NW Germany. The differences are so considerable that one could regard the South German assemblage as a separate subzone. This was indicated already by JÜNGST (1938).

In NW Germany the Angulata Zone ends with the complanata Subzone, sometimes already with the extranodosa Subzone. In South Germany above the complanata Subzone appears a new fauna characterized by Schlotheimia depressa and Schlotheimia marmorea. Arietitids are totally lacking herein. This horizon obviously represents a separate subzone. At the top of this subzone there is a gap which increases from west to east towards the ancient coast. That means the base of the Sinemurian rests on continuously older beds towards east. Therefore the youngest beds of the Angulata zone can be expected in the upper Rhine valley, perhaps also in Lorraine. In England above Schlotheimia complanata appears Schlotheimia pseudomoreana. This assemblage is too little known to be correlated with Germany.

The question of substages in the Hettangian seems not to be of major importance. The easiest compromise is certainly to retain the present solution not to introduce substages. The situation is most similar to that in the Pliensbachian: there is one major break of fauna, that at the base of the Angulata Zone.

In the Hettangian of the Tethyan province the subdivision of the megastoma and the marmorea Zones should be studied. The investigations of LANGE (1952) and BLIND (1963) at the locality of Fonsjoch have yielded different results in the calliphyllum Zone; this should be controlled.

In spite of the large material published by WÄHNER it can

be expected that new localities will yield new forms because the ammonite-bearing Hettangian is condensed and horizons of different age might be represented at different localities (lenticular occurrences).

There is little doubt that in NW Europe there is a more or less large gap between the Hettangian and the Sinemurian. Therefore it might be that in other parts of the world there occur beds which represent parts of this gap. If the fauna of these supposed beds is more of Hettangian or Sinemurian character is of course unknown.

The Sinemurian begins in SW-Germany with an assemblage of Vermiceras spiratissimum, V. rougemonti, Metophioceras brevidorsale, M. longidomus, M. conybearoides, M. latisulcatum, and M. bonnardi. The index species M. conybeari is lacking. At the type locality of the Sinemurian a similar assemblage seems to occur according to the collection in the Musée Municipal at Semur.

In South Germany there is found a sequence of four assemblages between the base of the Sinemurian and the first appearance of Coroniceras rotiforme. At least some of these assemblages occur also in England and France. In England the locality of Nash Point (Glamorgan) seems to be especially suitable for a revision (TRUEMAN 1930).

There are still many open questions on the stratigraphic sequence of Arietitidae which cannot be listed here in all detail. This is true especially in the Semicostatum, Turneri, and Obtusum Zones.

In spite of the conclusion of the colloquy at Luxembourg 1962 to fix the boundary Lower/Upper Sinemurian at the base of the Turneri Zone most stratigraphers follow the definition in DEAN et al. 1961 (base of Obtusum Zone). Since the base of the Obtusum Zone seems to be by far more easily and certainly recognizable than that of the Turneri Zone it seems reasonable to adopt the proposal of DEAN et al. 1962 it had been argued that in the Turneri Zone the Eoderoceratidae occur for the first time. But Microderoceras occurs already in the Semicostatum Zone and Promicroceras not earlier than in the upper part of the Turneri Zone (birchi Subzone). That means that the appearance of the Eoderoceratidae is successive and does not mark a distinct boundary, especially not the base of the Turneri Zone.

The distribution of some groups in the Sinemurian is especially little known. That are e.g. Arnioceras and the Schlotheimiidae.

The Tethyan province has provided rich faunas in some regions; the material of older collections is mostly not horizonted. Such regions should be restudied (e.g. region of La Spezia, Italy).

Every section rich in ammonites can provide new results if intensively studied, independent of listed problems.

Problems of other organisms

Though ammonites provide the most detailed subdivision of the Lower Lias other organisms might be of stratigraphical significance especially in cases in which the ammonites are rare or absent or the samples are too small to provide ammonites. Other organisms were studied especially under the aspect if they are suitable to characterize the Triassic/Jurassic boundary. Questions concerning this complex are excluded here.

Most organisms are rather long-living and seem therefore unsuitable for stratigraphy. Many are additionally dependent on facies. But at least their first appearance could be useful in a restricted area if the appearance is not combined with a change of facies. A good example is the first appearance of Gryphaea in a distinct horizon of the Hettangian in whole South Germany.

A detailed list of problems of the different groups of organisms, micro- and macrofossils, is not given here. This should be better compiled by the specialists. In regions in which ammonites are frequent the study of many other organisms, especially macrofossils was somewhat neglected. But for correlation with regions in which ammonites are rare or absent the study of ammonite-bearing sections is necessary.

Problems of information

For work in stratigraphy informations should be made better available. This could be attained by compilations which are provided by stratigraphers in their respective region of work.

For comparisons of sections with other regions most informative would be drawn profiles in the same scale as far as possible. With indications of the found important fossils such drawn profiles would show the distribution of fossils quickly and also - what seems important - the gaps of record. There should be taken in account also not published profiles, e.g. in theses and archives. Indications where the collected material is kept today would be also important.

Useful would be also compilations of collections with indications on the material, especially of originals. Of interest is also the availability of collections. If collections are not available there should be looked for possibilities to make them accessible for studies.

Another possibility to facilitate stratigraphical work could be compilations of literature on distinct regions. These compilations should contain also such publications which are difficult to obtain and manuscripts in archives, e.g. theses and similar works. Most references exist still in other publications so that it should be not too difficult to obtain such compilations.

References

BLIND, W. (1963): Die Ammoniten des Lias Alpha aus Schwaben, vom Fonsjoch und Breitenberg (Alpen) und ihre Entwicklung.- Palaeontographica, A, 121: 38-131; Stuttgart.

BUDWILL, H. (1960): Die Variabilität einiger Arten von Schlotheimia (Ammonoidea) Norddeutschlands. Unpublished Thesis Univ. Tübingen.

ELMI, S. & MOUTERDE, R. (1965): Le Lias inférieur et moyen entre Aubenas et Privas (Ardèche).- Trav. Lab. Géol. Fac. Sci. Lyon, n. sér., 12: 143-246; Paris.

JÜNGST, H. (1938): Der Pfälzer Lias und seine palaeogeographische Bedeutung.- Mitt. Pollichia, N.F. 7: 145-168; Neustadt an der Weinstrasse.

LANGE, W. (1941): Die Ammonitenfauna der Psiloceras-Stufe Norddeutschlands.- Palaeontographica, A, 93: 1-192; Stuttgart.

-- (1951): Die Schlotheimiinae aus dem Lias alpha Norddeutschlands.- Palaeontographica, A, 100: 1-128; Stuttgart.

-- (1952): Der Untere Lias am Fonsjoch (östliches Karwendelgebirge) und seine Ammonitenfauna.- Palaeontographica, A, 102: 49-162; Stuttgart.

TRUEMAN, A.E. (1930): The Lower Lias (Bucklandi Zone) of Nash Point, Glamorgan.- Proc. Geol. Assoc. London, 41: 148-159; London.

Report of the Pliensbachian Working Group

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The idea to establish working groups is born before the arrangements of the planned and later postponed meeting 1983 at Copenhagen.

In the beginning of 1983 the coordinator of the Pliensbachian working group has send out about eighty letters to persons inquiring about interest for establish a Pliensbachian working group. The result of this inquiry is satisfactory. From about 54 persons the coordinator has received a positive answer. A list of the members has been distributed during the session of the working group at Erlangen.

The activities of the interest persons show a great diversity. Unfortunately the majority has not indicate their current researches so it is impossible in the present time to summarize equivalent interest.

A successfull cooperation within the Pliensbachian working group I see as follows:

It would be a usefull action if everyone presents reference sections of his investigation area with precise indications of the fossil content, collected bed by bed, and lithological data. In realizing a scheme of multidisciplinary stratigraphy it is necessary to summarize all the data. A good example is given in COPE et al. (1980)[1]. This point has been emphasized by the present author at the meeting at Erlangen. In quoting a remark of Prof. Callomon, London, during the session it is of greatest importance to collect all the available data without looking over the shoulders of the colleague. In the present state of the Pliensbachian working group it is not yet the moment to enter into a discussion about special problems.

[1]) COPE, J.C.W. et al. (1980): A correlation of Jurassic rocks in the British Isles. I: Introduction and Lower Jurassic. Spec. Rep. geol. Soc. London, 14, 73 pp.

Report of the Toarcian Working Group

R. Fischer

The Toarcian Working Group had its first meeting during the Erlangen Congress, Wednesday, 29th of August of 1984, at 11 a.m. The convenor gave a report about some problems of Toarcian biostratigraphy (see this volume). It seems, that all these problems should be solved by regional or local teams of experts: elaboration of local standards, of local reference-sections, detailed studies of the ranges of all mayor or important fossil groups in well zonated sections, etc. Of course, in some areas already exist these basic studies, but in general they are only in different stages of progress. To start with the elaboration of an internationally usable Standard Zonation before finishing the local studies would be like to do the second step before the first one. At the moment, the Toarcian zonation proposed by HOWARTH (in DEAN,DONOVAN & HOWARTH 1961)for the NW European Province is used like an international standard. On the one hand this fact is favorable for the maintenance of uniformity in the different attempts of a Toarcian biostratigraphical subdivision. On the other hand this use makes believe in a precision of subdivision and correlation, with really does not exist at all.

The participant of the session of the Toarcian Working Group accepted the proposition of the convenor, to stop the activities of the Working Group in favor of an intensification of local investigation with the aim to elaborate local standards. Only one colleague, Mrs Guy-Ohlsen,Suede, deplored the loss of information about the activities of other Toarcian workers , which is connected with this decision. The content of the status report was not discussed.

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SOME PROBLEMS OF TOARCIAN BIOSTRATIGRAPHY

Rudolf Fischer

Abstract: The actually used biostratigraphic subdivision of the Toarcian stage is discussed. Special emphasis is given to the definition of the base of the Toarcian and of its basal zone, and to its subdivision in substages. Open problems are the zonation of the Tethyan Province and its correlation with the NW European Standard; the determination and caracterisation of "horizons"; the study of the exact ranges of the fossils, which are used for the zonation and the study of the ranges of all other fossil groups in sections, with well known ammonite succession.

In the course of the last 2o years a lot of papers were published, which dealt with the biostratigraphic subdivision of the Toarcian and with the definition of its limits, starting from local or regional stratigraphic field work. The starting-point of this prolific development was the elaboration of the Liassic zonal sequence of the NW European Ammonite Province by DEAN,DONOVAN & HOWARTH 1961. They also proposed a subdivision on the subzonal level, which was slightly modified for the Toarcian by HOWARTH 1973,1978 and 198o. Subsequently this zonation was generally accepted as a Standard Zonation, so that local subdivisions and zonations from other faunal provinces nearly always were correllated or at least compared with this standard. The result is a far reaching conformity in the basic structures of the subdivision of the Toarcian. The acceptance of the subdivision in the sense of a Standard Zonation is also reflected by the contributions of the (really very few) colleagues of the Toarcian Working Group, all of whom never discussed the zonation itsself, which was always used as a basic calender.

Less uniformity exists respective to the subzonal subdivision. An internationally applicable subzonal standard would lead to a generalization without scientific base: little is known about the temporal substitutes of characteristic species or assemblages and about their temporal succession(some attempts: GUEX 1972ff.; ELMI,ATROPS & MANGOLD 1974; GABILLY 1976; WIEDENMAYER 198o; HILLE-

BRANDT & SCHMIDT-EFFING 1981). Finally we have to mention the separation of "horizons" as elementary and undivisible biostratigraphic units (GABILLY 1976). Until now it is nearly impossible to paralize these units for their local character. Toarcian horizons were distinguished e.g. by GABILLY 1976 (Thouars), MOUTERDE 1967 (Portugal), ELMI,ATROPS & MANGOLD 1974 (Algeria), GUEX 1972, 1975 (Causses), and HILLEBRANDT & SCHMIDT-EFFING 1981 (Chile).

Speaking of the problems of Toarcian biostratigraphy we have to start with an aspect, which is statutary duty of the Stratigraphic Commission, that is the definition of stages and substages by means of the characterization of the base of these units. Without discussing the older literature, the base of the Toarcian was defined by "the first appearance of Dactylioceras in abundance" by HOWARTH (in DEAN,DONOVAN & HOWARTH 1961) and, additionally, by the anterior extinction of Pleuroceras and of the Amaltheids in general, mentioned by HOWARTH too, although the extinction of organisms can not be used in a formal definition of stratigraphical units.

The Dactylioceratids were focussed by a lot of paleontologic and stratigraphic papers (FISCHER 1966; DAGIS 1968; SCHMIDT-EFFING 1972; GUEX 1971 ff.; HOWARTH 1973,1975,1978; PINNA & LEVI SETTI 1971; FANTINI SESTINI 1975; WIEDENMAYER 1977,1980) so that it seems possible to make exact indications of their appearance at the Domerian/Toarcian boundary (fig.1). Certainly, the compilation is difficulted by the fact, that nearly each one of the above named authors has a different opinion about the taxonomy of the Dactylioceratids.

Dactylioceras (Eodactylites) in the sense of SCHMIDT-EFFING 1972 appears with various species at the base of the Toarcian. It is important part of the groups of "Sicilian Dactylioceratids", described by FUCINI 1935, which are the typical fauna of the lowest mediterranean Toarcian (see WIEDENMAYER 1980 for a detailed discussion).

Although the majority of the species of D.(Eodactylites) are of of the Mediterranean Province, some of them exist in the boreal province too. They confirm the basal Toarcian age. D.simplex was recently described by SCHLATTER 1982 out of the uppermost carbonate layer of the so called spinatum-beds of the Klettgau

(N.Switzerland), were it occurs together with the Pleuroceras ex gr.hawskerense. Following the stratigraphic rules, SCHLATTER decides, that the first appearance of his Dactylioceras has to mark the beginning of the Toarcian. Another species is D.(Eodactylites) pseudocommune, which characterizes the base of the Toarcian in England (HOWARTH 1973), as in the Northern (FISCHER 1966) and the Southern Calcareous Alps (WIEDENMAYER 198o) as well. WIEDENMAYER 198o mentions additionally the D.(Eodactylites) polymorphum as a species, which occurs outside of the Mediterranean too (see also foot-notes of fig.1).

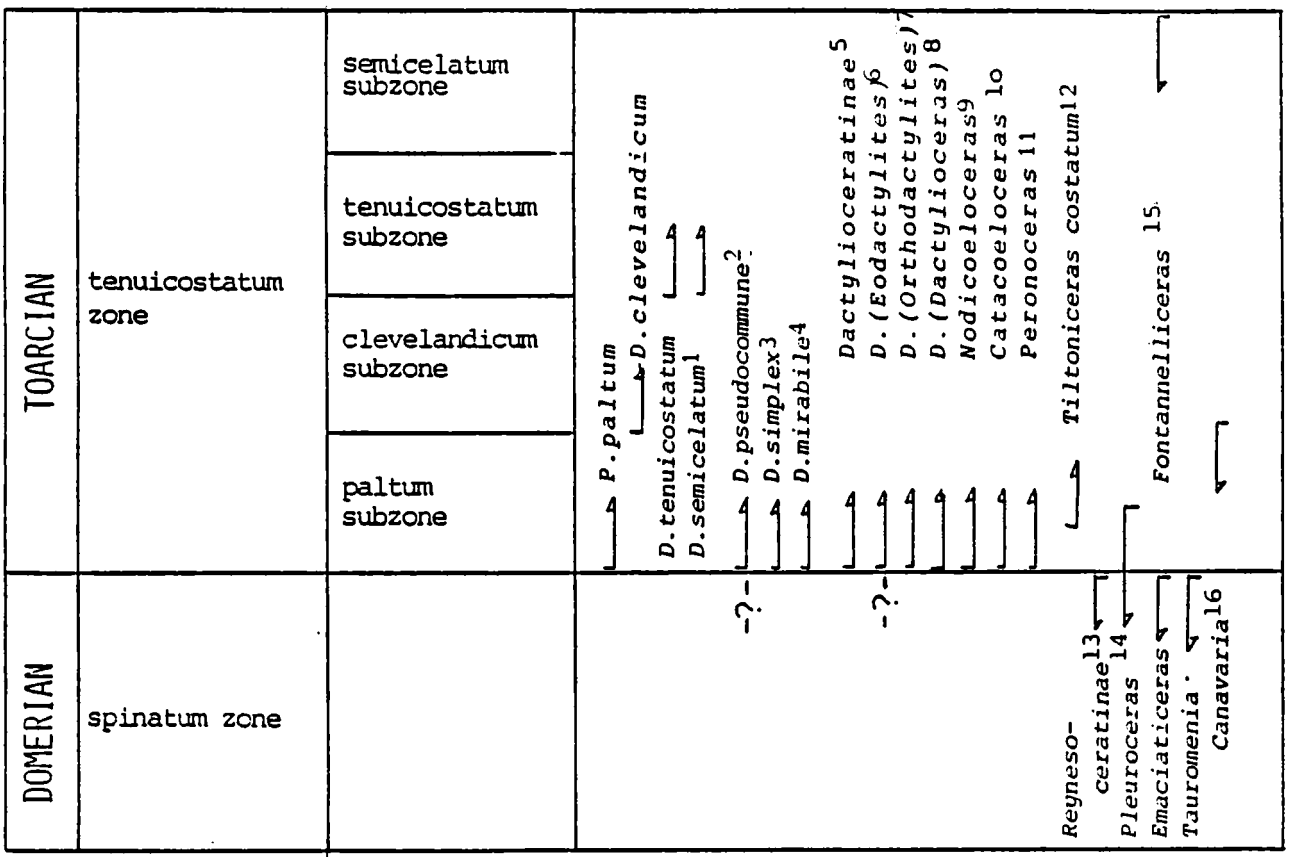

Fig.1 Appearance and disappearance of important ammonites at the Domerian/Toarcian boundary.

1) Appearance of D.Semicelatum just above the Clevelandicum Subzone is most recently reportet by RIEGRAF,WERNER & LÖRCHER 1984.

2) SCHMIDT-EFFING 1972:92 reports the species from the "spinatum-beds" of the SW German Lias δ, and supposes Domerian age for it. According to SCHLATTER 1982 the uppermost layer of the spinatum-bed of the neighbouring Klettgau is already of Toarcian age. Not knowing the exact horizon of SCHMIDT-EFFING's ammonite, the supposed Domerian age is uncertain.

3) comp.SCHLATTER 1982; HILLEBRANDT & SCHMIDT-EFFING 1981; WIEDENMAYER 198o.

4) After GUEX 1973; ELMI,ATROPS & MANGOLD 1974; WIEDENMAYER 198o.

5) Sensu WIEDENMAYER 198o.

6) Sensu SCHMIDT-EFFING 1972. D.(Eodactylites) is a constituent subgenus of the Sicilian Dactylioceratid fauna. The supposed Domerian age of some species is doubtful (see 2)).

7) Sensu SCHMIDT-EFFING 1972 and HOWARTH 1973.

8) Discussion see in the text. Despite of the first appearance of the subgenus at the base of the Toarcian, the number of species become abundant above the Tenuicostatum Zone (comp. HOWARTH 1978:252).

9) Discussion see in the text.

1o) Sensu WIEDENMAYER 198o.

11) Sensu WIEDENMAYER 198o. The author describes P.cf.verticosum from the base of the Tenuicostatum Zone (p.8o, 166).

12) See GABILLY 1976, fig.4.

13) Sensu WIEDENMAYER 198o.

14) SCHLATTER1982; RIEGRAF,WERNER & LÖRCHER 1984.

15) + 16): BRAGA,JIMENEZ & RIVAS 1983. For Emaciaticeras, Tauromenia, and Fontannelliceras see also WIEDENMAYER 198o.

Dactylioceras (Orthodactylites) sensu HOWARTH 1973 and SCHMIDT-EFFING 1972 starts at the base of the Toarcian (comp.collections by HOWARTH 1973; GABILLY 1976; MOUTERDE 1967; RIEGRAF,WERNER & LÖRCHER 1984). The range of D.(Orthodactylites) helianthoides YOKOYAMA seems problematic. It is a characteristic species of the Japanese Nipponicum Zone, which is thought to start in the Upper Domerian (HIRANO 1973). Outside of Japan the D.helianthoides is only reported from the Toarcian Tenuicostatum Zone (WIEDENMAYER 198o; SCHMIDT-EFFING 1972).

Dactylioceras (Dactylioceras) in the sense of SCHMIDT-EFFING 1972 is another subgenus with appears in the lowest Toarcian, from where it is reportet e.g. by JIMENEZ & RIVAS 1981, BRAGA,JIMENEZ & RIVAS 1983, and WIEDENMAYER 198o (his indications are not totally comparable because of the author's different concept of the subgenus). In the Appennines appears D.(Dactylioceras) together with D.(Orthodactylites), marking the base of the Toarcian (FANTINI SESTINI 1975).

The genus *Nodicoeloceras* is said to start with the Falciferum Zone, as GUEX 1972,1973 and WIEDENMAYER 189o stated. FISCHER 1966 and SCHMIDT-EFFING 1972 mention Nodicoeloceras from the basal Toarcian.

WIEDENMAYER 198o:166 himself cannot exclude a phylogenetic connection of Nodicoeloceras with the Domerian Aveyroniceras. If this hypothesis would be verified, we have to expect species of Nodicoeloceras in the basal Toarcian.

Also the genus *Catacoeloceras* is connected with Aveyroniceras by WIEDENMAYER 198o. The author postulates a probable first appearance already at the top of the Hawkerense Subzone of the Domerian. Other cites of lowest Toarcian finds of Catacoeloceras are mentioned by SCHMIDT-EFFING 1972 and IMLAY 1981.

The genus *Peronoceras*, outside of the Tethyan realm accepted as a genus which starts after the Tenuicostatum Zone seems to appear in the lowest Toarcian too (WIEDENMAYER 198o:8o). Possibly it does not begin exactly at the base of the Toarcian, because Peronoceras is not present in the Sicilian Dactylioceratid fauna.

The other Dactylioceratid genera appear for the forst time in higher zones of the Toarcian. Finally it has to be mentioned, that if we accept the definition of the Dactylioceratinae sensu WIEDENMAYER 1977,198o the appearance of the whole subfamily characterizes the beginning of the Toarcian.

Remaining at the level of higher taxonomic categories, there exists no group of ammonites, which marks the Domerian/Toarcian boundary as clear as the Dactylioceratinae. This applies especially to the Harpoceratinae and Hildoceratinae, groups which are frequent and which contain species of stratigraphic value during the Middle and Upper Lias. Their phylogenetic development shows no significant cut. On the one hand frequent genera of the Domerian continue in the Toarcian (Protogrammoceras, Fontannelliceras, Lioceratoides, Neolioceratoides, Harpoceratoides, Canavaria)on the other hand those genera which are typical of the Toarcian, already start in the Domerian (Hildaites, Orthildaites, Polyplectus, Mercaticeras; comp.BRAGA 1983; WIEDENMAYER 198o).

In spite of the fact, that the extinction of organisms cannot be used for the definition of unit-boundaries, it may be allowed to insist for a moment on this problem, particularly because until more recent days (DEAN,DONOVAN & HOWARTH 1961; HOWARTH 1973; GABILLY et al.1971:7) was postulated, that the Toarcian has to begin immediately above the highest Pleuroceras. Reviewing recent literature, Pleuroceras does not seem to disappear completely at the end

of the Domerian, even though its frequency is drastically reduced at this boundary. SCHLATTER 1982 described the coexistence of Dactylioceras simplex and of Pleuroceras in the same bed and RIEGRAF,WERNER & LÖRCHER 1984 (p.19,fig.17) observed Pleuroceras persisting in the Toarcian Paltum Subzone of S Germany. Some of the Hildoceratids of the Mediterranean disappear at the end of the Domerian, but a profound cut is not observable. This exists again only in the Dactylioceratids, observable by the extinction of the whole subfamily Reynesoceratinae sensu WIEDENMAYER 1977.

On the lookout for the basal zone of the Toarcian, which would be the zone defining the lower boundary of the whole stage, the study of the literature seems to present no problem. Nearly unanimously this unit is named Tenuicostatum Zone. This zone is to be understood as an OPPEL zone (see HÖLDER & ZEISS 1972; = "Zone sensu abstracto" HÖLDER 1964 or GECZY 1964), because the index species really only occurs in the upper part of the unit (comp.HOWARTH 1973, GABILLY 1976). Additionally, D.tenuicostatum is a species restricted to the "boreal" province, where it is not generally frequent and often substituted by D.semicelatum (e.g.GABILLY 1976, RIEGRAF,WERNER & LÖRCHER 1984; MAUBEUGE 1957; HOFFMANN 1968).

HOWARTH 1973:267 proposed a division of the Tenuicostatum Zone into 4 subzones, based on detailed studies of Yorkshire sections (fig.2). These units, the Paltum, Clevelandicum, Tenuicostatum, and Semicelatum Subzones are understood in senu concreto. The beginning of the Toarcian has therefore to be defined with the first appearance of Protogrammoceras ("Paltarpites" auctt., BRAGA 1983) paltum and of ammonites associated and contemporaneous with ist. P.paltum exists together with first Dactylioceratids at the base of the Toarcian in England (HOWARTH 1973), France (GABILLY 1976), Spain (MARIN & TOULOUSE 1972) and S Germany (RIEGRAF,WERNER & LÖRCHER 1984).The finds of"Paltarpites cf. paltus"described by MAUBEUGE & RIOULT 1964 from Luxembourg are probably of the same age. In the Mediterranean Province, where the "boreal" species P.paltum does not seem to exist, the basal Toarcian is characterized too by associations of Dactylioceras and Protogrammoceras (discussed by WIEDENMAYER 198o). Despite the differences in the species composition of basal Toarcian ammonite faunas in the Mediterranean province and outside of it, some common species exist (see above, discussion of D.(Eodactylites)).

The lowest subunit of the Tenuicostatum Zone is named differently

in different areas, because the Subzones should be named in sensu concreto. In N Africa a Mirabile Subzone is used (COLO 1961; GUEX 1972; ELMI,ATROPS & MANGOLD 1974). In Spain a Polymorphum Zone nearly substitutes the Tenuicostatum Zone; its lower part, A, is characterized by abundant D.(Eodactylites) species besides different species of Protogrammoceras, Canavaria and Lioceratoides

TOARCIAN	tenuicostatum zone	semicelatum						
		tenuicostatum	semicelatum	Tiltoniceras capillatum	semicelatum	horizon à semicelatum	B	tenuicostatum
		clevelandicum			clevelandicum		polymorphum	7
			1			5	6	simplex
		paltum	paltus	Lobolytoceras siemensi	paltum / 3 simplex	horizon à mirabile	A	
DOMERIAN		HOWARTH 1973 Yorkshire HOWARTH 1980 Standard subzonation	GABILLY 1976 Thouars y Centre-Ouest de la France	HOFFMANN 1968 NW Germany 2	RIEGRAF,WERNER,LÖRCHER 1984 S Germany 4 SCHLATTER 1982 Klettgau	ELMI,ATROPS, MANGOLD 1974 Algeria	JIMENEZ & RIVAS 1979 Cordillera Subbética	HILLEBRANDT & SCHMIDT-EFFING 1981 Chile

Fig.2 Zones and subzones at the base of the Toarcian

1) For the associations of ammonites indicated by GABILLY 1976:26 for the"horizon à Paltus"(I) and the "horizon à Semicelatum" (II) the limit between them coincides with the base of the Clevelandicum Subzone of the Standard Zonation.

2) First attempt of a subzonation of the lowest Toarcian in NW Germany. Presented only for historical reasons. The subdivision reflects a very local vertical distribution of the two naming species.

3) SCHLATTER 1982 uses Simplex Subzone for naming the basal Toarcian of the Klettgau.

4) RIEGRAF,WERNER & LÖRCHER 1984 have prooved P.paltum at the base of the SW German Toarcian. The Clevelandicum Zone is represented by D.(Orthodactylites) crosbeyi.

5) The Mirabile Horizon, established by GUEX 1973 as Mirabile Subzone, coincides probably only with the lowest Standard Subzone because of the Sicilian Dactylioceratids contained in it.

6) Part A of the Polymorphum Zone contains ammonite assemblages comparable with the faunas of the N.African Mirabile Subzone (BRAGA,JIMENEZ & RIVAS 1983).

7) Fixation of the limit by the authors. Discussion in the text.

(MOUTERDE,BUSNARDO & LINARES 1971; RIVAS 1972; BRAGA,JIMENEZ & RIVAS 1983). Finally HILLEBRANDT & SCHMIDT-EFFING 1981 introduced the Simplex Subzone for the lowest Toarcian of Chile. The name was adopted by SCHLATTER 1982 to name the lowest unit of the Klettgau Toarcian. The contemporaneity of the lower boundary of all these units was discussed by WIEDENMAYER 198o; supplementary information was given by BRAGA,JIMENEZ & RIVAS 1983). On the other hand it is uncertain, how far up into the Tenuicostatum Zone these units reach, in comparison to the subzonal sequence proposed by HOWARTH 1973 (comp.annotations to fig.2). It seems, that there are differences as well in the range of the same unit, but described from different regions.

SCHLATTER 1982 shows, that the Toarcian of the Klettgau starts with the Simplex Subzone, understood by him as equivalent of the Paltum Subzone of the Standard Subzonation. HILLEBRANDT & SCHMIDT-EFFING 1981 on their part mention ammonites from their Simplex Zone, which are typical for the Clevelandicum Subzone and they give their Simplex Subzone a range comparable with two subzones of the Standard (Paltum and Clevelandicum Subzone).

The problem of the correlation of subzones, established in different areas, is not only restricted to the Paltum Subzone, but is to be considered in the same manner for all other subzones of the Toarcian, a field, worth further studies.

HILLEBRANDT & SCHMIDT-EFFING 1981 and SCHLATTER consider it incorrect (SCHLATTER:unscientific!) to count Mirabile and Simplex units as subzones of the Tenuicostatum Zone, because the index species never was found in them. The first authors even believe, that it would be more correct to abandon the name Tenuicostatum Zone as the basal unit of the Toarcian and to substitute it by another Zone, named in sensu concreto. But as no serious doubt exists about the fact, that all the mentioned units mark the beginning of the Toarcian, it would appear favorable for the sake of taxonomic uniformity and stability to conserve the term Tenuicostatum Zone in the sense of a OPPEL,or Standard, or Biochrono Zone and to maintain the concrete units at the level of subzones.

Discussing the base of the Toarcian, it has to be mentioned, that after a study of a Japanese ammonite bearing section HIRANO 1973 introduced a Nipponicum Zone. HIRANO 1973:59

correlates this zone with the Upper Domerian Hawskerense Subzone, the Tenuicostatum Zone and the Exaratum Subzone of the NW European Standard Zonation. He repeats this opinion in a written contribution to the Toarcian Working Group. It must be stated that in Japan the base of the Toarcian cannot be defined at present.

A question of minor importance but forming part of the "official" duties of the Subcommission is the subdivision of the Toarcian in substages and the definition of their lower limits (fig.3). The relevant literature consists of a few cites (HOWARTH 1961 in DEAN, DONOVAN & HOWARTH 1961; MONESTIER 1922; ELMI 1967; GUEX 1972; ELMI, ATROPS & MANGOLD 1974; GABILLY 1976' : two principally possible subdivisions in 2 or 3 substages are presented.

Zonation by DEAN, DONOVAN, HOWARTH 1961	Subzones by HOWARTH 1980	HOWARTH 1961	HOWARTH 1962		GABILLY 1976		sous-zones
levesquei	P.aalensis	Upper Toarcian = Yeovilian	Yeovilian	Upper Toarcian	Yéovilien	Toarcien supérieur	buckmanni aalensis macura pseudoradiosa levesquei
	D.moorei						
	D.levesquei						
	Ph.dispansum						insigne
thouarsense	P.fallaciosum						fallaciosum
	G.striatulum						fascigerum thouarsense bingmanni
variabilis			Whitbian	Middle Toarcian	Whitbien	Toarcien moyen	vitiosa illustris variabilis
bifrons	C.crassum	Lower Toarcian = Whitbian					semipolitum bifrons sublevisoni
	P.fibulatum						
	D.commune						
falciferum	H.falciferum			Lower Toarcian		Toarcien inférieur	falciferum strangewaysi
	H.exaratum						
tenuicostatum	D.semicelatum						semicelatum costatum
	D.tenuicostatum						
	D.clevelandicum						
	P.paltum						

Fig.3 Attempts of defining substages of the Toarcian stage.

The bipartition is discussed by HOWARTH 1961, who subdivides into Lower Toarcian and Upper Toarcian, putting them in synonymy with Whitbian and Yeovilian. The base of the latter is defined by the Variabilis Zone. In 1962, in occasion of the 1st Jurassic Colloquium at Luxembourg, HOWARTH presented an alternative subdivision, connecting the bipartite and tripartite schemes. In the first one the Yeovilian starts with the Thouarsense Zone. So the Whitbyan recieves the duration originally proposed by BUCKMAN 1910. The second scheme, proposing the tripartition in Lower, Middle, and Upper Toarcian, corresponds with a subdivision, which was originally attempted by GLANGEAUD 1895 and elaborated more consequently by MONESTIER 1921 (comp.GABILLY 1976). The base of the Middle Toarcian is defined by the Bifrons Zone, the base of the Upper Toarcian is given by the Thouarsense Zone. GABILLY 1976 after studying the type sections of Thouars also uses MONESTIER's tripartition and defines the limits with the basal subzones of each substage. GABILLY shows that these limits are arbitrary and do not coincide with cuts in the evolution of Toarcian ammonites. In general, it can be said that the definition of formal substages of the Toarcian does not seem to be of fundamental interest.

A survey of the literature and of the written contributions to the Toarcian Working Group, which I recieved directly (BRAGA,GUEX,HILLEBRANDT,HIRANO,JIMENEZ JIMENEZ, KNITTER, OHMERT, POPA, RIEGRAF, RIVAS, SIVHED) or by mediation of O.MICHELSEN (AVRAM,BENPEI,CARRERA, CUBAYNES, HERNGREEN, IVIMEY-COOK,JORDAN,KRYMGOLTZ, MOUTERDE, TSAGARELI, URLICHS, VAKHRAMEEV) permits to deduce a series of additional unsolved problems which I wish to list at the end of this report.

-- Zonation of the Upper Toarcian (sensu HOWARTH 1961): In comparison with the generally accepted subdivision of the Lower Toarcian into three zones (Tenuicostatum, Falciferum or Serpentinus, Bifrons), the zonation of the Upper Toarcian is not so uniform. The NW European Standard Zonation distinguishes 3 zones (Variabilis, Thouarsense, and Levesquei), however in the area of Central France 5 zones are recognized (Variabilis,Thouarsense, Insigne, Pseudoradiosa, Aalensis).

---Zonation of the Tethyan Province: In spite of several attempts to establish a zonation of the Toarcian (comp.FLMI , ATROPS & MANGOLD 1974,fig.10) a satisfying solution still does not exist, in particular for the part above the Bifrons

zone. A finer subdivision into subzones for the whole Toarcian lacks completely. The reconnaissance of "horizons" is still in leading strings.

--- Correlation of zones and subzones of different provinces: a lot of correlation tables exist, which compare local subdivisions mainly with the NW European Standard Zonation. The precision of the correlation needs to be improved. For a more precise correlation we need not only the simple identification of a certain zone by determination of an index fossil or its supposed substitute, but it necessary to know the exact succession of single ammonite species and of their assemblages. Also the correlation tables, sent to the Working Group, brought no progress, because they coincided with the already published ones.

--- Determination of horizons: the reconnaissance of horizons with their characteristic ammonite assemblages (e.g."Sicilian Dactylioceratids") seems to be a great help for a more exact correlation.

--- Range of ammonite genera: the worldwide studies would be better comparable, if more descriptions of typical sections (bed by bed, horizon by horizon) would exist (comp. HOWARTH 1973 or GABILLY 1976).

--- Range of other organisms: the biostratigraphic use of non-ammonite invertebrates is very restricted. With few exceptions only local studies have been made. A lot of micropaleontological groups (Radiolarians, Nannoplancton, Ophiurans, Holothurians, Sporomorphs) have not yet reached the level of knowledge which the Toarcian biostratigrapher expects. Most desirable would be the study of non-ammonite organisms in sections of which the ammonite succession is well known (e.g.KNITTER & OHMERT 1983: ammonites/ostracods; RIEGRAF,WERNER & LÖRCHER 1984:ammonites/belemnites).

--- Synoptic tables: As an important aim of Toarcian Working Groups I personally would think of the compilation of synoptic tables which present the biostratigraphic datas of all studied organisms from the stage. In order to reach this aim we need at first the collaboration of local/national specialists in common projects.

All cites of the text are listed here. It is not a complete catalogue of papers over Toarcian biostratigraphic studies.

BRAGA ALARCON, J.C.(1983): Ammonites del Domeriense de la Zona Subbética (Cordilleras Béticas, Sur de España).-- 41o pp., 197 figs., 16 pls:, Granada (Fac.de Ciencias, Tesis Doctoral).

BRAGA, J.C.; JIMENEZ JIMENEZ, A.P. & RIVAS, P.(1982):Los Hildoceratidae del tránsito Domerense-Toarciense de la Zona Subbética (Cordilleras Béticas, S. de España).--Bol.R.Soc.espan. Hist.Nat.(Geol.),80:133-152,5 figs., 2 pls., Madrid.

COLO, G. (1961): Contribution à l'étude du Jurassique du Moyen-Atlas septentrional.-- Not.Mém.Serv.géol.Maroc,39,226 pp., 28 figs., Rabat.

COPE, J.C.W. et al. (198o): A correlation of Jurassic rocks in the British Isles. Part One: Introduction and Lower Jurassic.-- Geol.Soc.,Spec.Rep.,14,73 pp., 1o figs., London.

DAGIS, A.A.(1968): (Toarskie ammonity (Dactylioceratidae) Severa Sibiri).-- Akad.Nauk SSSR, Sibirsk Otdj., 4o,1o8 pp., 29 figs., 12 pls., Moscou (in Russian)

DEAN, W.Th.; DONOVAN, D.Th. & HOWARTH, M.K.(1961): The Liassic ammonite zones and subzones of the North-West European province.-- Bull.brit.Mus.(Nat.Hist.),Geol., 4,1o:437-5o5, pl.63-75, London.

ELMI, S.(1967): Le Lias supérieur et le Jurassique moyen de l'Ardèche.-- Doc.Lab.Géol.Fac.Sci.Lyon,19,1-3:1-845, 2o6 figs., 17 pls., Lyon.

ELMI, S.; ATROPS, F. & MANGOLD, C. (1974):Les zones d'ammonites du Domérien-Callovien de l'Algérie occidentales. Première partie:Domérien-Toarcien.-- Docum.Lab.Géol.Fac.Sci.Lyon,61: 1-84, 17 figs., 6 pls., Lyon.

FANTINI SESTINI, N. (1975): Dactylioceratidae (Ammonoidea) del Domeriano.-- Riv.ital.Paleont.,81,4:437-476, pl.5o-52, Milano.

FERRETTI, A. (197o): Il limite Domeriano-Toarciano nei gruppi montuosi del Nerone e del Catria (Appennino Marchigiano).-- Riv.ital.Paleont.,76,3:445-462, pl.35-36, Milano.

FISCHER, R. (1966): Die Dactylioceratidae (Ammonoidea) der Kammerker (Nordtirol) und die Zonengliederung des alpinen Toarcien.-- Abh.bayer.Akad.Wiss.,math.naturwiss.Kl.,N.F.126,83 pp., 4 figs., 5 tabs., 6 pls., München.

FUCINI, A. (1935):Fossili domeriani dei dintorni die Taormina.V.-- Paleontogr.ital.,35:85-1oo, pl.8-11, Pisa.

GABILLY, J. (1976) Le Toarcien à Thouars et dans le Centre-Ouest de la France. Biostratigraphie-evolution de la faune (Harpoceratinae, Hildoceratinae).-- Les Stratotypes français 3, 217 pp., 52 figs., 29 pls., Paris.

GABILLY, J. et al. (1971): Toarcien.-- C.R.somm.Séanc.Soc.géol. France,1971,fasc.6:82-84, Paris.

GARCIA-GOMEZ,R. & RIVAS,P.(198o):Pseudogrammoceras (Hildoceratacea,Ammonoidea) del Toarciense Medio y Superior de las Cordilleras Béticas (Andalucia, España).-- Estud.geol.,36:263-274, 3 pls., Granada.

GECZY, B.(1964):Szint,Eltszint,Idöszint,Zone, Biozone,Chronozone.- Földtani Közlöny 94:132-135, Budapest.

-- (1966): Upper liassic Dactylioceratids of Urkut.--Acta geol. 1o,3-4:427-443, 2pls., Budapest.

GRUPO ESPAÑOL DEL MESOZOICO (1978): Guia de las excursiones al Jurásico de la Cordillera Ibérica.-- Madrid (Dpto de Paleontología)

GUEX, J.(1971): Sur la classification des Dactylioceratidae (Ammonoidea) du Toarcien.-- Eclogae geol.Helv.,64,2:225-243,1 fig., 1 tab., 3 pls., Bâle.

-- (1972): Aperçu biostratigraphique sur le Toarcien inférieur du Moyen Atlas marocain et discussion sur la zonation de ce sous-étage dans les séries méditerranéennes.-- Eclogae geol. Helv.,66,3:493-523, 4 figs., 15 pls., Bâle. (1972a)

-- (1972): Répartition biostratigraphique des ammonites du Toarcien moyen de la bordure sud des Causses (France) et révision des ammonites décrites et figurées par MONESTIER (1931).-- Eclogae geol.Helv.,65,3:611-645, 2 fig., 13 pls., Bâle. (1972b)

-- (1973):Dimorphisme des Dactylioceratidae du Toarcien.-- Eclogae geol.Helv.,66,3:545-583,47 figs., 3 pls., Bâle.

-- (1975): Description biostratigraphique du Toarcien supérieur de la bordure sud des Causses (France).-- Eclogae geol.Helv., 68.1:97-129, 4 figs., 12 pls., Bâle.

HILLEBRANDT, A.v.(1982):Faunas de amonites del Liásico Inferior y Medio (Hettangiano hasta Pliensbachiano) de América del Sur (excluyendo Argentina).-- In:Comité Sudamericano del Jurásico y Cretácico (Ed.):Cuencas sedimentarias del Jurásico y Cretácico de América del Sur, 2:499-538, 1o pls, Buenos Aires.

HILLEBRANDT, A.v. & SCHMIDT-EFFING, R.(1981): Ammoniten aus dem Toarcium (Jura) von Chile (Südamerika).Die Arten der Gattungen Dactylioceras, Nodicoeloceras, Peronoceras und Collina.-- Zitteliana 6:1-74, 26 figs., 8 pls., München.

HIRANO, H. (1971): Biostratigraphic study of the Jurassic Toyora Group. I.--Mem.Fac.Sci.Kyushu Univ., Ser.D, Geol.,21,1:93-128, 7 figs., 4 tabs., pl.14-2o, Fukuoka.

-- (1973):(same title) II.-- TransProc.paleont.Soc.Japan,N.S. 89:1-14, 2 figs., pl.1-4, Tokyo.

-- (1973):(same title) III.-- Trans.Proc.paleont.Soc.Japan, N.S.9o:45-71, 4 figs., pl.9-1o, Tokyo.

HÖLDER, H. & ZEISS, A.(1972):Zu der gegenwärtigen Diskussion über Prinhipien und Methoden der Stratigraphie.-- N.Jb.Geol.Paläont.,Mh 1972:385-399, Stuttgart.

HOFFMANN, K.(1966):Die Stratigraphie und Paläogeographie der bituminösen Fazies des nordwestdeutschen Oberlias (Toarcium).- Beih.geol.Jb.,58:443-498, 4 figs., 1 tab., 3 pls., Hannover.

-- (1968): Neue Ammonitenfunde aus dem tieferen Unter-Toarcium (Lias ε) des nördlichen Harzvorlandes und ihre feinstratigraphische Bedeutung.-- Geol.Jb.,85:1-35, 5 pls., Hannover.

HOWARTH,M.K.(1973):The stratigraphy and ammonite fauna of the Upper Liassic Grey Shales of the Yorkshire Coast.-- Bull. brit.Mus.(Nat.Hist.),Geol.,24,4:235-277, 5 figsv, 9 pls., London.

-- (1975):The shell structure of the Liassic ammonite family Dactylioceratidae).-- Bull.brit.Mus.(Nat.Hist.),Geol.26,2: 66 pp., 1o pls., London.

-- (1978):The stratigraphy and ammonite fauna of the Upper Lias of Northamptonshire.-- Bull.brit.Mus.(Nat.Hist.),Geol.Ser., 29,3:235-288, 5 figs., 9 pls., London.

-- (198o): Toarcian correlation chart.-- In:COPE,J.W.C. et al.: A correlation of Jurassic rocks in the British Isles. Part One:Introduction and Lower Jurassic. Geol.Soc.Spec.Pap.14: 53-59, fig.1o, London.

IMLAY, R.W. (1981): Early Jurassic ammonites from Alaska.-- Geol. Surv.prof.Pap.,1148:IV+49 pp., 14 figs., 7 tabs., 12 pls., Washington.

JIMENEZ, A.P. & RIVAS, P. (1981): El Toarcense de la Zona Subbética.-- Cuad.geol.Univ.Granada 1o:379-411, Granada.

KNITTER, H. & OHMERT, W.(1983): Das Toarcium an der Schwärze bei Badenweiler (Oberrheingebiet S Freiburg).-- Jh.geol.Landesamt Baden-Württemberg 25:233-281, 6 figs., 5 pls., Freiburg.

MARIN, Ph. & TOULOUSE, D. (1972):Le Lias du Nord de la province de Teruel (Espagne):précisions d'ordre chronoestratigraphique.-- C.R.Acad.Sci.Paris,274:3356-3358, Paris.

MAUBEUGE, P.L.(1957): Les ammonites de la zone à Dactylioceras semicelatum-tenuicostatum dans l'est de la France et plus spécialement dans le Grand-Duché de Luxembourg.--Arch. Sect.Sci.Inst.Grand-Ducal, N.S.34:189-226, 3o pls., Luxembourg.

MAUBEUGE, P.L. & RIOULT, M. (1964): Présance de Paltarpites dans le Lias du Grand-Duché de Luxembourg.-- Inst.grand-ducal Luxembourg, Sect.Sci.nat.phys.math.,Arch.3o, N.S., p.1o7-113, 7 figs., Luxembourg.

MONESTIER, J. (1921): Sur la stratigraphie paléontologique du Toarcien inférieur et du Toarcien moyen dans la région SE de l'Aveyron.-- Bull.Soc.géol.France, (4),21:322-344, Paris.

MOUTERDE, R. (1967):Le Lias du Protugal. Vue d'ensemble et division en zones.-- Com.Serv.geol.Portugal,52:2o9-226, 1 fig., Lisboa.

-- (1971): Le Lias du Portugal. Vue d'ensemble et division en zones.-- Mém.B.R.G.M.,75:537-546, 1 fig, Paris.

MOUTERDE, R.; BUSNARDO, R. & LINARES, A.(1971):Le Domérien supérieur dans le Subbétique Central (Andalousie). (Données préliminaires).-- Cuad.Geol.Iber.2:237-254, Madrid.

MOUTERDE, R. et al. (1971) Les zones du Jurassique en France.-- C.R.somm.Soc.géol.France, 1971,6:76-1o3, Paris.

OPPEL, A.(1856-58):Die Juraformation Englands, Frankreichs und des südwestlichen Deutschlands.-- IV+857 pp., 1 map , Stattgart (Ebner & Seubert).

PINNA, G. & LEVI SETTI, F. (1971):I Dactylioceratidae della provincia mediterranea (Cephalopoda, Ammonoidea).-- Mem.Soc. ital.Sci.natur.Mus.civ.Stor.natur.Milano,19,2:49-136, 21 figs., 12 pls., Milano.

RIEGRAF, W.; WERNER, G. & LÖRCHER, F.(1984):Der Posidonienschiefer. Biostratigraphie, Fauna und Fazies des südwestdeutschen Untertoarciums (Lias ε).-- 195 pp., 5o figs., 12 pls., Stuttgart (Enke).

RIVAS, P.(1972): Estudio paleontológico estratigráfico del Lias en el sector central de las Cordilleras Béticas.-- Tesis Doctoral, Univ. Granada (Resumen de 77 pp).

SCHLATTER, R. (1982): Zur Grenze Pliensbachian-Toarcian im Klettgau (Kanton Schaffhausen, Schweiz).-- Eclogae geol.Helv., 75,3:759-771, 1 fig., 1 pl., Bâle.

SCHMIDT-EFFING, R.(1972):Die Dactylioceratidae, eine Ammoniten-Familie des unteren Jura.-- Münster.Forsch.Geol.Paläont., 25/26,255pp., 31 figs., 7 tabs., 19 pls., Münster.

URLICHS, M.(1977):The Lower Jurassic in Southwestern Germany.-- Stuttgarter Beitr.Naturk.(B),24,41 pp., 11 figs., 2 tabs., 5 pls., Stuttgart.

WIEDENMAYER, F. (1977):Die Ammoniten des Besazio-Kalks (Pliensbachian, Südtessin).-- Schweiz.paläont.Abh.,98,169 pp., 19 figs., 2 tabs., 19 pls., Basel.

-- (198o): Die Ammoniten der mediterranen Provinz im Pliensbachian und unteren Toarcian aufgrund neuer Untersuchungen im Generoso-Becken (Lombardische Alpen).-- Denkschr. schweiz.naturforsch.Ges.,93:261 pp.f 56 figs., 34 pls., Basel.

Report of the Aalenian Working Group

H. Rieber

The session of the Aalenian working group took place Thursday, 6 September, 8.30 a.m. It was directed by H. Rieber, who acted as substitute for D. CONTINI, the coordinator of the Aalenian working group.

H. Rieber started the session with commenting a table, in which the succession of zones, subzones and horizons of the Aalenian and lowermost Bajocian of France and the British Isles were listed according to some recent papers.

He pointed out especially that most French and German authors use the term comptum (sub)zone instead of scissum subzone of British authors. French and German authors used comptum zone because Tmetoceras scissum and the other species of Tmetoceras are no good guide fossils. They are too rare or completely missing in France and Germany.

Furthermore it was stated that the obviously large intraspecific variability of the species of the Graptoceratidae and of the Hammatoceratidae make the determination of single specimens often very difficult or nearly impossible.

The problem concerning the position of the lower and upper boundary of the Aalenian stage were only mentioned shortly.

Finally it was stated that there is still neither enough knowledge on the taxonomy and range of Aalenian ammonites and other guide fossils nor on stratigraphy of Aalenian deposits to draw definite boundaries and to choose a type locality.

During the discussion British colleagues expressed the opinion that the scissum (sub)zone has the priority over the comptum and/or bifidatum (sub)zone. Furthermore they pointed out the fundamental

difference between a guide fossil and an index fossil. The index fossil Tmetoceras scissum serves as a label for the higher part of the opalinum zone. The participants of the session agreed to this proposal.

A. C. RICCARDI criticized that H. Rieber had only related to the Aalenian of Central Europe, though there are lots of Aalenian deposits outside this area.

The session was finished without any resolution concerning the boundaries, the division, and the choice of a type locality for Aalenian stage. It was recommended to deepen the studies on the whole fauna, flora (especially the palynomorphs) and stratigraphy of the Aalenian all over the world and to exchange experience on its fossils and stratigraphy.

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Division and boundaries

Since 1864, when the Aalenian was established by CH. MAYER many papers dealt with the usefulness, the division and the boundaries of this stage. After the first "Colloque du jurassique, Luxembourg" (1962) the term Aalenian is used generally. Concerning the different interpretations of the Aalenian it can be refered to several papers which were published during the past 25 years by specialists (MOUTERDE 1961, MAUBEUGE 1964, CONTINI 1969, GABILLY & RIOULT 1971, DUBAR et al. 1971, MOUTERDE et al. 1971, RIEBER 1977, COPE et al. 1980).

A survey of the succession of zones, subzones and horizons according to some essential papers of the last 15 years is given in table 1.

The division of D. CONTINI 1969 is based on studies of the Graphoceratids and the stratigraphy of the Aalenian franc-comtois. It corresponds well with that of the Aalenian of the middle and western part at the Swabian Alb established by H. RIEBER 1963. MOUTERDE et al. 1971 took over the division of CONTINI with unimportant modifications. In 1980 C.F. PARSONS published in COPE et al. a division in which he re-introduced the scissum Subzone (NEUMAYR 1871) instead of *comptum* Zone in the sense of CONTINI 1969.

Recently KNITTER & OHMERT stated that in southwestern Germany the layers with *Pachylytoceras torulosum* precede those with *Leioceras opalinum*. Therefore they separated the *torulosum* Zone from the *opalinum* Zone.

Remarks concerning the ammonites

There is not enough sound knowledge of the different forms - species - of *Leioceras*, chiefly of those of the *opalinum* Subzone. This depends on one side on the lack of good characteristics of these poorly ornamented

forms combined with large instraspecific variability of all species and on the other side on the preservation, which is often rather bad, especially in the Opalinuston of southern Germany and northern Switzerland.

The intraspecific variability of the species of Leioceras, Ludwigia, Brasilia, Graphoceras and Ludwigella seems to be very large. Therefore it is often difficult or nearly impossible to determine a single specimen.

In the author's experience the number of forms - species - especially of the genera Leioceras, Ludwigia, Brasilia, Graphoceras and Ludwigella but also of the Hyperlioceras of the lower Bajocian is rather great. At many exposures of Aalenian only few layers contain ammonites. Therefore the ammonite faunas of localities with fossiliferous layers, which are not exactly coeval, may be rather similar but not equal regarding the forms of the present genera. This factor often complicates the correlation of sections.

The species of the genus Staufenia, especially S. staufensis und S. sehndensis are recognized as good guide fossils for the middle part of the Aalenian of Germany, northern Switzerland and the eastern part of France.

The Graphoceratids, which are the predominant ammonites in the Aalenian of Europe,are very rare or completely missing in the Circum-Pacific area. There the representatives of Pseudolioceras and of the Hammatoceratinae are prevailing.

General remarks

To correlate the european epicontinental Aalenian with the mediterranean and with far distant regions as the Circum-Pacific area it is necessary to deepen the knowledge on the systematics, phylogeny and stratigraphic position of rare representatives as Tmetoceras, the Hammatoceratinae (Bredyia/Pseudammatoceras, Planammatoceras, Euaptetoceras/Parammatoceras, Eudmetoceras, Erycites + Abbasites, Haplopleuroceras) as the Stephanoceratids (Docidoceras), the Phylloceratids, and the Lytoceratids. For this purpose more well dated material of these forms is needed, bedrock collections are indispensable.

The author is of the opinion that the paper of R. MOUTERDE et al. (1972) is very important for the discussion on boundaries of zones and stages.

After having studied thick and more or less continously fossiliferous series of upper Aalenian and lower Bajocian from Portugal and from the French Low Alps, they showed the difficulties to set a boundary line on paleontological base between Aalenian and Bajocian. The divisions which are quite clearly defined on a larger scale as within the lacunary series of the epicontinental Aalenian change into a relative continuity on a smaller scale within thick relatively continously fossiliferous series.

MOUTERDE et al. did the proposal to draw the boundary where new forms become frequent. The first appearance of a single new form seemed to them not suitable to establish a boundary.

Problems and questions

The torulosum Zone sensu KNITTER & OHMERT (1983) is it to treat as the lowermost zone or subzone of the Aalenian or the uppermost of the Toarcien? According to the results of the studies of KNITTER & OHMERT the torulosum Zone does not coinside with the opalinum Zone, because Pachylytoceras torulosum is recognized to precede Leioceras opalinum.

When CH. MAYER introduced the term Aalenian, he listed the "Couches de Boll à 'Am. Torulosus" as the lowermost part of this stage. Nevertheless, for the time being it seems the best thing to treat the torulosum Zone as a range zone, which should not be confused with a zone or subzone of the chronostatigraphical scale.

PARSONS in COPE et al. (1980) expressed that the scissum subzone has the priority over the comptum and/or bifidatum zone resp. subzone.

Within the Aalenian of Germany, nothern Switzerland and France Tmetoceras scissum is very rate and therefore for this region no good guide fossil. Furthermore the genus Tmetoceras, which ranges at least

from the opalinum Subzone until the uppermost part of the murchisonae Zone ist not yet studied thoroughly. Despite of these facts Tmetoceras scissum may be used as a label for the second subzone of the opalinum Zone.

A further point in question concerns the synonymy of the genera Costilioceras of Germany, Switzerland and France and Ancolioceras of the English inferior oolite. The forms of Ancolioceras, which the author has seen from the inferiore oolite of Dorset, are often rather similar but not equal to the forms of Costileioceras resp. Staufenia (Costileioceras), which are frequent in southwestern Germany, especially in the Wutach region. Therefore the synonymy of Costileioceras and Ancolioceras is still open to question. It needs careful studies of this group.

Altogether it seems that also the specialists are far away from the knowledge they need for the final definition of the boundaries, of the typesection(s), and of the definitive division of the Aalenian. To reach this aim it is necessary to study not only the ammonites but also the other fossils - especially microfossils and palynomorphs - which are useful for stratigraphy.

Table 1: Succession of zones, subzones and horizons of the Aalenian

	Present zonal scheme	Succession of zones, subzones, and horizons according to: Contini 1969		Mouterde et al. 1971		Cope et al. 1980		Knitter & Ohmert 1983
		Zone	Horizon	Subzone	Horizon	Zone	Subzone/Horizon	Zone
BAJOCIAN	Witchellia laeviuscula			Laeviuscula		W. laeviuscula	W. laeviuscula	
				Ovalis			S. (F.) ovalis	
	Hyperlioceras discites	discites	Hyperlioceras	Discites		Hyperl. discites		
			G. formosum					
AALENIAN upper	Graphoceras concavum	concavum	?	Formosum-Limitatum		Graph. concavum	"G. formosum-horizon"	
			Concavum-Cornu	Concavum			G. concavum	
	Ludwigia murchisonae	murchisonae	Gigantea	Murchisonae	Gigantea	Ludw. murchisonae	"B. gigantea-horizon"	
			Bradfordensis		Bradfordensis		B. bradfordensis	
			Murchisonae		Murchisonae		L. murchisonae	
			Sehndensis		Sehndensis			
			Opalinoides	Haugi	Opalinoides/ Sinon		L. haugi	
AALENIAN lower	Leioceras opalinum	comptum	Crassicostatum	Comptum or Bifidatum	Crassicostatum	Leioceras opalinum	Tmetoceras scissum	
			Bifidatum		Bifidatum			
		opalinum	Lineatum	Opalinum	Lineatum		L. opalinum	opalinum
			Opaliniformis		Opaliniformis			
			Subglabrum		Subglabrum			
TOARCIAN	Pleydellia aalensis	aalensis	Buckmani	Buckmani		Dumort. levesquei	Pl. aalensis	torulosum
								aalensis

References

ARKELL, W.J. (1933): Jurassic System of Great Britain. - 681 p., 97 figs., 41 pls.; Oxford.

- (1956): Jurassic Geology of the world. - 806 pp., 102 figs., 26 tabs., 46 pls.; Edinburgh & London.

COPE, J.C.W., DUFF, K.L., PARSONS, C.F., TORRENS, H.S., WIMBLEDON, W.A. & WRIGHT, J.K. (1980): A Correlation of Jurassic rocks in the British Isles. Part Two: Middle and Upper Jurassic. - Geol. Soc. London, Special Report No. 15, 109 pp.; Oxford.

Colloque sur le Lias français "Chambéry" 1960. - Mém. B.R.G.M., 4; Paris 1961.

Colloque du Jurassique à Luxembourg 1962. - Publ. Inst. gd.-duc., Sect. Sc.nat. phys. math, 948 pp,; Luxembourg 1964.

Colloque du Jurassique à Luxembourg 1967. - Mém. B.R.G.M., Fr., 75; Paris 1971.

CONTINI, D. (1969): Les Graphoceratidae du Jura franc-comtois. - Ann. sc. Univers. Besançon, 3e sér., Géol., 7, 95 pp., 24 pls.; Besançon.

DONOVAN, D.T., CALLOMON J.H. & HOWART, M.K. (1981): Classification of the Jurassic Ammonitina. In: HOUSE, M.R. & SENIOR, J.R. (ed.): The Ammonoidea. - Syst. Ass. Spec. Vol. 18, p. 101-155; Acad. Press, London, New York.

DUBAR, G., ELMI S., MOUTERDE, R. & RUGET-PERROT, CH. (1971): Divisions et limites de l'Aalénien (Sud-est de la France et quelques régions méridionales). - Colloque du Jurassique à Luxembourg 1967, p. 397-410; Paris.

ELMI, S. (1963): Les Hammatoceratinae (Ammonitina) dans le Dogger inférieur du Bassin rhodanien. - Trav. Lab. Géol. Lyon, N.S., no. 10, 144 p., 35 fig., 2 pls.; Lyon.

GABILLY, J. & RIOULT, M. (1971): Le Bajocien inférieur et le Toarcien supérieur sur les bordures du massif amorcain. Limite entre le Jurassique inférieur et le Jurassique moyen. Problème de l'Aalénien. - Colloque du Jurassique à Luxembourg 1967, p. 385-396; Paris.

HILLEBRANDT, A. v. (1973): Neue Ergebnisse über den Jura in Chile und Argentinien. - Münster. Forsch. Geol. Paläont., No.31/32, p. 167-199, 4 figs., 1 tab.; Münster.

KNITTER, H. & OHMERT, W. (1983): Das Toarcium an der Schwärze bei Badenweiler (Oberrheingebiet S Freiburg). - Jh. geol. Landesamt Baden-Württemberg, 25, p. 233-281, 6 figs., 5 pls.; Freiburg i.Br.

MAUBEUGE, P.L. (1964): La question de l'étage Aalénien et son stratotype. - Colloque du Jurassique à Luxembourg 1962, p. 203-215; Luxembourg.

MAYER, CH. (1864): Tableau synchronistique des terrains jurassiques; Zürich.

MOUTERDE, R. (1961): Le problème de l'Aalénien et la limite Lias-Dogger. - Colloque sur le Lias français, Chambéry 1960, p. 407-410; Paris 1961.

MOUTERDE, R., ENAY, R., CARIOU, E., CONTINI, D., ELMI, S., GABILLY, J., MANGOLD, CH., MATTEI, J., RIOULT, M., THIERRY, J. & TINTANT, H. (1971): Les zones du Jurassique en France. - C.R. Séances Soc. Géol. France 1971, fasc. 6, p. 1-27; Paris.

MOUTERDE, R., RUGET, CH. & CALOO, B. (1972): Les limites d'étages. Examen du problème de la limite Aalénien-Bajocien. - Mém. B.R.G.M., Fr., no. 77, p. 59-68; Paris.

PLUMHOFF, F. (1963): Die Ostracoden des Oberaalenium und tiefen Unterbajocium (Jura) des Gifhorner Troges, Nordwestdeutschland. - Abh. senckenb. naturf. Ges., 503, p. 1-100, 4 figs., 12 pls., 1 tab.; Frankfurt.

RIEBER, H. (1963): Ammoniten und Stratigraphie des Braunjura β der Schwäbischen Alb. - Palaeontographica, A, 122, p. 1-89, 25 figs., 8 pls.; Stuttgart.

-- (1977): Remarks to the Aalenian of the Swabian Alb. - Stuttgarter Beitr. Naturk., Ser. B., No. 29, p. 1-5, 2 tab.; Stuttgart.

WESTERMANN, G.E.G. (1981): Ammonite Biochronology and Biogeography of the Circum-Pacific Middle Jurassic. - In: HOUSE, M.R. & SENIOR, J.R. (ed.): The Ammonoidea. - Syst. Ass. Spec. Vol. 18, p. 459- 498; Acad. Press, London, New York.

WESTERMANN, G.E.G., RICCARDI, A.C., PALACIOS, O. & RANGEL, C. (1980): Jurásico Medio en el Perú. - Inst. Geol. Miner. Metal., Bol. 9, Ser. D, p. 1-47; Lima.

WESTERMANN, G.E.G. & RICCARDI, A.C. (1982): Ammonoid Fauna from the Early Middle Jurassic of Mendoza Province, Argentina. - J. Paleont., 56/1, p. 11-41, 6 pls., 7 textfigs.

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Report of the Bajocian Working Group

Giulio Pavia

This correlation chart summarizes the conclusions of the ammonite biostratigraphic analysis on the European Bajocian; we also add the data from Arabia, Sinai and Morocco for their structural Tethyan affinities, notwithstanding faunal provincialisms (i.e., Thamboceras/Ermoceras assemblages). The tables A and B have been made using up-to-date literature and unpublished data obtained from many collegue: J.H. Callomon, London; D. Contini, Besançon; G. Dietl, Stuttgart; S. Elmi and R. Enay, Villeurbanne; S. Fernandez Lopez, Madrid; A. Galacz, Budapest; G. Krymgolts, Leningrad; A. Parnes, Jerusalem; R. Rocha, Lisboa; J. Sandoval, Granada; G.E.G. Westermann, Hamilton.

All the zonal subdivisions, assembled in the schema, classically found on Oppel biozones. Their interregional extension is so wide that they allow accurate time correlations as Standard Zones (Torrens in Cope et al., 1981). Such European zones nevertheless are not chronozones (i.e., global time correlation units) as they are not directly correlated to the biozones of the Bajocian of the Boreal Realm and the Pacific provinces (Westermann, 1981). Therefore we have to limit the use of this zonal schema as standard for the Bajocian of the western Tethyan provinces.

Such European limitation is more obvious for the subzonal scale, in which regional differences are heavier. The tables A and B yet show the possibility to obtain an European Bajocian standard subzonation, by assembling the data from southern France, England, southern Germany and Bakony Montains for different biostratigraphic intervals. Most of the regional differences would be reduced in the future, as they appear due to failing both of typical ammonites or lito- and biostratigraphic horizons. The most delicate case is the sauzei Biozone with the problems of its lower boundary and of the

hebridica subzone.

The aim of this correlation chart is hence to point out problems and to discuss a more detailed European standard scale, to be used as a base for worldwide time correlations. It is evident that many details of the ammonite biostratigraphy are far to be clear. To solve these difficulties we can try to operate by biohorizons, looking for those biological contents and events more usefull for time correlation; each zone or subzone may be hence composed by addition of successive and correlated biohorizons. In this respect, we also have to recognize the position of the horizons of the type-species and to describe the associated ammonite fauna with the whole biological content. The lower bio- and, when possible, chronostratigraphic boundaries of the stage, zones and subzones may then be identified by significant faunal changes (biohorizons) and therefore fixed in selected type-sections.

Some points can be stressed for the discussion on the correlation chart.

1 - Definition of the stage - Is the Bajocian Stage defined with enough evidence in respect to its lower boundary? What biostratigraphic changes and how many partings can we determine for a correct division of the stage? In this connection I should call your attention on the break existing between humphriesianum and subfurcatum/niortense Biozones, which is sharper than the one between parkinsoni and zigzag Biozones, i.e. between Bajocian and Bathonian. For this purpose, I shall remember the suggestion of Sturani (1967) about the possibility to modify the chronostratigraphic scale for the middle part of the Dogger as follows: unnamed stage (perhaps Marcou's Ledonian) from discites to humphriesianum Biozone; Bajocian from subfurcatum/niortense to zigzag Biozone (= Swdzinski'Kouyavian).

2 - Boundaries - We have to concentrate our efforts to fix the lower boundaries of biozones and subzones, most of which are poorly defined. The best way for this purpose seems to be both (A) locating type-sections where ammonite sequences are clear and continue and (B) selecting typical and correla

ble biohorizons.For example, Dietl and I propose to fix the lower boundary of the subfurcatum/niortense Biozone in the Chaudon section (Digne area) by the horizon of first appearance of Caumontisphinctes diniensis (cf. Erlangen Symposium reports).

3 - Subzonal nomenclature - According to I.S.S.C. (1976, p. 20) and to the new North American Stratigraphic Code (N.A.C.S.N., 1983, p. 855, art. 19), the retention of the same index both for a stratigraphic unit and for one of its subdivisions is unsuitable and would risk confusion. So, it seems properer to change some subzonal index: for example, the humphriesianum subzone, in the middle humphriesianum Biozone, may be changed as umbilicum subzone with the same biostratigraphic significance.

4 - "Sowerbyi Biozone" - Waiting for a more accurate definition of some biostratigraphic units, like discites and laeviuscula Biozones, some authors maintain the usage of "sowerbyi Biozone", notwithstanding the type of Ammonites sowerbyi is an undeciferable Sonninia probably from the sauzei Biozone (Parsons, 1974). In my opinion it is suitable to reject definitively the "sowerbyi Biozone" also in the localities where the discites and laeviuscula Biozones are slightly clear. Once overcame the problem expressed in the point 2, the collegues should verify their data keeping in mind a common European zonation of the earlier Bajocian.

5 - Sauzei Biozone and the lower boundary of the humphriesianum Biozone - The Kumatostephanus Assemblage zone, proposed by Galacz in the lower part of the sauzei Biozone from the Bakony Mountains, seems to correspond to other European ammonite faunas intermediate between laeviuscula and sauzei Biozones, as well as the ones from southern England (Parsons, 1976) and Digne area (Pavia, 1983). Have they a regional significance? May they then be correlated as biohorizons at the base of the sauzei Biozone? If they do, the sauzei Biozone can be divided in two temporarily unnamed subzones, proved that the upper ammonite assemblage (i.e., the hebridica subzone of Morton, 1976) shows more "humphriesianum" affinities.

In fact, the validity of the hebridica subzone is questionable (Parsons in Cope et al., 1981). It seems more correct and usefull (Dietl, in

litt.) to restore the use of the pinguis subzone (Westermann, 1967), marked by the appearance and the development of Dorsetensia at the base of the humphriesianum Biozone, and to reject the romani subzone too, that is a distorted interpretation of Haug's biostratigraphy.

6 - Blagdeni subzone - It is characterized by the development of Teloceras s.s.; its lower boundary appears well marked by the first appearance of Telocèras acuticostatum group (Pavia, 1983). Moreover the blagdeni unit shows a wide and extra-European correlation, so that it may assume a chronostratigraphic value. May it then be regarded as a standard zone at the top of the Lower Bajocian? In the French sections it has been divided in two parts: T. acuticostatum or T. dubium horizon in the lower part, with "cadomitid" Stephanoceras and "perisphinctid" Phaulostephanus; T. coronatum horizon in the upper part, with the first appearance of Cadomites and Leptosphinctes.

7 - Subfurcatum/niortense Biozone - Dietl (1981) pointed out that the lectotype of Ammonites subfurcatus is a microconch of the garantiana Biozone and then the name subfurcatum cannot be used to define the first biozone of the Upper Bajocian; this one must be renamed as niortense Biozone. Some collegues (Callomon, Westermann, ...) do not agree with this technical conclusion because of the well-established use of the name "subfurcatum Biozone" and because of doubts on Dietl's nomenclatural statement on Schlotheim's material. This problem may require an opinion of the I.C.Z.N.; I should just note that the International Stratigraphic Codes do not refuse any changes of zonal nomenclature.

The distinction between banksi and polygyralis subzones has been questioned by Dietl & Hugger (1979) and by Sandoval (1979), owing to lack of faunal evidences. On the other hand, Caumontisphinctes aplous and C. polygyralis seem to represent a single chronospecies; the marking of the lower boundary of the polygyralis subzone by the first appearance of C. polygyralis (Pavia, 1973) is then a subjective matter. If this subzonation has no general value, the subfurcatum/niortense Biozone must be divided in two parts: banksi subzone with most of the Caumontisphinctes fauna and with last Stephanoceratinae; baculata subzone with Strenoceras, Garantiana,

TABLE A - CORRELATION CHART FOR THE BAJOCIAN OF W. ASIA, N. AFRICA, S. EUROPE

CENTRAL ARABIA 2,13,22	NEGEV - SINAI 13,30	MOROCCO-W ALGERIA 3,11,13,30	ALGERIA 3,12	PORTUGAL 26,27,35,36	C. IBERICA 14,15,16,17,21	C. BETICAS 24,37,38	SOUTH FRANCE 33,34	
Thambites - "Clyd. avus" assemblage	Thamb. planus assemblage	Thambites - "Clyd. avus" assemblage	PARKINSONI	PARKINSONI: bomfordi; parkinsoni	PARKINSONI: parkinsoni; acris	PARKINSONI: Dim.dimorphus assemblage; Cad. daubenyi assemblage	PARKINSONI: bomfordi; densicostata; acris	UPPER BAJOCIAN
ERMOCERAS ASSEMBLAGES: Erm.mogharense Spiroceras Thamboceras assemblage	Ermoceras - Thamboceras - Spiroceras assembl.	Ermoceras - Cadomites assemblage	GARANTIANA	GARANTIANA	GARANTIANA: tetragona; trauthi; dichotoma	ANNULATUM	GARANTIANA: tetragona; subgaranti; dichotoma	UPPER BAJOCIAN
ERMOCERAS ASSEMBLAGES: main Ermoceras assemblage	SUBFURCATUM: Ermoceras - Caumontisph. assemblage	?	SUBFURCATUM: baculata; polygyralis; banksi	SUBFURCATUM: baculata?; aplous	SUBFURCATUM: baculata; polygyralis; banksi	"LEPTOSPH.": sauzeanum; phaulus; ?	NIORTENSE: "schroederi"; baculata; polygyralis; banksi	UPPER BAJOCIAN
ERMOCERAS ASSEMBLAGES: Ermoceras - Dorsetensia assemblage	HUMPHRIESI.: T.diadema ass.; Dorsetensia assemblage	HUMPHRIESI.: "blagdeni"; Dorsetensia assemblage	HUMPHRIESI.: "blagdeni"; humphriesianum; romani	HUMPHRIESI.: blagdeni; humphriesianum	HUMPHRIESI.: blagdeni; humphriesianum	HUMPHRIESI.: blagdeni; humphriesianum; cycloides	HUMPHRIESI.: blagdeni; humphriesianum; romani	LOWER BAJOCIAN
SONNINIIDAE ASSEMBLAGES: Sonninia - Normannites assemblage	SAUZEI ?	SAUZEI	SAUZEI	SAUZEI	SAUZEI: "hebridica"; "sauzei"	SAUZEI: hebridica; "sauzei"	SAUZEI: "hebridica"; sauzei	LOWER BAJOCIAN
SONNINIIDAE ASSEMBLAGES: "Shirbuirnia" assemblage		?	?	SOWERBYI: ?	"SOWERBYI": laeviuscula; ovalis	SOWERBYI: laeviuscula; ovalis	LAEVIUSCULA: laeviuscula; ovalis	LOWER BAJOCIAN
SONNINIIDAE ASSEMBLAGES: Euhoploceras assemblage			"DISCITES"	SOWERBYI: discites	"SOWERBYI": discites?	SOWERBYI: discites	DISCITES: Euhoploceras assemblage; Graphoceratidae assemblage	LOWER BAJOCIAN
?								

TABLE B - CORRELATION CHART FOR THE BAJOCIAN OF EUROPE

NORTH FRANCE 5,18		SOUTH ENGLAND 1,6,31,32		NORTH GERMANY 43		SOUTH GERMANY 7,9,10		NORTH ITALY 4,39,41		HUNGARY 19,20		CAUCASUS 29,42		
PARKINSONI	bomfordi	PARKINS.	bomfordi	PARKINSONI	fried.-augusti	PARKINSONI	bomfordi	PARKINSONI	Dim.dimorphus assemblage	PARKINSONI	bomfordi	PARKINSONI	parkinsoni / eimensis	UPPER BAJOCIAN
	acris / subarietis		truellei		parkinsoni		parkinsoni		Park.acris assemblage		densicostata		acris / rarecostata	
		GARANTIANA	acris		acris		acris				acris			
GARANTIANA			tetragona	GARANTIANA	tetragona	GARANTIANA	garantiana	GARANTIANA		GARANTIANA		GARANTIANA		
			subgaranti		garantiana									
			dichotoma		dichotoma		dichotoma							
SUBFURCATUM		SUBFURCATUM	baculata	SUBFURCATUM	schroederi	NIORTENSE	baculata	SUBFURCATUM	schroederi	SUBFURCATUM		SUBFURCATUM		
					subfurcatum				baculata					
			polygyralis		phaulus		polygyralis		polygyralis					
			banksi				banksi		banksi					
HUMPHRIESI.	blagdeni	HUMPHRIESI.	blagdeni	HUMPHRIESI.	blagdeni	HUMPHRIESI.	blagdeni	HUMPHRIESI.	?	HUMPHRIESI.	blagdeni	HUMPHRIESI.	blagdeni	LOWER BAJOCIAN
	humphriesianum		humphriesianum		humphriesianum		umbilicum		humphriesianum		humphriesianum		humphriesianum	
			romani		umbilicum		cycloides		romani		romani			
					frechi/pinguis		pinguis							
SAUZEI		SAUZEI		SAUZEI		SAUZEI		SAUZEI		SAUZEI	hebridica	SAUZEI		
											sauzei			
											Kumatosteph. assemblage			
LAEVIUSCULA	laeviuscula	LAEVIUSCULA	laeviuscula	LAEVIUSCULA	laeviuscula	LAEVIUSCULA	laeviuscula	LAEVIUSCULA		LAEVIUSCULA		SOWERBYI	laeviuscula	
	ovalis		ovalis		sowerbyi		ovalis							
DISCITES	Hyperlioceras assemblage	DISCITES		DISCITES		DISCITES		DISCITES		DISCITES			discites	
	Euhoploceras assemblage													

Spiroceras and lots of Leptosphinctes l.s.

8 - Lower boundary of the parkinsoni Biozone - The position of the acris subzone at the base of the parkinsoni Biozone, instead that at the top of the garantiana Biozone (Parsons in Cope et al., 1981), is justified as it is the first appearance horizon of Parkinsonia l.s., associated with last representatives of Garantiana subgaranti group.

9 - Multidisciplinary correlation - Ammonites are always the key for the standard zonation of the Bajocian. But it is necessary to select fossiliferous and well studied outcrops, from which it would be possible to obtain different biostratigraphic and magnetostratigraphic scales. So we would be able to put side by side different zonations for drawning a more complete and detailed chronostratigraphy. In this respect, I can inform you that prof. R. Lanza, a collegue of the Earth Science Department of Turin, has begun to sample the section of Chaudon (Digne area) to obtain a magnetostratigraphic scale for the whole Bajocian; his results will be compared to the ammonite zonation I studied there in the last years. I think that the same section may be tested for other biostratigraphic analysis, like nannoplancton, dinoflagellates, pollens, scolecodonts, radiolarians, belemnites, ...

References

1) ARKELL, 1951 - A monograph of the English Bathonian ammonites - Palaeont. Soc. London, mon. 24.

2) ARKELL, 1952 - Jurassic ammonites from Jebel Tuwaiq, Central Arabia - Phil. Trans. R. Soc., 236.

3) ARKELL, 1956 - Jurassic geology of the world - Edinburgh.

4) CLARI & PAVIA, 1980 - Osservazioni preliminari sulle facies condensate nel Giurassico delle Alpi Feltrine (Belluno) - Paleont. Strat. Evol., 1, Roma

5) CONTINI, 1970 - L'Aalénien et le Bajocien du Jura Franc-Comtois - Ann. Sc. Univ. Basançon, 11.

6) COPE et alii, 1981 - A correlation of Jurassic rocks in the British Isles - Geol. Soc., Spec. Rep., 14, 15.

7) DIETL, 1977 - The Braunjura in Southwest Germany - Stuttg. Beitr. Naturk., B-25.

8) DIETL, 1981 - Zur systematischen Stellung von Ammonites subfurcatus und deren Bedeutung für die subfurcatum-Zone (Bajocium, Mittl. Jura)- Stuttg. Beitr. Naturk., B-81.

9) DIETL & HAAG, 1980 - Über die sowerbyi-Zone (=laeviuscula-Zone) in einem Profil bei Nenningen - Stuttg. Beitr. Naturk., B-60.

10) DIETL & HUGGER, 1979 - Zur Stratigraphie des Ober-Bajocium der Zolllernalb - Stuttg. Beitr. Naturk., 43.

11) DU DRESNAY, 1975 - Relations paléogéographiques entre sillons atlasiques (Haut et Moyen Atlas) et plate-forme des Hautes Plateaux (Maroc oriental) pendant l'Aalénien et le Bajocien. 2ème Colloque Jurassique Luxembourg, 1967 - Mém. B.R.G.M., 75 (1973).

12) ELMI, 1971 - Les zone d'Ammonites dans la série Bajocien supérieur-Callovien de l'Oranie (Ouest algérien) - Bull. Soc. Géol. France, 13.

13) ENAY et alii, in press - The Jurassic of Jebel Tuwaiq (Central Saudi Arabia): new data on litostratigraphic units, faunas, age and correlations.

14) FERNANDEZ LOPEZ, 1977 - Nuevos datos estratigraficos sobre el Bajociense inferior en Moscardon - Bol. R. Soc. Esp. Hist. Nat., 75.

15) FERNANDEZ LOPEZ, 1983 - La biozona Garantiana (Bajociense, Jurasico Medio) en la region de Tivenys-Sierra de Cardò (Tarragona) - Est. Geol., 38.

16) FERNANDEZ LOPEZ et alii, 1978 - El Dogger en Moscardon - Dp.to Paleont. Estr., Madrid.

17) FERNANDEZ LOPEZ & SUAREZ VEGA, 1979 - Estudio bioestratigrafico del Aaleniense y Bajociense en Asturias - Est. Geol., 35.

18) GABILLY et alii, 1971 - Bajocien. in Mouterde et al., Les zones du Jurassique en France - C.R.S. Soc. Géol. France.

19) GALACZ, 1976 - Bajocian sections from the northern Bakony - Ann. Univ. sC. Budapest, Geol., 28.

20) GALACZ, 1980 - Bajocian and Bathonian ammonites of Gyenespuszta, Bakony Mts., Hungary - Geol. Hung., Pal., 39.

21) GOY & URETA, 1978 - Bioestratigrafia del Aalaniense en Prejano-Muro de Arguas (Logrono) - Cuad. Geol., 10.

22) IMLAY, 1970 - Some Jurassic ammonites from Central Saudi Arabia - U.S. Geol. Prof. Pap., 643D.

23) I.S.S.C., International Subcommission on Stratigraphic Classification, 1976 - International Stratigraphic Code. Hedberg ed. - J. Wiley and sons.

24) LINARES & SANDOVAL, 1978 - Contribucion al estudio del Bajociense de la Sierra de Ricote (Murcia) - Cuad. geol., 9.

25) MORTON, 1976 - Bajocian (Jurassic) stratigraphy in Skye, Scotland - Scott. J. Geol., 12.

26) MOUTERDE et alii, 1971 - Le Jurassique du Portugal. Esquisse stratigraphique et zonale - Bol. Soc. Geol. Portugal, 18.

27) MOUTERDE et alii, 1980 - Stratigraphie et faune du Lias et de la base du Dogger au Nord de Mondego - Com. Serv. Geol. Portugal, 66.

28) N.A.C.S.N., North American Commission on Stratigraphic Nomenclature, 1983 - North American Stratigraphic Code - A.A.P.G., 67.

29) NIKANOROVA, 1972 - Stratigraphy and several types of ammonites of Middle Jurassic deposits of the central Caucasus (in russian) - Bull. Moscow Soc. Natur., 47.

30) PARNES, 1981 - Biostratigraphy of the Mahmal Formation (Middle and Upper Bajocian) in Makhtesh Ramon (Negev, Israel) - Bull. Geol. Surv. Israel, 74.

31) PARSONS, 1974 - The sauzei and "so-called" sowerbyi Zones of the Lower Bajocian - Newsl. Stratigr., 3.

32) PARSONS, 1976 - A stratigraphic revision of the humphriesianum/subfurcatum rocks (Bajocian Stage, Middle Jurassic) of southern England - Newsl. Stratigr., 5.

33) PAVIA, 1973 - Ammoniti del Baiociano superiore di Digne (Francia SE) - Boll. Soc. Pal. It., 10 (1971).

34) PAVIA, 1983 - Ammoniti e biostratigrafia del Baiociano inferiore di Digne (Francia SE) - Mus. Reg. Sc. Nat. Torino, mon. 2.

35) ROCHA, 1976 - Estudo estratigrafico e paleontologico do Jurassico do Algarve ocidental - Cien. Terra, Lisboa, 2.

36) ROCHA et alii, 1981 - Carta geologica do Portugal na escala de 1/50000. Noticia explicativa da folha 19-C, Figuera da Foz - Serv. Geol. Portugal.

37) SANDOVAL, 1979 - El Jurasico de las zonas externas de las Cordilleras Beticas. III-Zona Subbetica - Granada.

38) SANDOVAL, 1983 - Bioestratigrafia y paleontologia (Stephanocerataceae y Perisphinctaceae) del Bajociense y Bathoniense en las Cordilleras Beticas - Thesis Univ. Granada.

39) STURANI, 1964 - La successione delle faune ad ammoniti nelle formazioni mediogiurassiche delle Prealpi Venete Occidentali - Mem. Ist. Geol. Min. Padova, 24.

40) STURANI, 1967 - Ammonites and stratigraphy of the Bathonian in the Digne-Barrême area (S.E. France) - Boll. Soc. Pal. It., 5 (1966).

41) STURANI, 1971 - Ammonites and stratigraphy of the "Posidonia alpina" beds of the Venetian Alps - Mem. Ist. Geol. Min. Padova, 28.

42) VAKHRAMEEV et alii, 1982 - The Jurassic zones of the USSR (in russian). Krimgolts ed. - Ac. Sc. USSR, Interdep. Stratigr. Comm., 10.

43) WESTERMANN, 1967 - Lexique Stratigraphique Internationale. Vol. I, Europe, Fasc. 5, Allemagne, Jurassique Moyen - C.N.R.S., Paris.

44) WESTERMANN, 1980 - Ammonite biochronology and biogeography of the circum-Pacific Middle Jurassic. in "The Ammonoidea" - Syst. Ass. Spec. Vol., 18.

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A D D E N D A

It may be interesting to summarize some remarks, pointed out from the meeting of the Bajocian working-group and from frequent contacts with colleagues.

1) The partecipants to the meeting accepted the proposals of Dietl & Pavia both to divide the Bajocian Stage in two substages (Lower Bajocian from discites to humphriesianum Biozone, Upper Bajocian from niortense/subfurcatum Biozone) and to fix the lower boundary of the Upper Bajocian by the diniensis horizon (type-section at Chaudon, Digne area, bench n. 281).

2) The lowermost Bajocian is represented by the discites Biozone; nevertheless its lower boundary with Aalenian cannot be fixed at present, even though some workers indicate the possibility to define this boundary according the range of the genus Hyperlioceras. It has been emphasized the necessity to look for some continue and fossiliferous sections, where it is possible to recognize correlable biohorizons; one of those sections will then be selected as stratotype for the lower boundary of the discites Biozone.

3) Owing to the fact that many discussions concerned the position and the extension of the biostratigraphic units (for example: the sauzei Biozone; the pinguis/hebridica subzone and the lower boundary of the humphriesianum Biozone; the acris subzone), we agreed on getting to a survey on which zones and subzones can and have to be maintained. It was planned to prepare a paper by different colleagues, collecting the original definition of all commonest units with the indications of possible type-horizons. We also planned to present the first drawing of this paper during the next meeting of the working-group (in Budapest?).

4) A. Galacz indicated the possibility to organize a meeting for both Bajocian and Bathonian working-groups, next year in Hungary, with sessions in Budapest and excursions to the Bakony Mountains. The convenors have been charged to contact and inform the colleagues of their working-groups and to collaborate with Galacz. We hope to get some financial support by the Subcommission for the organisation of the meeting.

Giulio Pavia

Report of the Bathonian Working Group

Ch. Mangold

The definition of the Bathonian stage given by W.J. Arkell (1951-1959) and at various international colloquia is well accepted by the majority of authors. The general opinion of Bathonian workers is that a stratotypical definition from the Bath region in England "is quite unsuitable for a typological definition of the stage" (H.S. TORRENS, 1971). There is a large agreement to consider "stages as part of a hierarchy of stratigraphical units and to define typologically only the members of lower rank, the zones .... defined only at their bases" (J.H. CALLOMON, 1965).

The report I presented in Erlangen was discussed and amended by several members of the Bathonian working group, especially by J.H. Callomon, G. Dietl, A. Galacz and H.S. Torrens. Many thanks to all of them.

The aim of the proposed correlation chart is to point out and discuss a more detailed European standard scale and to be a starting point in the future for world-wide time correlations.

The main problems are : 1. limit of substages, 2. Zonation, 3. choice of type-sections, 4. setting up of parallel biostratigraphical scales.

1. Substages

Boundaries of the classical Lower, Middle and Upper Bathonian are placed respectively at the base of the Convergens Subzone, at the base of the Progracilis zone and at the base of "Retrocostatum" Zone *sensu* H.S. Torrens (1971) or Hodsoni Zone (H.S. TORRENS, 1980). During the discussion in Erlangen a new proposition was made by H.S. Torrens to begin the Middle Bathonian with the Subcontractus Zone, the Progracilis Zone becoming then Lower Bathonian. The base of the Upper Bathonian in the French author's opinion coincides with the first horizon *(Procerites mirabilis)* of the Blanazense Subzone. This position is marked by extinction of *Wagnericeras* and *Bullatimorphites* with regular coiling. In Torren's opinion this boundary agrees with the dying out of *Procerites*.

2. Zonation

On both sides of tables 1 and 2 are columns countaining Arabic numbers from 1 to 15. Each number represents a horizon described from the Vendée by J. Gabilly and from Southern Jura mountains by C. Mangold. This attempt was elaborated by both authors in 1971 and recently completed by J.H. Callomon for the Bathonian working group.

	These horizons are :	Jura chain	Vendée
15	Clydoniceras discus	?	gap
14	Clydoniceras hollandi	fauna 12	gap
13	Prohecticoceras retrocostatum	fauna 11	Horizon J
12	Prohecticoceras ochraceum blanazense	fauna 10	Horizon I
11	Procerites mirabilis	fauna 9	gap
10	Wagnericeras	fauna 8	Horizon H
9	Cadomites daubenyi	faunas 7 + 6 b	Horizon G
8	Morrisiceras morrisi	fauna 6 a	gap
7	Tulites subcontractus	fauna 5 b	gap
6	Gracilisphinctes	gap	Horizon F
5	Cadomites orbignyi	fauna 5 a	Horizon E
4	Asphinctites tenuiplicatus	fauna 4	Horizon D_2 Horizon D_1
3	Oxycerites yeovilensis	fauna 3	Horizon C
2	Morphoceras macrescens	fauna 2	Horizon B
1	Gonolkites convergens	fauna 1	Horizon A

In correlation charts zones and subzones are written in capital letters, horizons or assemblages in small letters.

2.1. ZIGZAG ZONE (Horizons 1 to 4)

This zone is mainly divided into 4 Subzones but the Tenuiplicatus Subzone was considered by H.S. Torrens (1980) to be a separate Zone of the highest Lower Bathonian. This problem will be discussed in the future by members of the working group. It seems that Dimorphitiformis and Postpollubrum Subzones of Southern Spain (J. SANDOVAL, 1983) are equivalent to Convergens and Tenuiplicatus Subzones. Finally a general agreement exists for the Zigzag Zone subdivisions and therefore correlations in Europe are very easy.

The Lower Bathonian of Saudi Arabia is characterized by three faunal assemblages (R. ENAY and C. MANGOLD, 1984). At the bottom there is a possibility that the higher part of sediments containing the *Thambites* and *"Clydoniceras" avus* assemblage reaches from Upper Bajocian (see Bajocian report) into the earliest Lower Bathonian. According to biogeographic arguments the *Tulites* and *Micromphalites* assemblages are also included in the Lower Bathonian.

2.2. PROGRACILIS ZONE (Horizons 5 and 6)

The Progracilis faunas has been recorded in England, Normandy, Vendée, Ardèche, Southwestern Germany, Hungary and perhaps'in Poland. There is a possibility that the *Cadomites orbignyi* horizon based on Mangold's fauna 5 a and on Gabilly's horizon E, the first below *Tulites* and the second below *Gracilis-*

sphinctes, belongs to the Progracilis Zone and so can be placed into lower part of this Zone.

2.3. SUBCONTRACTUS ZONE (Horizon 7)

This Zone is well known in England, Normandy, the Jura moutains, Ardèche, NW and SW Germany, Switzerland and Hungary. Correlations are very difficult with Southern Europe. In the Betic Cordilleras the Sofanum Zone (J. SANDOVAL, 1983) based on a fauna containing *B. (Bullatimorphites) ymir*, *B. (B.) eszeterense* known from the *Orbignyi* horizon, *Procerites* of the *progracilis* group and *T. (Tulites)* - *T. (Rugiferites)* may be an equivalent of the Progracilis and Subcontractus Zones *sensu* H.S. Torrens.

In Saudi Arabia the position of the *Dhrumaites* assemblage coming above the monogeneric *Micromphalites* fauna is of a postzigzag and preCallovian age. It may be rather Middle than Upper Bathonian.

2.4. MORRISI ZONE (Horizon 8)

This Zone taken in a restricted sense (England, SW Germany, Bulgaria) represents the equivalent to *Morrisiceras morrisi* Horizon (C. MANGOLD, 1970) restricted to one bed in the Southern Jura mountains. Therefore the Morrisi Subzone *sensu* Mangold with horizons 8, 9 and 10 reaches into the Hodsoni zone.

Great difficulties appear in Southern Europe where the genus *Morrisiceras* has not yet been found. The Bullatimorphus Subzone in Spain stretches a little higher covering perhaps horizon 8 and surely horizon 9. The same problem exists in Portugal where at Cap Mondego only *Bullatimorphites* of the *bullatimorphus* group are known. It seems that the position of this assemblage is post *Morrisiceras morrisi* horizon.

2.5. HODSONI ZONE (Horizons 9, 10 and 11)

This is the new name porposed by H.S. Torrens for his "Unnamed zone" or "Retrocostatum" Zone. At the bottom it is possible to distinguish in most places a *Cadomites daubenyi* horizon or a *Bullatimorphites bullatimorphus* horizon correlatable to the lower part of the Bremeri Zone of Poland (J. KOPIK, 1974) and Southern Spain (C. MANGOLD, 1979). This horizon contains many large *Procerites* and *Siemiradzkia* in association with *Parachoffatia arisphinctoides*, *Paroecotraustes prevalensis* and *P. densecostatus*. This is also the level of *Cadomites* of the *daubenyi* - *bremeri* group. *Bullatimorphites* are known in England, Vendée, Jura chain, Southern Spain, Portugal forming a good argument for correlations between subMediterranean and NW-European areas.

Horizon 10, the so called *Wagnericeras* horizon coincides with the acme of the genus *Wagnericeras*. At the same level there are *Procerites (subcongener-*

hodsoni) and *Siemiradzkia*, several *Paroecotraustes (densecostatum, maubeugei, waageni)*.

Horizon 11, called the *Mirabilis* horizon in Southern Jura chain is dominated by large *Procerites (mirabilis, magnificus, quercinus, hodsoni)* represented also in England, Burgundy, and associated in Swabia and Jura mountains by the same *Paroecotraustes* species as in horizon 10. This fauna lies at the base of the Retrocostatum Zone (Blanazense Subzone).

2.6. ASPIDOIDES ZONE (Horiozns 12 and 13)

The Aspidoides Zone is difficult to identify after *Oxycerites*. S. Elmi and C. Mangold (1967) found *Oxycerites oppeli* ELMI with an acute shape at this level (Retrocostatum Zone) while forms closely allied to Oppel's type have been collected in Lower Bathonian. G. Dietl (1982) in Southwest Germany studying the *locus typicus* of *Ammonites aspidoides* had shown that the true *O. aspidoides* is an Upper Bajocian species and that in the Upper Bathonian occurs a form for which the name *Oxycerites orbis* GÜMBEL can be used.

In southern regions occur *Prohecticoceras* of the *retrocostatum* group with two subspecies : 1. *retrocostatum blanazense* and above 2. *retrocostatum retrocostatum*. The first, in the Ardèche department and in Portugal, is associated with *Hemigarantia julii* and the second with *Epistrenoceras histricoides* (S. ELMI, 1967).

Horizon 13 is characterized by *H. homœomorphus*, several *Parachoffatia* of the *subbackeriæ* group, *P. retrocostatum*, *P. angulicostatum*, *Clydoniceras planum*, *Delecticeras* and the first ellipticonic *Bullatimorphites* of the subgenus *Kheraiceras*.

2.7. DISCUS ZONE (Horizons 14 and 15)

In most parts of the studied axeas except in England, Normandy and perhaps in NW Germany, the Discus Zone is incomplete. The lower part (Horizon 15) corresponding to the Hollandi Subzone is developed in addition to the previous regions in the Jura chain and Burgundy. The distinction between both subzonal index species based only on suture line features is very difficult on account of poor preservation and therefore rather a matter of personal opinion. In England besides *Clydoniceras* and *Delecticeras* there are *Parachoffatia* of the *subbackeriæ* group illustrated by W.J. Arkell (1951-1959).

3. Choice of type sections

. Zigzag Zone : it appears a general agreement to consider the Bas Auran section near Barrême (C. STURANI, 1967) as the type section.

. Progracilis Zone : two regions can be selected in which the faunal succes-

sion is not too obscure, namely the Vendée and northern Swabia. But further collecting is necessary before a choice can be made.

. Subcontractus Zone : H.S. Torrens (1971, p. 588) has proposed the Troll quarry, Thornford, Dorset, England where the zone is represented in the Fuller's Earth Rock (Thornford beds). Unfortunately, the lower part of this section appears poor in ammonites.

. Morrisi Zone : H.S. Torrens (1971, p. 589) has selected the south side of Bruton railway station cutting, Bruton, Somerset, England also developed in Fuller's Earth Rock facies. In this section boundaries with *Tulites* below and large *Procerites* above are well exposed.

. Hodsoni Zone : type section, none designated. Regions where the ammonite successions are fairly well known are the Ain district (Southern Jura chain) and Swabia. But further studies and collecting are also necessary.

. Aspidoides Zone : type section, none designated. The problem of nomenclature of this zone (see below) does not influence our search for a type section, but fossiliferous and non condensed beds are rare. The ammonite bearing Aspidoides Oolith of SW Germany must be more studied to determine the degree of condensation.

For his submediterranean equivalent, the Retrocostatum Zone, it seems that the best sections are localized in the Ardèche department (S. ELMI, 1967) and also in Portugal at the Cap Mondego outcrops (Elmi *et alii*, 1971).

. Discus Zone : in 1971, H.S. Torrens proposed as type section the Neue Tongrube Temme, near Hildesheim, NW Germany (G.E.G. WESTERMANN, 1958).

4. Precision on zonal index level - Parallel biostratigraphical scales

The choice of a new index species for the Aspidoides Zone between *Ox. Orbis* or *Ox. oppeli* must be a matter of open discussion in the working group.

Studies are necessary to know the exact level of standard zone and subzone indexes and also for index species of biostratigraphical units. After this work it will be possible to correlate biostratigraphical units by horizontal overlapping between different paleobiogeographical realms.

On the other hand, biostratigraphical studies founded on other paleontological groups than ammonites are necessary in various type-sections and outcrops to complete knowledge of the Bathonian stage and this should be done first in ammonite-bearing sections and then in sections without ammonites.

Table 1 : Correlation chart for the Bathonian of North and Middle Europe.

		ENGLAND Torrens 1980		NORTH GERMANY Westermann 1958		SOUTH GERMANY HAHN 1969		HUNGARY GALACZ 1969	FRANCE, JURA MOUNTS Mangold, 1970			FRANCE, VENDÉE Gabilly, 1964, 1967	POLAND Dayczak Calikouus Ka, 1981		
UPPER	15	DISCUS	DISCUS	DISCUS		DISCUS			DISCUS	DISCUS	Clydoniceras discus		DISCUS	15	UPPER
	14		HOLLANDI		HOLLANDI					HOLLANDI	Clydoniceras hollandi			14	
	13	ASPIDOIDES or ORBIS		ASPIDOIDES	ASPIDOIDES	ASPIDOIDES			RETROCOSTATUM	RETRO COSTATUM	Prohecticoceras retrocostatum	J Oxycerites aspidoides	PARADOXUS	13	
	12				PARADOXUS					BLANAZENSE	Prohecticoceras ochraceum blanazense	I Homeoplanulites homoeomorphus	HETERO COSTATUS	12	
	11	HODSONI			DENSECOSTATUS	"RETROCOSTATUM"		RETROCOSTATUM			Procerites mirabilis			11	
	10								SUBCONTRACTUS	NORRISI	Wagnericeras	H Wagnericeras	BREMERI	10	MIDDLE
	9							?			Cadomites daubenyi	G Bullatimorphites bullatimorphus		9	
MIDDLE	8	NORRISI				NORRISI					Morrisiceras morrisi	?	NORRISI	8	
	7	SUBCONTRACTUS		SUBCONTRACTUS		SUBCONTRACTUS		SUBCONTRACTUS		SUBCONTRACTUS	Iulites subcontractus			7	
	6	PROGRACILIS		?		PROGRACILIS		PROGRACILIS			? Cadomites orbignyi	F Gracilisphinctes	Procerites sp. sp.	6	
	5											E Cadomites orbignyi		5	
LOWER	4	TENUIPLICATUS		FALLAX		ZIGZAG	TENUIPLICATUS	ZIGZAG	ZIGZAG	TENUIPLICATUS		D_2 Procerites postpollubrum D_1 Oxy. yeovilensis	TENUI PLICATUS	4	LOWER
	3	ZIGZAG	YEOVILENSIS				YEOVILENSIS			YEOVILENSIS		C Procerites schloenbachi		3	
	2		MACRESCENS	ZIGZAG			MACRESCENS			MACRESCENS		B Zigzagiceras	COMPRESSA	2	
	1		CONVERGENS							CONVERGENS		A Gonolkites	FERRUGINEA	1	

Table 2 : Correlation chart for the Bathonian of Southern Europe, North Africa and Saudi Arabia.

		FRANCE, ARDECHE Elmi 1967		PORTUGAL Elmi et alii 1971		SOUTHERN SPAIN Mangold 1983		SOUTHERN SPAIN Sandoval 1983		ALGERIA M, MOROCCO-t, Elmi 1971		SAUDI ARABIA 1984		
UPPER	15	RETROCOSTATUM	?	RETROCOSTATUM								?	15	UPPER
	14		ANGULICOSTATUM		ANGULICOSTATUM								14	
	13		HISTRICOIDES		HISTRICOIDES			ASPIDOIDES					13	
	12		JULII		JULII								12	
	11								SUSPENSUM				11	
MIDDLE	10	SUBCONTRACTUS	MORRISI	SUBCONTRACTUS	MORRISI	BREMERI	SUSPENSUM	COSTATUM		SUBCONTRACTUS	Magnericeras		10	MIDDLE
	9						BULLATINORPHUS		BULLATINORPHUS		Bullatimorphus		9	
	8											Ohrumaites	8	
	7		SUBCONTRACTUS		SUBCONTRACTUS								7	
	6	PROGRACILIS			?			SOFANUM					6	
	5							?					5	
LOWER	4	ZIGZAC	YEOVILENSIS	ZIGZAC	YEOVILENSIS	ZIGZAC	TENUIPLICATUS	ZIGZAC	POSTPOLLUBRUN	ZIGZAC	?	Micromphalites	4	LOWER
	3						YEOVILENSIS		YEOVILENSIS		YEOVILENSIS		3	
	2		MACRESCENS		MACRESCENS		MACRESCENS		MACRESCENS		MACRESCENS	Tulites	2	
	1		CONVERGENS		CONVERGENS		CONVERGENS		DINORPHETIFORMIS		CONVERGENS	Thambites . "Cl." avus	1	

REFERENCES

ARKELL W.J. (1951-1959) : A monograph of the English Bathonian Ammonites. *Palæont. Soc. G.B.*, Mon. 24.

ARKELL W.J. (1956) : Jurassic Geology of the world. Edinburgh.

DAYCZAK-CALIKOWSKA K. (1981) : Korelacja biostratygraficzna jury srodkowej Polski z innymi obszarami. *In :* Budova geologiczna Polski, III, Atlas skamienialosci przewodnich i charakterystycznych, 2 b, Mezozoik, Jura. Instytut geologiczny, Wydawnictwa geologiczne, Warszawa 1980.

DIETL G. (1982) : Das wirkliche Fundniveau von *Ammonites aspidoides* OPPEL *(Ammonoidea,* Mittl. Jura) am *locus typicus. Stuttgarter Beitr. Naturk.*, B, 87.

DIETL G. (1983) : Das Bathonium (Mittlerer Jura) zwischen Aalen und Bopfingen, östl. Schwäb. Alb. 1. Mittel-Bathonium. *Stuttgarter Beitr. Naturk.*, B, 93.

ELMI S. (1967) : Le Lias supérieur et le Jurassique moyen de l'Ardèche. *Docum. Lab. Géol. Fac. Sci. Lyon,* n° 19.

ELMI S. (1971) : Les zones d'Ammonites dans la série Bajocien supérieur - Callovien de l'Aranie (Ouest algérien). *Bull. Soc. géol. France,* (7), XIII, 1-2.

ELMI S. and MANGOLD C. (1967) : Etude de quelques *Oxycerites* du Bathonien inférieur. *Trav. Lab. Géol. Fac. Sci. Lyon,* N.S. 13.

ELMI S., MANGOLD C., MOUTERDE R. and RUGET C. (1971) : Révision de l'étage Bathonien au Cap Mondego (Portugal). *Ann. Inst. Geol. Publ. Hung.*, LIV, 2.

ENAY R. and MANGOLD C. (1984) : The ammonite succession from Toarcian to Kimmeridgian in Saudi-Arabia. Correlation with the european faunas. *Jura-Symposium* Erlangen, Sept. 84.

GABILLY J. (1964) : Le Jurassique inférieur et moyen sur le littoral vendéen. *Trav. Inst. Géol. Anthropol. Préh. Poitiers,* 5.

GALACZ A. (1980) : Bajocian and Bathonian Ammonites of Gyenespuszta, Bakony Mts. Hungary. *Geologica Hungarica,* 39.

HAHN W. (1966) : Zur Stratigraphie des Bajociums und Bathoniums (Dogger δ-ε) der Schwäbischen Alb. *J. h. geol. Landesamt Baden-Wüsttemberg,* 8.

HAHN W. (1968) : Die *Oppeliidæ* BANARELLI und *Haploceratidæ* ZITTEL *(Ammonoidea)* des Bathoniums (Brauner Jura ε) im südwestdeutschen Jura. *J. h. geol. Landesamt Baden-Württemberg,* 10.

KOPIK J. (1974) : Genus *Cadomites* MUNIER-CHALMAS, 1892 *(Ammonitina)* in the Upper Bajocian and Bathonian of the Cracow-Wielun Jurassic range and the Gory Swietokrzyskie mountains (Southern Poland). *Inst. geol. Biul.*, VII.

MANGOLD C. (1970) : Stratigraphie des étages Bathonien et Callovien du Jura méridional. *Docum. Lab. géol. Fac. Sci. Lyon*, n° 41.

MANGOLD C. (1979) : Le Bathonien de l'Est du Subbétique (Espagne du Sud). *Cuad. Geol.*, 10.

MANGOLD C., ELMI S. et GABILLY J. (1971) : Les faunes du Bathonien dans la moitié sud de la France. Essai de zonation et de corrélations. *Mém. B.R.G.M.*, 75.

MANGOLD C., ELMI S. et GABILLY J. (1971) : Bathonien. *In :* Les zones du Jurassique en France. *C.R. som. Soc. géol. France*, 6.

SANDOVAL GABARRON J. (1983) : Bioestratigrafia y Paleontologia *(Stephanocerataceae* y *Perisphinctaceae)* del Bajocense y Bathonense en las Cordilleras beticas. *Tesis Doctoral*, Univ. Granada.

STURANI C. (1967) : Ammonites and stratigraphy of the Bathonian in the Digne-Barrême area (SE France). *Bol. Soc. paleont. Ital.*, 5.

TORRENS H.S. (1971) : Standard zones of the Bathonian. *Mém. B.R.G.M.*, 75.

TORRENS H.S. (1980) : A correlation of Jurassic rocks in the British Isles. Part Two : Middle Jurassic. *Geol. Soc. Spec. Rep.*, 15.

WESTERMANN G.E.G. (1958) : Ammoniten-Fauna und Stratigraphie des Bathonien NW Deutschlands. *Beih. Geol. Jb. Dtsch.*, 32.

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Report of the Callovian Working Group

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Abstract. - The proceedings of the first meeting of the Callovian Working-Group of the International Subcommission on Jurassic Stratigraphy held at Erlangen in September 1984 are summarized. A statement of the present status of the rather well-established definition of the Callovian Stage and its boundaries is followed by a brief review of some of the major developments and problems in Callovian stratigraphy in various parts of the world.

A. ORGANIZATIONAL

THE Callovian Working-Group was set up in 1983 and, at the invitation of the President and Secretary of the Subcommission, J.H. Callomon agreed to act as co-ordinator. The first meeting was held during the Symposium at Erlangen on 7 September 1984. From among those present and others, some 40 expressed a desire to join the Working Group, either as active members at present working on problems of Callovian stratigraphy, or as passive members interested but not immediately involved in the Callovian. Membership is not restricted, and readers of this report not present at Erlangen wishing to join are cordially invited to do so by informing the co-ordinator.

The future programme of the Working-Group is envisaged to be primarily one of disseminating information. To this end, the co-ordinator agreed to act as central post-box and forwarding-agent for enquiries. He did not think that it would be practical for the Working-Group *per se* to initiate programmes of active work on out= standing stratigraphical problems, for it disposes neither of the manpower nor of the material resources needed to support such ventures. It should however be in a strong position to identify and

formulate the problems to be tackled by individuals as the oppor= tunities arise.

The main part of the meeting was then taken up by a brief review by the co-ordinator of the present status of the chrono= stratigraphic zonation of the Callovian Stage. This is summarized below.

B. DEFINITION AND STANDARD ZONATIONS

For purposes of refined chronostratigraphy, ammonites have so far had no serious challengers in the Callovian. They form the basis of what appears to have been the first zonation of a Jurassic Stag according to the principles summarized elsewhere in this volume, down to the level of the typological definition of the lowest unit in the hierarchy, the Subzones.

(1) European Sub-Boreal zonation.

The standard European Sub-Boreal zonal scale put forward at the fi Luxembourg Colloquium (Callomon 1964) has stood the test of time almost unchanged. It was based to a considerable degree on the classical work of Brinkmann in the Oxford Clay of Peterborough (adapted as explained in Callomon, 1968), and has been modified mainly by refinement in those parts of the succession now better known. The present scale is presented in the Geological Society of London's Correlation Charts (Duff 1980)(figure 1(a)), and is at present almost universally accepted as the primary standard. It defines the Callovian Stage in terms of the lower boundary strato= type of the basal Macrocephalus Subzone of the Macrocephalus Zone, taken (rightly or wrongly, for reasons explained in Callomon, 1964 at the base of bed 4, Upper Cornbrash, Sutton Bingham, Somerset, England (Arkell 1954). One of the uncertainties relating to the subzonal index has since been resolved. The interpretation of *M. macrocephalus* in terms of a neotype proposed by Callomon, 1971, has been validated by the ICZN in Opinion 1275 (ICZN, 1984). The other, whether this species in fact occurs in its nominal Subzone, is mentioned further below.

The European Sub-Boreal zonation is applicable at zonal level more or less from East Greenland (except for the lowest Zone) via the Anglo-Norman and Rhodano-Swabian basins through Poland, central and southern Russia to the Caucasus and trans-Caspian Turkmenistan

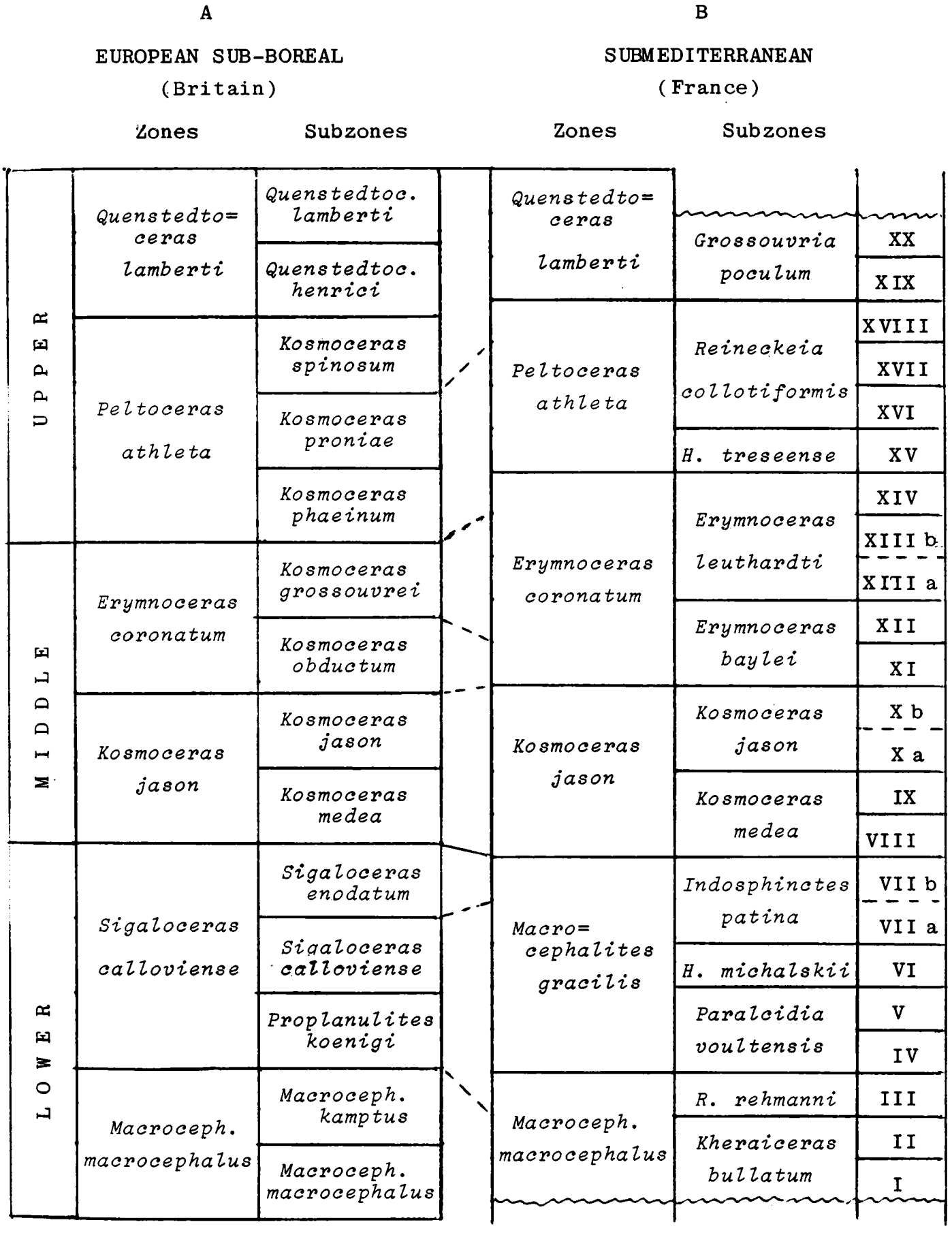

FIGURE 1. - Standard zonations of the Callovian Stage. (A): drawn with Subzones equispaced. (B): drawn with faunal horizons I-XX equispaced (after Cariou, 1980). Approximate correlations (JHC) indicated by dashed lines.

(Mangyshlak). It fails further south, however, because its faunas are there replaced by others. Alternative, parallel standard zonations are needed.

(2) European Submediterranean zonation.

A standard zonation of finesse comparable to the N European standar has been put forward by Cariou (1980), based on the superbly developed, exposed and fossiliferous successions of W France, in Poitou and the Aquitaine Basin (figure 1(b)). Correlation between the two standard scales is very close at most levels, but two problems remain. The first concerns the relative ranges of the Macrocephalus Zone. There is no evidence that the base of the Bullatus Subzone in Poitou coincides with the Macrocephalus Subzone A precise correlation must await a fuller study of the Macrocephali tinae and Tulitidae and ther comparisons with those of Swabia (see below). In the author's opinion based on the evidence so far, the oldest Callovian found in Poitou is younger than that in England and in Swabia, the lowest parts having been lost in what is a well-recognized regional non-sequence that has also cut out much of the Upper Bathonian. The second problem concerns the top of the Callovian. The Callovian-Oxfordian boundary beds seem to be missing over wide areas in the Submediterranean Province; and even when present, their recognition must await a proper evaluation of the only ammonites likely to be diagnostic, the Perisphinctinae.

C. OTHER REGIONS

The zonation of the Callovian in other parts of the world ranges from the advanced to the rudimentary, for the usual reasons: frag= mentary faunal successions, sparse exposures, faunal provincialism and insufficient study. There is space here only for some notes and comments.

(1) Western Europe: Swabia.

A most significant step towards the closer correlation of the Lower Callovian in its type successsions in England with those further afield has been taken by Dietl (1981), who has begun to re-examine, for the first time since Oppel, the classcial Macrocephalenoolith of Swabia. Contrary to the impresssion given by the literature, a

clearly resolvable faunal succession is discernible. At least four ammonite horizons are present below the Calloviense Zone. The lowest (Sw1) is characterized by *Kepplerites keppleri* (Oppel), the next one up (Sw2) by *Macrocephalites macrocephalus s.s.* and *Cadoceras quenstedti* Spath. *K. keppleri* occurs in England at a level some= where near the base of the Upper Cornbrash (Callomon 1959), i.e. a little above the base of the Macrocephalus Subzone and hence the Callovian by definition, and the *keppleri* horizon at the base of the Macrocephalenoolith of Swabia lies therefore very close to the base of the Callovian. The Macrocephalitids of the lowest two horizons there differ only to a minor degree, and hence there can be little doubt that the second horizon, with *M. macrocephalus*, also still lies within the Macrocephalus Subzone. Work on the Swabian faunas and successions continues. The area is also notable for the first undisputable records in Europe of true *Macrocephalites* from the Orbis Zone (*olim* Aspidoides Zone) of the Upper Bathonian.

(2) Portugal.

Without doubt one of the finest Bathonian-Callovian successions in the world is the one around Cap Mondego, but beyond a brief summary (Ruget-Perrot 1961, Rocha *et al.* 1981) no account in the detail that it deserves appears yet to have been published. The natural sections are being obliterated by quarrying and a stratigraphical rescue operation would seem to be a matter of urgency.

(3) Eastern Europe: USSR.

The zonations of the Callovian adopted in the USSR west of the Urals, from the Caucasus in the south to the Petshora in the north have recently been reviewed by Krymgolts *et al.* (1982). Those of the central and northern Russian Platform differ from the west European Sub-Boreal standard mainly in the Lower Callovian, in which alternative Zones of *Cadoceras elatmae* and, in the north, *Arctico= ceras kochi* are introduced. The Elatmae Zone is equated with the lower Calloviense Zone, but the close similarity between *C. elatmae* and *C. quenstedti* of Swabia (see above, horizon Sw2) suggests strongly an earlier age, equivalent at least in part to the Macro= cephalus Subzone. A detailed re-examination of the classical successions on the Oka around Elatma would seem a very worthwhile project. As for the Kochi Zone, the evidence in the Arctic is now

overwhelming that its age lies somewhere near the Middle-Upper Bathonian boundary (see Callomon 1972, 1984a); and as *Arcticoceras kochi* (type from Greenland) is a junior synonym of *A. ishmae* (type from the Petshora), Ishmae Zone seems a more appropriate name.

(4) The Arctic.

At high latitudes, ammonites of the Macrocephalitinae and the Kosmo ceratidae used in the Sub-Boreal zonation are absent or sporadic, so that another family, the Cardioceratidae, have to be used instead. These provide an almost uninterrupted evolutionary sequenc from the Upper Bajocian to the Kimmeridgian (see Callomon 1984a), at present best known in East Greenland. Location of the Bathonian-Callovian boundary there again depends on the presence of *Kepplerit* very close to, even if not quite identical with, *K. keppleri*. The associated *Cadoceras apertum* Callomon & Birkelund (in Callomon 1984 finds its closest matches in *Cadoceras frearsi* (d'Orbigny, 1845) of the Elatmae Zone of the Volga Basin. Near the top of the Callovi a fauna intermediate between *Longaeviceras* and *Quenstedtoceras* has been used as basis for a Subordinarium Zone in northern Siberia (Meledina 1977), but the forms are not identical with *Quenstedtocer subordinarium* as defined by English type material, and may be a little older (see Callomon 1984a). The Lamberti Zone is also not recognizable, and is replaced by a Zone of *Longaeviceras keyserling*

(5) North America.

The ammonite faunas have recently been reviewed in detail (Callomon 1984b). They are mixtures of Boreal forms and a long succession marking yet another distinct faunal realm, the Eurycephalitinae of the East Pacific Realm. It transpires that most of the faunas previously thought to be Callovian are still Bathonian. Callovian is present in any quantity only in Alaska, and the Bathonian-Callov boundary is located yet again by *Kepplerites* very close to *K. keppl* *K. (olim Symourites) loganianus* (Whiteaves).

(6) South America.

A revision of the long-known "Callovian" faunas of the Andes (Ricca and Westermann, in progress) is going to call for reassignments, mostly downwards into the Bathonian, every bit as drastic as in

North America. Most of the forms formerly assigned to Callovian Macrocephalitinae are also Pacific Eurycephalitinae, and many, even if not all, of the "Callovian" Reineckeiidae belong to another Pacific assemblage, the Neuqueniceratinae, whose age is in part also certainly still Bathonian and whose relations to the true, Tethyan Reineckeiinae remains unclear.

(7) The Indo-Malagasy Province.

The stratigraphically best-known successions are those of Cutch, but even so our knowledge is by European standards still rudimentary. The best published summary is still that to be found in Arkell (1956; see also Krishna 1983). The richest and best part of the succession is in the Lower Callovian, but the apparently long ranges of some of the ammonites suggests that the sequence may not be as near to complete as its thickness might have led one to hope. Brief bursts of thick sedimentation may turn out to have been separated by long non-sequences. A modern revision is urgently needed. Enormous new collections made in Madagascar, notably by Collignon (1958), have greatly amplified our knowledge of the faunas but have added very little to their stratigraphy. A problem of renewed interest is that of the position of the Bathonian-Callovian boundary in the region. There are growing reports of the overlapping of the ranges of the ammonite *Clydoniceras* (Bathonian) and *Macrocephalites* (Callovian par excellence). The earliest forms of the latter - *M. triangularis* - may turn out to be still of Bathonian age. At the top of the succession, the precise identification of the equivalents of the European Lamberti and Mariae Zones at the Callovian-Oxfordian boundary remains problematical, as it does almost everywhere south of the Tethys.

(8) Indonesia.

The rich faunas of the Sula Islands described by Boehm have been recollected by Westermann, Sato and Skwarko (1978). A description is nearly complete (Westermann and Callomon MS). Enough stratigraphical evidence was available to establish the main features of the successions and, above all, the faunal associations; and it is quite clear from the accessory elements such as *Cadomites*, *Bullatimorphites*

and *Oppelia* that the earliest representatives of *Macrocephalites* are of early Upper Bathonian, perhaps even already Middle Bathonian age.

(9) Israel - Arabia.

The Jurassic rocks along the eastern borders of the Arabo-Nubian craton stretching in extensive outcrops from 20° to 35°N have so far yielded only intriguing glimpses of their faunas, which differ so strongly from those elsewhere that their interest is out of all proportion to their known volume. The Callovian is revealed by ammonites at a few horizons, particularly in the Upper part, and the earlier descriptions, summarized by Arkell (1956) and based to a considerable degree on his own work (1952; see also Imlay 1970), have recently been amplified by new discoveries in Sinai and the Negev (Lewy 1983). New collections from Jebel Tuwaiq reported at the present Symposium by Enay and Mangold promise to add even more to our knowledge. These are exciting prospects.

D. CONCLUSION

As the foregoing notes indicate, much remains to be done in many parts of the world. The biostratigraphy of groups other than the ammonites has hardly been touched upon here, and some collective summaries in tabular form would be most welcome.They should also help to focus attention on unsolved problems and gaps in knowledge. The compilation of such summaries would be a worthwhile task for our Working-Group. Your co-ordinator welcomes contributions.

REFERENCES

ARKELL, W.J., 1952. Jurassic ammonites from Jebel Tuwaiq, Central Arabia. *Phil.Trans.Roy.Soc.Lond.*, *B236*, 257-313.

--- 1954. Three complete sections of the Cornbrash. *Proc.Geol. Ass.*, *65*, 115-132.

--- 1956. *Jurassic Geology of the World;* Edinburgh & London, Oliv & Boyd.

CALLOMON, J.H., 1959. The ammonite Zones of the Middle Jurassic beds of East Greenland. *Geol.Mag.*, *96*, 505-513.

CALLOMON, J.H., 1964. Notes on the Callovian and Oxfordian Stages. *In:* P.L. MAUBEUGE, ed., *Comptes rendues et Mémoires, Colloque Jurassique Luxembourg 1962*, p.269-291; Luxembourg, Inst.gd-ducal, sect.Sci.nat.,phys.,math.

--- 1968. The Kellaways Beds and the Oxford Clay. *In:* P.C. SYL= VESTER-BRADLEY & T.D. FORD, eds., *The Geology of the East Midlands*, p.264-290; Leicester, University Press.

--- 1971. On the type species of *Macrocephalites* Zittel, 1884, and the type specimen of *Ammonites macrocephalus* Schlotheim, 1813. *Palaeontology*, *14*, 114-130.

--- 1972. Jurassic System. *In:* An annotated map of the Permian and Mesozoic formations of East Greenland. *Meddr om Grønl.*, *168*, no.3, 15-20.

--- 1984a. The evolution of the Cardioceratidae (Jurassic ammoni= tina). *Spec.Pap.Palaeontology*, in press.

--- 1984b. A review of the biostratigraphy of the post-Lower Bajocian ammonites of western and northern North America. *Geol. Ass.Canada Spec.Pap.*, in press.

CARIOU, E., 1980. L'étage Callovien dans le centre-ouest de la France. *Thèse, Dr.Sci.nat.Univ.Poitiers, U.E.R.Sci.fond. appliquées*, *325*, 1.partie, 37p.

COLLIGNON, M., 1958. *Atlas des fossiles characteristiques de Madagascar. Fasc.iii: Bathonien-Callovien.* Tananarive, Serv. geol.

DIETL, G., 1981. Über *Macrocephalites* (Ammonoidea) aus dem Aspidoides-Oolith und die Bathonium-Callovium-Grenzschichten der Zollernalb (SW-Deutschland). *Stuttg.Beitr.Naturk.*, *B68*, 15p.

DUFF, K.L., 1980. Callovian correlation chart. *In:* J.C.W. COPE, ed., A correlation of Jurassic rocks in the British Isles, part 2: Middle and Upper Jurassic. *Geol.Soc.Lond.Spec.Repts*, *15*, 45-60.

IMLAY, R.W., 1970. Some Jurassic ammonites from central Saudi Arabia. *U.S.Geol.Surv.Prof.Pap.* *643-D*, 17p.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1984. Opinion 1275: *Macrocephalites* Zittel, 1884, and *Ammonites macrocephalus* Schlotheim, 1813 (Mollusca, Cephalopoda): placed on the Official Lists. *Bull.zool.Nomencl.*, *41*, 34-35.

KRISHNA, J., 1983. Callovian-Albian ammonoid stratigraphy and palaeobiogeography in the Indian Sub-continent with special reference to the Tethys Himalaya. *Himal.Geol.*, *11*, 43-72.

KRYMGOLTS, G. Ya., ed., 1982. The Jurassic Zones of the USSR. *Trans.Interdeptl Strat.Comm.USSR*, *10*, 191p; Leningrad, Nauka.

LEWY, Z., 1983. Upper Callovian ammonites and Middle Jurassic geological history of the Middle East. *Bull.geol.Surv.Israel*, *76*, 56p.

MELEDINA, S.V., 1977. Ammonites and zonal stratigraphy of the Callovian of Siberia. *Trans.Acad.Sci.USSR, Siber.branch*, *356*, 228p.

ROCHA, R., MANUPPELLA, G., MOUTERDE, R., RUGET, Ch. & ZBYSZEWSKI, G 1981. *Carta geológica de Portugal: notícia explicativa de folha 19-C, Figuera da Foz*, 29-33; Lisbon, Serv.geol.Portugal.

RUGET-PERROT, Ch., 1961. Études stratigraphiques sur le Dogger et le Malm Inférieur du Portugal au nord du Tage. *Mem.Serv.geol. Portugal, N.S.*, *7*, 197p.

WESTERMANN, G.E.G., SATO, T. & SWARKO, S.K., 1978. Brief report on the Jurassic biostratigraphy of the Sula Islands, Indonesia *Newsl.Stratigr.*, *7*, 96-101.

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Report of the Oxfordian Working Group

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I. INTRODUCTION

1) The Meeting of the Oxfordian Working Group took place within the Symposium on Jurassic Stratigraphy, Erlangen, on 5/11/1984, after the lecture sessions. A whole of c. 30 participants attended the meeting. Discussions were coordinated by the convenor of the Group, Prof. R. Enay (Lyon). The present notes summarize the discussions held by all participants and have been elaborated by the convenor of the Group and by the secretary, Dr. G. Meléndez.

2) Two sets of Biostratigraphic correlation tables of Oxfordian zonal scales (on the base of ammonites) were elaborated in order to serve as a basis for discussions in the meeting. The first by R. Enay (August 1984), restricted to the more recent zonal tables now in use for Europe and Northern Africa only, was delivered to all participants ; the second, by G. Meléndez, including recent zonal schemes for Southern and Central Americas, was also projected and used, as complementary informative material in the discussions.

A copy of the first set of tables, once revised and corrected, is here enclosed.

3) List of Members : A first, provisional, list of potential members of the Oxfordian Working Group, elaborated by the secretary of the Group, was completed here, by means of personal application of participants. The Group has been, therefore, enlarged, from 65 to 81 members, and the actualized list of members names and addresses is here also included and has already been dispatched to all colleagues.

4) The discussions are not summarized in their right order during the meeting and we present successively problems concerning 1) Zonal tables, 2) Correlations of zonal schemes, 3) Delineation of boundaries.

II. PROVINCIAL ZONAL SCHEMES (TABL. 1 AND 2)

A fairly large set of problems concerning correlation of zonal (and subzonal) schemes of different authors for Boreal/Subboreal and Submediterranean Areas was discussed, and constituted the main part of polemics in the meeting. In this inform we are only giving the main ideas and/or results of discussions, when available.

During the discussion, J. H. Callomon expressed the opinion that the classical NW European zonal scheme - a long time the more advanced ! - is to be disused leaving side by side only two, for Submediterranean and Subboreal/Boreal provinces.

1. Boreal/Subboreal and NW European Zonal schemes (Tabl. 2). According to Callomon the new zonal schemes based on Cardioceratids only (Sykes & Callomon, 1979) can be used also for the NW European province.

1.1. Upper Oxfordian. During the discussion his own table is modified by J. H. Callomon himself : on the base of new informations in Skye (Birkelund & Callomon, in press) Bauhini Subzone of 1979 coincides with Baylei Zone and belongs to Lower Kimmeridgian ; hence Rosenkrantzi Zone is now restricted to beds up to base of Baylei Zone.

1.2. Cautisnigrae Zone. Discussions concern the use and the place of this Zone (and Subzone) owing to the finding of the species in some parts of the Submediterranean province :

a) (Callomon) : There is growing evidence that in Southern England generally, *Perisphinctes* (*Per.*) *variocostatus* (BUCKL.) appears above *P.* (*P.*) *cautisnigrae* ARKELL, well allowing the distinction of two subzones, i.e. Cautisnigrae, and Variocostatus Subzones, in the NW European Zonal Scheme.

b) (Meléndez) : *Per. cautisnigrae* has been found in Transversarium Zone in some parts of Southern Europe-Poland (Malinowska, 1972 ; Brochwicz-Lewinski, 1976, 1979 ; Brochwicz-Lewinski & Rozak, 1974). The species is also regarded by these authors as a typical *Perisphinctes* of the Transversarium Zone, not of the *panthieri-varicostatus* group. This would open the possibility that Cautisnigrae Subzone would, at least partly, correspond to Schilli Subzone.

c) According to Callomon, the evidence in the type-locality is that the typical Cautisnigrae assemblage (i.e., the *cautisnigrae* biospecies sensu

Callomon), comprises a whole of taxa characteristic and correlable with lower Bifurcatus Zone. This would not exclude, in any case, that the morpho-species *Per. cautisnigrae* ARKELL may be found within Transversarium Zone in some parts of Europe.

d) Further evidence on that problem comes from Gygi, who reported the finding of *Per. variocostatus* (BUCKL.) in Switzerland, above *Per. parandieri*.

2. Submediterranean Zonal Scheme (Tabl. 1). There is a general agreement on the succession of the characteristic faunas, although their accomodation as standard zonal scheme and the selection of zonal indexes are different. A more or less achievement concerning Subzones and/or Horizons is reached in some country.

a) (Enay) : The elaboration of a Perisphinctids zonation scale for Lower and Middle Oxfordian of Submediterranean and Mediterranean Areas, as a complementary tool of that of Cardioceratids, is regarded as positive and useful for correlation, regarded that it should be established in points where faunal successions were complete (see Meléndez, Sequeiros & Brochwicz-Lewinski, in this volume).

In Poland (Brochwicz-Lewinski, 1976) and Bulgaria (Sapunov, 1976), then in Spain, iberic chains (Sequeiros & Meléndez, 1979 ; Meléndez *et alii*, 1982 ; Meléndez & Brochwicz-Lewinski, 1983, 1984), Perisphinctids appear as alternative index in part of the Lower (Claromontanus Zone or Subzone and Mazuricus Subzone) and Middle Oxfordian (Episcopalis/Paturattensis Zone).

That is the first step to replace Cardioceratids by Submediterranean zonal indexes and to achieve a complete and unified zonal scheme using only Submediterranean groups. But much work is needed on these faunas including Perisphinctids, Peltoceratids, Oppelids etc... Progress in the biostratigraphical value of such groups is of special interest for the Mediterranean province in Southern Europe and Northern Africa where Cardioceratids are absent.

b) The recent use of a Densiplicatum Zone by Gygi and Marchand (1982) is on a quite different way. It is proposed as a full zone with the same extent as the Vertebrale Subzone of the Plicatilis Zone (the Antecedens Subzone being included in as larger Transversarium Zone). Moreover Densiplica-

tum Zone has quite different extent in Submediterranean and Boreal/Subboreal zonal schemes.

c) Hauffianum Subzone : According to Zeiss, *T. hauffianum* (OPPEL) would not be a useful index for uppermost Bimammatum Zone in the Franconian Alb, the Litocerum Subzone appearing as a much more valuable alternative name, (Index Species : *T. litocerum* (OPPEL).

Evidence from the Iberian Chain (Meléndez), would also support this view, and that solution for this part of Southern Europe.

IIIa. CORRELATIONS BETWEEN PROVINVIAL ZONAL TABLES (TABL. 3 AND 4)

Difficulties to correlate faunas from different biogeographical provinces in Europe begin by the end of Lower Oxfordian and increase during Middle Oxfordian. Tentative correlations have been proposed by many authors, among whom Brochwicz-Lewinski (1976) or Sykes and Callomon (1979).

After J. H. Callomon proposal for retaining only two zonal schemes, the discussion focuses on correlations between submediterranean and boreal/subboreal provinces on the basis of Tabl. 3 (including correction by J. H. Callomon).

1 - "Middle" Oxfordian Correlations (e.g. below Submediterranean Bimammatum Zone = Middle Oxfordian or Middle and Upper Oxfordian, pars, according to various authors).

a) Problems would be summarized as follows (Enay) :

1) As an horizon, Tenuiserratum was first proposed by E. Cariou (1966) in Poitou and L. Malinowska (1966) in Poland, for the upper part of the Antecedens Subzone, Plicatilis Zone. The species is not known in the Submediterranean Parandieri Subzone, but a longer range in boreal/subboreal regions cannot be excluded.

2) Nunningtonense Subzone appears well correlable with Schilli Subzone, in Submediterranean Area, on the occurence of *A. nunningstonense* (listed as *Am. alternans*) in Poitou and Southern French Jura. It is noticeable that

such correlation disagrees with the proposal (see above p. 2 § 1.2.) to correlate NW-European Cautisnigrae Subzone and Submediterranean Schilli Subzone.

3) *A. nunningtonense* is probably present in upper part of Ilovaiskii Subzone (Callomon), so correspondency may be roughly established with Boreal/Subboreal zonal scheme.

4) Within Glosense Zone (Standard Zone), Glosense Subzone is still uncertainly correlable with Stenocycloides Subzone. The necessity of revising Amoeboceratids successions in Franconian Alb was, in this sense, stressed by Callomon (and in the whole Submediterranean Area, by Enay !).

2 - Correlation of Submediterranean Bimammatum Zone and Boreal/Subboreal scales ; this is connected with the appearance of first representatives of *Ringsteadia*.

a) According to Zeiss (1984) : Pseudo-yo, and Pseudocordata ? Subzones would roughly correspond respectively to Planula and Grandiplex ? Horizons (= Planula Subzone), and Evoluta Subzone, to Gigantoplex ? Horizon (= Galar Subzone).

b) According, however, to Sykes & Callomon (1979), and to Wright & Callomon (1980), first species of *Ringsteadia* would occupy a rather lower position, the Caledonica, Pseudo-yo, and Pseudocordata Subzones being roughly equivalent to Bimammatum and Hauffianum Subzones.

c) According to Wierzbowski, in Poland, and Enay for Southern French Jura, first *Ringsteadia* (? - pre-*caledonica* forms), appears sharply at the base of Hypselum Subzone.

d) According to Gygi, in Switzerland *R. pseudo-yo* is recorded together with *E. bimammatum*, i.e., a position close to that assumed by Sykes & Callomon (1979).

e) Finally, despite these precisions, the possibility of a level by level correlation in base of Cardioceratids was reputed as difficult, if not impossible, by Callomon, who stressed the large variability the representatives of this group show in a single level, and remarked the necessity of counting with large assemblages of coeval populations in different regions, in order to identify such variability and try to work with the real Biospecies.

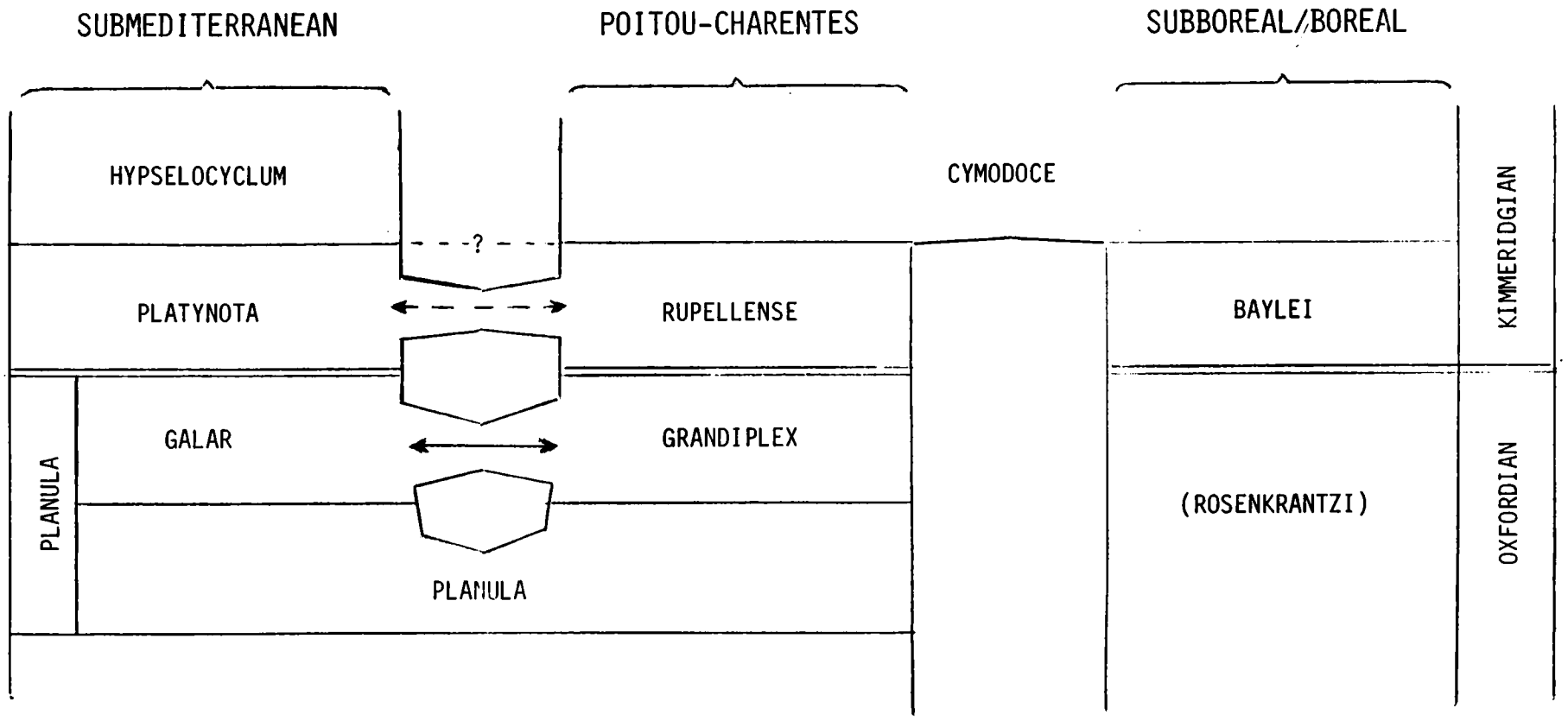
III b. Delineation of Boundaries

1) Oxfordian-Kimmeridgian Boundary :

a) According to Callomon (see above), in NW European and Boreal regions it is traced at the base of Baylei Zone, actually equivalent to base of Bauhini Subzone. As far as Submediterranean and Mediterranean Areas is concerned, there is growing evidence that upper part of Planula Zone (i.e. Galar Subzone), belongs really to lower Kimmeridgian instead of the uppermost Oxfordian (Callomon).

b) Some questions and objections arose on that point (Sarjeant) ; on the other hand, evidence from S European areas was exposed (Meléndez), in the sense that, actually, *Subnebrodites planula* (HEHL), as remarked by Atrops (1982) has never been found within Galar Subzone. This would simplify the problem, if the coincidence between the Biozone of *S. planula* and the Planula Standard Zone is assumed and, either a Galar Zone for Lowermost Kimmeridgian is erected (or else, the Galar Subzone is convenctionally incorporated as lower subzone of Platynota Standard Zone).

c) P. Hantzpergue proposes a different way using Cymodoce zone and the peculiar sequence of faunas in the Poitou-Charentes region (the Type area of *Rasenia cymodoce*). Neither subboreal/boreal Baylei Zone nor Submediterranean Platynota Zone can be used ; and the new Rupellense Zone, with a fauna of Submediterranean affinities, fill the interval between the Cymodoce Zone above and a will defined Planula Zone below, divided into a lower Planula Subzone and an upper Grandiplex Subzone. As *S. galar* has been found (Barale *et al.*, 1983) in the Grandiplex Subzone (Gigantoplex Horizon) the discrepancy concerning the Oxfordian-Kimmeridgian boundary in boreal/subboreal and submediterranean provinces seems to be not so important as J. H. Callomon supposed.


SUBMEDITERRANEAN
POITOU-CHARENTES
SUBBOREAL/BOREAL
HYPSELOCYCLUM
CYMODOCE
?
PLATYNOTA
RUPELLENSE
BAYLEI
KIMMERIDGIAN
GALAR
GRANDIPLEX
PLANULA
(ROSENKRANTZI)
OXFORDIAN
PLANULA

NOTA - *S. platynota* is listed by Cariou (1972) North of Poitiers, on the southern border of the Paris basin just above a typical fauna of Planula Zone, but the specimen is not well preserved and not convincing, in opinion of R. Enay.

The correlation table above has been prepared after the meeting by R. Enay and received agreement by P. Hantzpergue.

2) Callovian-Oxfordian Boundary : As recently stated in several papers by Marchand (1980... ; also this Symposium), in Subboreal and, partly, Submediterranean Areas, the Callovian-Oxfordian Boundary could well be delimited at the base of Paucicostatum Horizon Marchand, actually recognised in numerous points of Europe, according to this author. Objections to that interpretation were set by Callomon, on the grounds of the slight difference existing between *Quenstedtoceras woodhamense* ARKELL assemblage and *Cardioceras paucicostatum* assemblage. Despite these real objections there seems to be a general agreement on the acceptance of such Horizon as basal Biostratigraphic Unit for lower Oxfordian. Objections set by Sarjeant on the grounds that Paucicostatum Horizon partly falls both within Lamberti and Mariae were worked out by Enay's proposol, i.e. : placing the lower boundary of Scarburgense Standard Subzone (and so, of Mariae Standard Zone !) at the base of Paucicostatum Horizon.

As far as more South European Areas is concerned (i.e. Submediterranean-Mediterranean Regions), a stratigraphic gap comprising at least the Lamberti/Mariae Zones interval is most normally found. The usual lowest assemblage identified comprises the "*claromontanus* assemblage", roughly equivalent to Lower-Middle Cordatum Zone (Brochwicz-Lewinski, 1981 ; Meléndez *et alii*, this Symposium). Therefore, a good Perisphinctids zonation for lowermost Oxfordian remains still hypothetical. Moreover, the status, as well as the stratigraphic position of some lowermost Oxfordian Perisphinctids species, such as *Per. bernensis* LORIOL appears still not definitively stablished or, at least, not sure (Marchand).

3) Substages or stage divisions within the Oxfordian stage

a) Defining Substages : The possibility and convenience of defining substages within Oxfordian vs. the nowadays assumed division in Lower, Middle, and Upper Oxfordian, was pointed out by W. Sarjeant, on the grounds

that a formally defined substage, in its Stratotype, and with a type-Localy is "potentially unambiguous". Objections were cast mainly by Callomon and others, supporting the currently accepted subdivision of Oxfordian, in Lower, Middle, and Upper, with the simple rule that they should be written in capital letters when used in formal sense.

b) Stage divisions (or substages) boundaries : Such problems arose again recently in papers by a part of the Polish and Spanish schools, especially for the Middle-Upper Oxfordian boundary in the Submediterranean province. There is a good enough agreement (cf. correlation tables) for the Lower-Middle Oxfordian boundary... although R. Tarkowski intend to propose a different one... !

c) Lower-Middle Oxfordian Boundary : The internal boundaries within the Oxfordian are regarded as questions of minor importance (Enay). In Submediterranean Areas the Lower-Middle Oxfordian Boundary has been classically placed at the base of Plicatilis Zone, i.e. Base of Tenuicostatum Subzone (= Cariou *et alii*, 1971). Recently, several authors (Brochwicz-Lewinski, 1976 ; Brochwicz-Lewinski & Rozak, 1974 ; Meléndez *et alii*, this Symposium) tend to place it at the base of Antecedens Zone, or Antecedens Subzone of Plicatilis Zone, in the former scheme. The discussion at this point still remains open.

d) Middle-Upper Oxfordian Boundary : It was currently accepted as placed by Cariou *et alii* (1971) at the base of Bifurcatus Zone by numerous authors (see tables here in). Some other authors recently (Brochwicz-Lewinski, 1976, 1978 ; Meléndez, 1978, 1984 - Meléndez *et alii*, this Symposium, and others), have relocated this boundary at the base of Hypselum Subzone (i.e. Base of Bimammatum Zone). According to Meléndez, this boundary should be better placed here, on the grounds of the important renewal of the fauna recorded in the Submediterranean Area, i.e. The substitution of representatives of Perisphinctinae (genus *Perisphinctes* and its allies), by that of Passendorferiinae (Genus *Passendorferia* and related forms), that is : Typically mesogean forms. This solution would be also supported by Zeiss (1984, correlation Table), and was similarly admitted by Callomon, as the classical "Oppelian" acception.

IV. CORRELATION TABLES OUTSIDE EUROPE AND MULTIDISCIPLINARY CORRELATION

There are two major aspects on which discussions failed completely. Shortness of the 1st Oxfordian Working Group meeting is the main reason.

1) On the first point, correlation tables for countries outside Europe, G. Meléndez prepared a table with the more recent zonal schemes used in Central and Southern Americas, but any time was available for discussion. This attempt will be enlarged for others Jurassic basins in the world where zone schemes or faunas exist.

2) Concerning multidisciplinary correlations using as numerous fossil groups as possible, both the Secretary and the Convenor cannot prepare by themselves such correlation tables and draw the major points of discussion.

The necessity of establishing close relations with specialists in other Fossil Groups besides Ammonoids, in order to correlating different Biostratigraphic scales for other countries was stressed by Sarjeant, and also intensely pointed out by the Secretary of the Subcommission, O. Michelsen. According to that, relations with coordinators of other Working Groups, and with specialists in other Fossil Groups than Ammonites from different countries have already been started by the Coordinator and the Secretary of the Oxfordian Working Group. Contacts have been established, mainly, with :

- Sarjeant (Canada) : Dinocysts
- Herngreen (Netherland) : Palynomorphs
- Copestake (Great Britain) : Foraminifera
- Cooper (Great Britain) : Nannofossils
- Pessagno (U.S.A.) : Radiolarians
- Boullier/Delance (France) : Brachiopods
- Beauvais (France) : Corals
- Ogg (U.S.A.) : Magnetostratigraphy.

V. CONCLUSIONS

As the Erlangen meeting was the first for the Oxfordian working group members, we cannot expect a lot of results. It gave us occasion to list the main unsolved problems and to define perspectives for the future...

1) Ammonites Reference or standard zonal schemes in Europe

- to promote a Submediterranean (and Mediterranean ?) zonal scheme fully based on autochtonous faunas or groups, particularly for the Lower Oxfordian in which Cardioceratids indexes are rare or missing ;

- to improve correlations between faunal sequences and zonal tables for boreal/subboreal and submediterranean/mediterranean biogeographic provinces, using mixed faunas (e.g. Cardioceratids-Amoeboceratids in Submediterranean province).

2) Zonal schemes for countries outside Europe

- to increase zonal schemes in connection with the stratigraphical and paleontological studies ;

- to select european or non european indexes according to biogeographical peculiarities of the faunal sequences ;

- to correlate such zonal tables one another and with European standard zone scheme.

3) Multidisciplinary correlation tables

- to urge such correlation tables of the larger extent as possible and the larger number as possible of both macro- and microfossils groups ;

- to correlate them with ammonite reference or standard zonal schemes authorizing inconnected usefullness.

4) Oxfordian divisions (or substages) and stage boundaries

Will they be able to obtain a general agreement before the next meeting in Lisboa ? We think not.

So, in the meantime, the best thing we can do is :

- to prepare, by collecting new data, the next meeting where we shall be able (We hope) to agree on such conventional boundaries ;

- not to change the classic on the most used boundaries until we arrive to a large (or unanimous ?) agreement.

COMMENTS ON TABLES 1, 2 AND 3

TAB. 1

(1) Formaly (1974) as subzones, later (1979) as full zones.

(2) Marquès B. (in press) - Oxfordiano-Kimmeridgiano do Algarve oriental : estratigrafia, paleobiologia (Ammonoidea) e paleobiogeografia. Thes. Doc. Univ. Lisboa, 1983.

(3) Wrongly placed in the published paper ; introduced as Horizon for the upper part of the Antecedens subzone.

(4) According Gygi (MS) to be replaced by Percaelatum : after Kniozev (1975) C. *costicardia* is a younger synonym of C. *percaelatum*.

TAB. 2

(5) No suitable index for the upper part of the Transversarium/Pumilus Zone. Transversarium is only used for the Main area in the South ; Pumilus is more useful for the Coast.

(6) New information in Skye (Callomon) : Oxfordian-Kimmeridgian boundary has had to be revised. Bauhini Subzone of 1979 coincides with Baylei Zone ; hence Rosenkrantzi Zone now restricted to beds up to base of Baylei Zone.

TAB. 3

(7) According Callomon (in Press), *Amoeboceras bauhini* occurs in the Galar Subzone and in the Baylei Zone some way above its base (Birkelund & Callomon - The Kimmeridgian ammonites Faunas from Milne Land, East Greenland. Bull. Grønl. Geol. Unders., in press, 1984).

(8) see Tab. 2, (6)

TAB. 1 - MEDITERRANEAN/SUBMEDITERRANEAN ZONAL SCHEMES (continued)

TUNISIA-ALGERIA	SPAIN-BETIC	SPAIN-IBERIC	PORTUGAL	POITOU-CHARENTES and S of the Paris Basin	LORRAINE-BURGONDY-FRENCH JURA-SE BASIN	AARGAUER JURA & BADE	SOUTHERN GERMANY	
Belaussean & Cariou, 1983 Atrops & Renoat, 1984	[illegible]	Meléndez, 1978, 1983 Meléndez & alii, 1983 Sequeiros & Melendez, 1979 Enay & alii, 1979 Meléndez & Brochwicz-Lewinski, 1983	Rocha & Marques, 1977, 1979 a, b. Marques, 1983 (2)	Cariou, 1966, 1972 - Cariou & alii, 1971 Enay & alii, 1974 - Hantzpergue, 1980 Hantzpergue & Dommergues & Rousseau, 1981	Cariou & alii, 1971 - Enay & alii, 1974 Marchand, 1979 - Enay & alii, 1980 a, b Enay & Boullier, 1981 - Atrops, 1982	Gygi, 1966, 1969, 1977 Gygi & Marchand, 1982	SWABIAN ALB Kuerner, 1961 Ziegler, 1977	FRANCONIAN A Hetzpergue, 19 Zeiss, 1977, 198
PLANULA	PLANULA: GALAR / PLANULA	PLANULA	PLANULA	PLANULA: GALAR / PLANULA PLANULA: GRANDIPLEX / PLANULA	PLANULA: GALAR / PLANULA Praecursor / Tonnerense	PLANULA: GALAR	PLANULA: GALAR / PLANULA	GALAR / PLANULA
BIMAMMATUM	BIMAMMATUM	BIMAMMATUM	BIMAMMATUM: HAUFFIANUM / BIMAMMATUM / HYPSELUM	BIMAMMATUM: HAUFFIANUM / BIMAMMATUM / HYPSELUM /BERRENSE	BIMAMMATUM: HAUFFIANUM / BIMAMMATUM / HYPSELUM Berrense / Semimammatum	BIMAMMATUM	BIMAMMATUM	LITOCERUM / BIMAMMATUM / BEPRENSE / UHLIGI
BIFURCATUS	TRANSVERSARIUM: (1) BIFURCATUS	BIFURCATUS	BIFURCATUS	BIFURCATUS: GROSSOUVREI / STENOCYCLOIDES	BIFURCATUS: GROSSOUVREI / STONOCYCLOIDES	BIFURCATUS	ALTERNANS (Bifurcatus)	BIFURCATUS
TRANSVERSARIUM	TRANSVERSARIUM: (1) RIAZI	TRANSVERSARIUM: SCHILLI / PARANDIERI /WARTAE	TRANSVERSARIUM: SCHILLI / PARANDIERI	TRANSVERSARIUM: SCHILLI / PARANDIERI PLICATILIS: Schilli / Collinii / 'doublieri' / (epuisea-tum(3))	TRANSVERSARIUM: SCHILLI / PARANDIERI Collinii / "Alligaticeras"	PARANDIERI	TRANSVERSARIUM: PARANDIERI	TRANSVERSARIUM
PLICATILIS	PLICATILIS: (1) ANTECEDENS	PLICATILIS: ANTECEDENS / TENUICOSTATUM	PLICATILIS: ANTECEDENS / ?	PLICATILIS: ANTECEDENS / VERTEBRALE / ? / Vertebrale	PLICATILIS: ANTECEDENS / TENUICOSTATUM /VERTEBRALE	PLICATILIS: ANTECEDENS / VERTEBRALE	TRANSVERSARIUM: ANTECEDENS PLICATILIS: DENSIPLICATUM	PLICATILIS /VERTEBRAL
NOT IDENTIFIED SURELY OR MISSING	NOT IDENTIFIED SURELY OR MISSING	CORDATUM: GAP (not identified) / BUKOWSKII/ CLAROMONTANUS NOT IDENTIFIED	CORDATUM MARIAE	CORDATUM: CORDATUM / COSTICARDIA / BUKOWSKII MARIAE: PRAECORDATUM / ?	CORDATUM: CORDATUM / COSTICARDIA / BUKOWSKII MARIAE: PRAECORDATUM / SCARBURGENSE	CORDATUM MARIAE	CORDATUM: CORDATUM / COSTICARDIA (4) / BUKOWSKII MARIAE: PRAECORDATUM / SCARBURGENSE	CORDATUM / BUKOWSKII MARIAE

TAB. 1 - MEDITERRANEAN/SUBMEDITERRANEAN ZONAL SCHEMES

RUMANIA	BULGARIA	EXTRA-CARPATHIAN POLAND						
Barbulescu, 1976	Sapunov, 1976, 1979	Brochwicz-Lewinski, 1976 Kutek & alii, 1973 Matyja, 1977 Kozlowski, 1978 Gizejo & Tarkowski, 1980	Brochwicz-Lewinski, 1976, 1981 Brochwicz-Lewinski & Bazak, 1975, 1976		MALINOWSKA 1963, 1964, 1966, 1967, 1968, 1970, 1971, 1977 a, b	MALINOWSKA 1980, 1982	
GALAR	PLANULA	PLANULA			PLANULA	PSEUDOCORDATA	
PLANULA					PSEUDOCORDATA		
BIMAMMATUM	BIMAMMATUM / HYPSELUM	BIMAMMATUM / HYPSELUM	BIMAMMATUM / HYPSELUM		CAUTISNIGRAE		
?	BIFURCATUS	TRANSVERSARIUM / BIFURCATUS	BIFURCATUS	GROSSOUVREI / STENOCYCLOIDES	ALTERNANS	CAUSTINIGRAE / VARIOCOSTATUM	
TRANSVERSARIUM	RIAZI		TRANSVERSARIUM / PARANDIERI	SCHILLI / PARANDIERI	WARTAE	WARTAE	ALTERNANS / ?
PLICATILIS	ANTECEDENS / DOROGENSIS / ROTOIDES / EPISCOPALIS	PLICATILIS / ANTECEDENS / VERTEBRALE / TENUICOSTATUM	PLICATILIS	ANTECEDENS / TENUICOSTATUM / VERTEBRALE	ANTECEDENS / BUCKMANI / ROTOIDES / EPISCOPALIS / FATURATTENSIS	CHLOROOLITHICUS and/or TENUISERRATUM	ANTECEDENS / TENUISERRATUM / EXCAVATUM
CORDATUM	RENGGERI	CORDATUM / COSTICARDIA / BUKOWSKII	CORDATUM	CORDATUM / COSTICARDIA / BUKOWSKII	CLAROCONTRUS / AZURICUS	EXCAVATUM / BUKOWSKII	BUKOWSKII
MARIAE	ATHLETOIDES	MARIAE / PRAECORDATUM / SCARBURGENSE	MARIAE			MARIAE	MARIAE

No correlations implied between Tab. 1 and 2 (see Tab. 3 and 4)

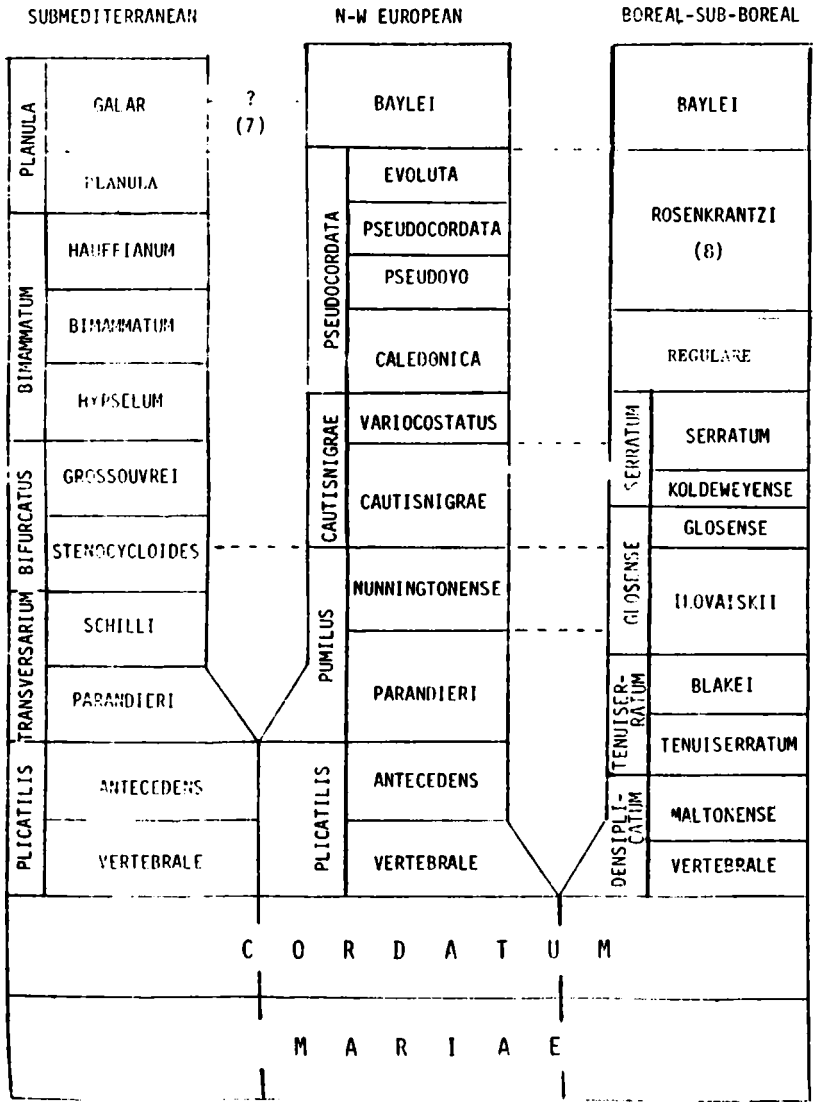
TAB. 2 - NW EUROPEAN/SUBBOREAL/BOREAL ZONAL SCHEMES

NW EUROPEAN					BOREAL			
Rioult, 1975, 1980 (NORMANDY)		Wright, 1972 (YORKSHIRE)		Sykes & Callomon, 1979 Wright, 1980, 1983 Callomon, 1984 (NS)	Sykes, 1975 (SCOTLAND)		Sykes & Surlyk, 1976 Callois & Cox, 1977 Sykes & Callomon, 1979	
PSEUDOCORDATA		PSEUDOCORDATA		PSEUDOCORDATA / EVOLUTA / PSEUDOCORDATA / PSEUDOYO / CALEDONICA	PSEUDOCORDATA		ROSENKRANTZI (?) / REGULARE	
DECIPIENS		DECIPIENS		CAUTISNIGRAE / VARIOCOSTATUS / CAUTISNIGRAE	CAUTISNIGRAE		SERRATUM	SERRATUM
CAUTISNIGRAE	BIFURCATUS / BOWENI	TRANSVERSARIUM	CAUSTINIGRAE					KOLDEWEYENSE
TRANSVERSARIUM / PUMILUS	? (5) / PARANDIERI		NUNNINGTONENSE / PARANDIERI	PUMILUS / NUNNINGTONENSE / PARANDIERI	TRANSVERSARIUM / NUNNINGTONENSE / ANTECEDENS		GLOSENSE / TENUISERRATUM	GLOSENSE / ILOVAISKII / BLAKEI
PLICATILIS	ANTECEDENS / VERTEBRALE	PLICATILIS	ANTECEDENS / VERTEBRALE	PLICATILIS / ANTECEDENS / VERTEBRALE	PLICATILIS		DENSIPLICATUM	TENUISERRATUM / MALTONENSE / VERTEBRALE
CORDATUM	CORDATUM / COSTICARDIA / BUKOWSKII	CORDATUM	CORDATUM / COSTICARDIA / BUKOWKSKII	CORDATUM / CORDATUM / COSTICARDIA / BUKOWSKII	CORDATUM		CORDATUM	CORDATUM / COSTICARDIA / BUKOWSKII
MARIAE	PRAECORDATUM / SCARBURGENSE	(MARIAE)		MARIAE / PRAECORDATUM / SCARBURGENSE	MARIAE		MARIAE	PRAECORDATUM / SCARBURGENSE

TAB. 3 - CORRELATIONS SUBMEDITERRANEAN/N-W EUROPEAN/BOREAL

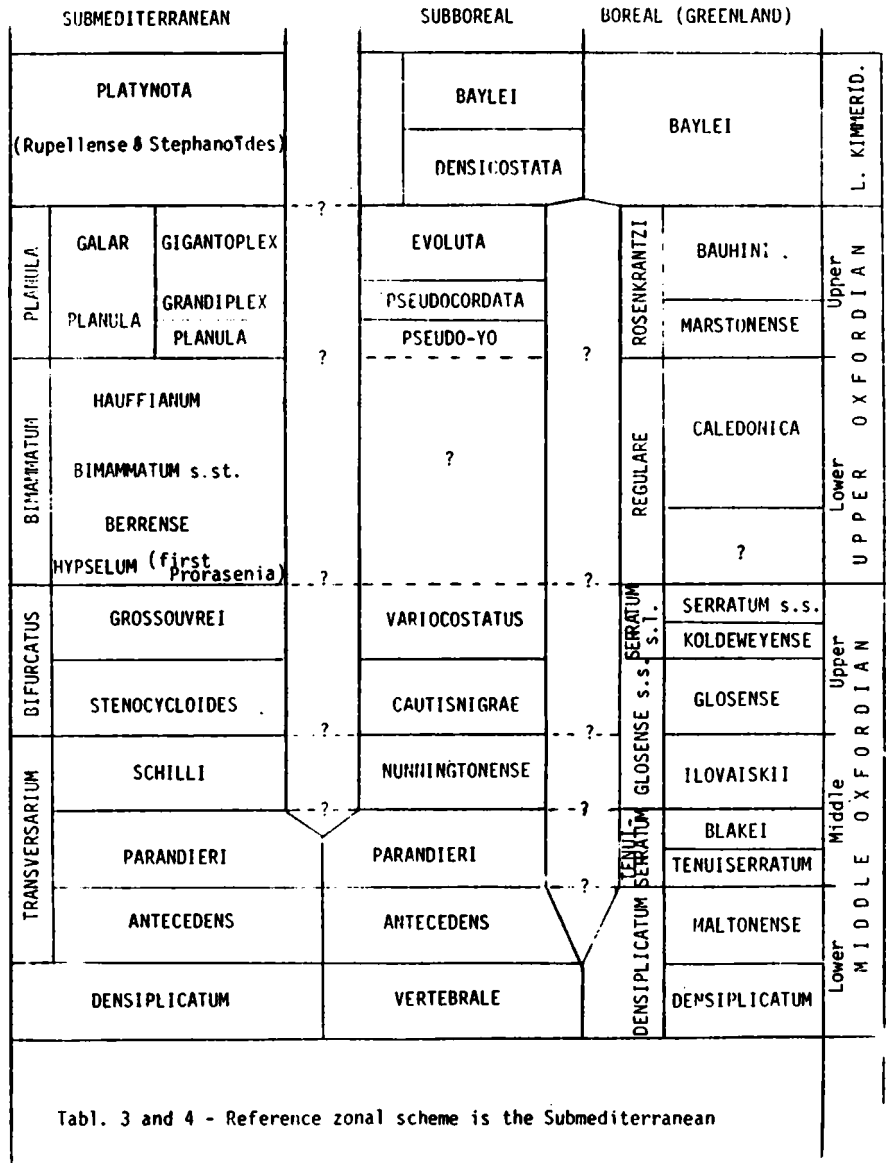
according Sykes & Callomon, 1979

(Modified after Wright & Callomon, 1980 ; Callomon, in press)



TAB. 4 - CORRELATIONS SUBMEDITERRANEAN-SUBBOREAL-BOREAL

(Modified after A. Zeiss proposal this meeting)



Tabl. 3 and 4 - Reference zonal scheme is the Submediterranean

TAB. 5 - TENTATIVE ZONAL SCHEME FOR SUBMEDITERRANEAN PROVINCE (SPAIN, IBERIC CHAIN)

by G. Meléndez, 1984 (Dr. thesis, still unpublished) ;
G. Meléndez, L. Sequeiros, W. Brochwicz-Lewinski, 1984
(this meeting).

		ZONA	SUBZONA	HORIZONTE
OXFORDIENSE	SUPERIOR	PLANULA	GALAR	
			PLANULA	[illegible]
				"MINUTUM"
		BIMAMMATUM	HAUFFIANUM	
			BIMAMMATUM	
			HYPSELUM	[illegible]
				SEMIBAMMATUM
	MEDIO	BIFURCATUS	GROSSOUVREI	
			STENOCYCLOIDES	GUOKGI
				BIFURCATOIDES
		TRANSVERSARIUM	SCHILLI	SUBSCHILLI
				SCHILLI
			WARTAE	LUCIAECORDIS
				WARTAE
		ANTECEDENS	BUCKMANI	
			ROTOIDES	
	INFERIOR	PATURATTENSIS	? MAGNOUATIUS	
			? PATURATTENSIS	
		CLAROMONTANUS	(MAZURICUS)	
			CLAROMONTANUS	
		(MARTAE)		

Zonación propuesta para el Oxfordiense de la Cordillera Ibérica. La Subzona Mazuricus (Brochwich-Lewinski 1981), no ha sido identificada con seguridad. Las Subzonas Paturattensis y Magnouatius se proponen tentativamente, en espera de un mejor registro estratigráfico en otros puntos. Los Niveles con S. minutum, dentro de la Subzona Planula, no tienen por el momento carácter de Horizonte, y su posición es aún incierta.

TAB. 6 - ZONAL SCHEMES AND CORRELATIONS BETWEEN SUBMEDITERRANEAN, SUBBOREAL AND BOREAL

proposed by A. Zeiss, 1984 (this meeting).

	SUBMEDITERRANEAN					SUBBOREAL	BOREAL	
L.KIMM.	Platynota [Rueppelenia & Stephanoides]				Kitchini-Gr.	Bayleyi / Bayleyi / Densicostata	Bayleyi	
UPPER OXFORDIAN upper	Planula s.l.	Galar	Gigantoplex	Bauhini	Pseudocordata-Gr.	Evolute	Rosenkranzi	Bauhini
		Planula	Grandiplex			Pseudocordata		Mariae
			Planula			Pseudo-ra		
lower	Bimammatum s.l.	Hauffianum		Alternans/Ovale	Flaxoid/Submediterranea	?	Regulare	Calodonica
		Bimammatum s.str.						
		Berrense						
		Hypsulum (first Prorsenia)						
MIDDLE OXFORDIAN upper	Bifurcatus	Grossouvrei				Variocostatus	Serratum s.l.	Serratum s.str.
		Stenocycloides				Cautionigrae	Glosense	Kaldewaeyense
						Nunningtonense		Glosense s.str.
middle	Transversarium	Schilli						Hovskhvi
		Parandieri				Parandieri	Tenuiserratum	Bisker
								Tenuiserratum
		Antecedens				Antecedens	Densiplicatum	Moltonense
lower	Densiplicatum					Vertebrale		Densiplicatum

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Postscriptum of the author: This tentative correlation chart was compiled by using the data of various authors, mainly those of Dietrich (1940), Koerner (1963), Ziegler (1977), Schuler (1965), Zeiss (1966, 1982), Kliebar (1981), Enay (1966a, 1966), Enay et al. (1980), Gygi & Marchand (1982), Rozak & Brochwicz-Lewinski (1978), Wierzbowski (1978), Malinowska (1980), Sykes & Callomon (1979), Wright (1980), and of kind personal communications by Callomon, Enay and Gygi. It has been revised after the meeting to some degree.

VI. FINAL REMARKS

The Coordinator and the Secretary of the Oxfordian Working Group will warmly acknowledge any new contact on any of these fields, as well as any suggestions on new zonal Tables concerning other Fossil Groups, or correlation with zonal scales of other Countries.

Correspondance may be addressed either to the Coordinator (Lyon), or to the Secretary of the Group (Zaragoza).

P.S. - Ammonite Specialists working on Lower Oxfordian Peltoceratids may contact Dr. A. von Hillebrandt (Berlin).

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Report on the current state of the Oxfordian working group

R. Enay & G. Melendez

1) The current state of progress

The first general Meeting of the Oxfordian Working Group was held in Erlangen, on 5-IX-1984, within the frame of the Jurassic Symposium. After that first encounter of Oxfordian Stratigraphy and Paleontology specialists it appears that the first steps of a program of work for the Oxfordian Working Group may be established. As stated in the report of the O.W.G. Meeting, "During the last 20 years following the first Luxemburg Jurassic Colloquium, 1962, Oxfordian Stratigraphy has much progressed.(...), besides Ammonites, important new data are now available in many other systematic groups".

At the present moment, the O.W.G. has grown up to 81 members. A completed list of them has been elaborated and dispatched to all collegues and the secretary of the Group remains in close contact with all members. A first file, or bank of data has already been elaborated, with the speciality, geographic area, field of work of everyone, in order to facilitate contacts and provide information to everyone who eventually would need it.

Work on Oxfordian Stratigraphy and correlation problems is being actively carried out by all members in different countries, as the two different sets of correlation tables, summarized respectively by the convenor and the secretary of the Group, and dispatched to all collegues, clearly evidence it. These sets of tables, once corrected and modified by different authors, have been enclosed in the Sympossium Volume, together with the Report on the O.W.G. Meeting.

2) The list of main Problems

The main problems treated during the Erlangen Meeting, and considered as more important basis for future discussions are, as listed by the Convenor of the Group:

a) Those concerning different zonal schemes for each biogeographical province.

b) Those concerning correlation of zonal schemes between different biogeographical provinces.

c) Problems concerning boundaries, i.e. Callovian-Oxfordian boundary; Lower/Middle, and Middle/Upper Oxfordian boundary, and Oxfordian-Kimmeridgian boundary.

The first point is the subject of active research work in every country by all specialists on Oxfordian Stratigraphy. Problems of correlation (2nd. point), have been the subject of vivid discussions between members of the Group, mainly on the question of equivalence of different zonal

indexes for separate biogeographic provinces (i.e. Biostratigraphic equivalence of different fossil groups). Problems of boundaries, although regarded as much less important, have been as well the subject of discussions, and some proposals modifying the positions of boundaries were raised by several authors, on the basis of strong biogeographic changes and faunal renewals at certain moments, which are well known nowadays.

In this chapter it is important to note the recorded great adva of studies by some collegues on paleontology, and biostratigraphical value of many Fossil groups beside Ammonites, both macro (Brachiopods, Corals), and miscrofossils(Palynomorphs, Dinocysts, Nannofossils, Foraminifers, etc which shall, no doubt, contribute in the next years to enrich and facilitate correlation tasks.

3) Decissions and Propositions; Projects for the Future:

Since this was the first general meeting of the O.W.G. no deffinitive decission was taken, except for the firm intention of keeping on th studies and trying to make correlations as much accurate as possible. As general conclussions of the Meeting, those proposed by partizipants, and summarized by the Convenor of the Group, may be briefly outlined:

1) For European Provinces, to promote the elaboration of autochtonous faunal biostratigraphic scales, for Submediterranean-Mediterranean areas, and to improve correlations with already established scales for Subboreal-Boreal areas.

2) For Countries outside Europe, to increase the work of elaboration of autochtonous zonal schemes, and correlations with European ones.

3) For other Groups besides Ammonites, the elaboration of new, local zonal schemes appears neccessary for the larger number as possible of both macro and microfossils. Correlation with Ammonite zonal schemes should be the next task.

4) As far as the possition of boundaries is concerned it is desirable to keep as far as possible the currently accepted possition in the "classical" scales, on the grounds of stability, until a wide discussion on that matter may be open and a good agreement is reached.

Report of the Kimmeridgian Working Group

G. Melendez & A. Zeiss

The meeting of the Kimmeridgian Working Group was a good occassion for all specialists and potential members to get in touch and to briefly outline the main problems and aims of the Kimmeridgian stratigraphy, as well as to summarize the main tasks of the group for future meetings. Some 30 specialists from different countries, mainly Europe and North America, attended the meeting.

The coordinator of this Working Group was not able to attend the Symposium, due to an accident. Therefore the chairman of the Subcommission read a letter from the coordinator, in which he proposed to discuss the following problems:

1. Correspondance in time of the Oxfordian/Kimmeridgian boundary in the subboreal and submediterranean provinces. Possibility of using submediterranean amoeboceratids to advance in this direction.
2. Vertical range of the Kimmeridgian stage; it is proposed to draw the upper boundary below the Gravesia beds, thus corresponding to the Crussolian with a recommendable type-section at Mount Crussol.
3. Detailed zonal subdivision in each region of research work. Compilations as precise as possible are necessary.
4. Integration of zonations by other fossil groups than ammonites.

In the absence of the coordinator only an open discussion, partly on the problems just mentioned and partly on related questions, could take place.

Re 1. As far as the Kimmeridgian lower boundary is concerned, the question appears more and more obscured by the effect of provincialism, which makes correlation of mediterranean areas with the type-section of Dorset very difficult. Contributions in that direction have been recently achieved by Atrops (1982), who discovered a

basal level with Amoeboceras at the base of Platynota Zone in the SE. France, Ardéche area, which is hoped to make correlations with NW-Europe areas easier. A precision made by Hantzpergue was in the sense of making the base of Platynota and of the Rueppelense Zones coincident. Further contributions, given by Callomon were (1) that the boreal Bauhini Subzone would belong to the Lower Kimmeridgian and not to the Upper Oxfordian, and (2) consequently the correlation between submediterranean and subboreal successions would lead to the inclusion of the upper part of the Planula Zone (Galar Subzone) into the Lower Kimmeridgian because in this subzone a typical assemblage of Amoeboceras bauhini is present. Several participants remarked, that the base of the Gravesia Zone would not be a good marker bed for the top of the Kimmeridgian stage, as the first income of Gravesia species in (sub)mediterranean areas is not well known. - It is therefore proposed to use the base of the Hybonotum Zone.

Re 2. What concerns the usage of different vertical ranges for the Kimmeridgian stage a possible solution to be accepted for the majority at least should be found until the next meeting of the Subcommission at Lisboa 1987. It is extremely desirable that on chronostratigraphic charts the use of this stage will be a unified one in the future.

As the Kimmeridgian Working Group is still in a phase of formation and this was the first meeting no general decision and/or resolution could be taken. The most important proposals are to progress as much as possible in correlation problems between boreal and mediterranean areas i.e.

1. To proceed in the elaboration of detailed local stratigraphic/faunistic successions in both mediterranean and boreal regions.

2. To pay special attention to the presence of boreal elements (Amoeboceratids) in mediterranean sections and vice-versa, which may facilitate correlation tasks.

3. To promote and to support further research in intermediate areas which show both boreal mediterranean influences in their faunistic record (Southern Germany, Poitou-Charentes, Poland etc.)

It is hoped that the group will gain some activity by the efforts of its coordinator, F. Atrops.

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Report of the Terminal Jurassic Stage Working Group

John C. W. Cope

Although the subject of selection of the terminal Jurassic stage is fraught with many difficulties, there has until now been no Working Group to consider the problems. The tasks of the Group are not solely ones of correlation, for we have also to make recommendations to fix the level of the base of the stage (to be defined by the base of its basal chronozone in a selected type section) and to select an appropriate name for the stage.

The first meeting of the Group was held in Erlangen on September 5th 1984. The Co-ordinator began a well-attended session by reviewing the history of the problem of the tripartite nomenclature for the terminal Jurassic stage. He reiterated his belief, that the procedure which would ultimately produce agreement on the stage, was that the horizon at which the boundary was to be drawn should be agreed before the name of the stage was selected. Of the four options suggested by the Co-ordinator in his earlier presentation (see this volume) only three were further considered. These were:

(i) the base of the Elegans Zone (the base of the Upper Kimmeridgian *sensu anglico*, the base of the Portlandian *sensu gallico*, or equivalent horizons at the base of the Volgian or the base of the Tithonian).

(ii) the base of the Pallasioides Zone (or equivalent horizons at the base of the Upper Tithonian or base of the Middle Volgian).

(iii) The base of the Albani Zone (the base of the Portlandian *sensu anglico*, falling within the Middle Volgian and within the Upper Tithonian).

Concern was expressed by several speakers over the dual interpretation of the word 'Kimmeridgian'. At this juncture an important point (which has been referred to in Subcommission Newsletters) was clarified. It was confirmed, by those present also at the 1967 Luxembourg Colloquium, that there was an error in the published Proceedings of that meeting; no resolution had in fact been passed to fix the summit of the Kimmeridgian stage (contrary to the report by Maubeuge 1970, p.38). It seems important to stress again here that only the bases of chronostratigraphical units should be defined - the tops are fixed automatically by the base of the

succeeding unit of the same rank. This point is internationally recognised and is made in various stratigraphical guides such as the International Stratigraphic Guide (Hedberg 1976), the Geological Society of London's A Guide to Stratigraphical Procedure (Holland et al. 1978) and A code of Mesozoic Stratigraphical Nomenclature (Callomon and Donovan 1974). It is also the procedure adopted by the International Commission in fixing the Silurian / Devonian boundary and the basis for all decisions on boundaries ratified at the International Geological Congress in Moscow in 1984.

Various suggestions were put forward to resolve the confusion over the interpretation of the term 'Kimmeridgian'. One suggestion was to replace the Lower Kimmeridgian (sensu anglico) by a term such as Crussolian (Rollier 1909) and use such a term as Danubian (Rollier 1909) for the succeeding stage. There was little support for Danubian although Crussolian was favoured by several present (although a minority).

Clearly one of the deciding factors in the use of the term 'Kimmeridgian' will be the level at which the base of the terminal stage is ultimately drawn. If we can all agree that we should fix bases and not tops of stages, then the problem over the present dual interpretation of 'Kimmeridgian' may be solved by the fixing of the base of the terminal Jurassic stage. Until then no action on the term Kimmeridgian seems either necessary or desirable.

If ammonites are to be used as a basis for correlation at the level of the Elegans Zone or its equivalents, it was suggested that the genera Gravesia, Sutneria and Hybonoticeras could be useful in correlation. If the Tithonian were ultimately to be chosen as the global standard, its base would be defined by the base of the Hybonotum Zone. At the base of the Pallasioides Zone correlation by Pavlovia seems assured for the whole Boreal Realm, but correlations with the base of the Upper Tithonian are at present less certain. This latter boundary level found favour with some present as, in addition to its other merits, it effects a compromise solution between the Portlandian sensu anglico and sensu gallico. Correlation by ammonites at the base of the Albani Zone appears at the moment to be rather tenuous.

Present at the meeting were many workers on diverse microfossil groups who expressed interest in contributing to the correlation problems at these critical intervals. Their results are awaited with interest.

After the meeting I was informed by Dr. V.A. Zakharov that a decision had very recently been taken in Moscow that the Soviet Union would now use Tithonian rather than Volgian as their standard. This decision will materially affect future work and discussions; it will focus more attention on the problems of correlation of the Tithonian with the Kimmeridgian/ Portlandian of North-west Europe.

The recommendations of the Jurassic/Cretaceous Boundary Working Group will have an important bearing upon our work, as their decision on where to fix the boundary will, ipso facto, fix the top of the terminal Jurassic stage. With the dropping of the Volgian as their standard by the U.S.S.R. in favour of the Tithonian, it would now appear more likely that a basal Berriasian boundary will be accepted as the global standard for the basal Cretaceous.

Finally may I appeal for anyone who feels they have any contribution to make to the many problems of correlation of the terminal Jurassic stage to contact me. By full international co-operation we may be able to solve a problem which has been with us now for more than a century.

REFERENCES

CALLOMON, J.H. & DONOVAN, D.T. 1974. A code of Mesozoic stratigraphical nomenclature. in Colloque du Jurassique a Luxembourg 1967. Mém. Bur. Rech. géol. minières, 75, 75-81.

HEDBERG, H.G. (ed.). 1976. International Stratigraphic Guide: a guide to stratigraphic classification, terminology and procedure. Wiley. New York. 200p.

HOLLAND, C.H. et al. 1978. A guide to stratigraphical procedure. Geol. Soc. Lond. Spec. Rep. 10, 18p.

MAUBEUGE, P.L. 1970. Résolutions du deuxième Colloque International du Jurassique. in Colloque du Jurassique à Luxembourg 1967. Publ. Mus. Hist. nat. Grand-duché Luxembourg. p.38.

ROLLIER, L. 1909. Compte rendu 9th Congres Assoc. franc-comtoise à Pontarlier. 13-30.

	BRITAIN	E. GREENLAND	VOLGA BASIN		POLAND	S. GERMANY		S. FRANCE S. SPAIN
PORTLANDIAN	Lamplughi Preplicomphalus Primitivus Oppressus Anguiformis Kerberus Okusensis Glaucolithus Albani	Groenlandicus Anguinus Pseudapertum Gracilis Liostraca Communis Rugosa Iatrensis Primus Pectinatus Hudlestoni Wheatleyensis Scitulus Elegans	Nodiger Subditus Fulgens	U. VOLG.		Chaperi	L. BERR.	Jacobi
			?Blakei Nikitini Virgatus Panderi	M. VOLGIAN	Zarasjkensis	Transitorius Scruposus	U. TITHONIAN	'Durangites' Micracanthum
U. KIMMERIDGIAN	Fittoni Rotunda Pallasioides Pectinatus Hudlestoni Wheatleyensis Scitulus Elegans		Tenuicostata Pseudoscythica Sokolovi Klimovi	L. VOLGIAN	Tenuicostata Pseudoscythica ? Klimovi	Puschi Bavaricum Palatinum Vimineus Parvinodosum Triplicatus Tagmersheimense Hybonotum	L. TITHONIAN	Ponti Fallauxi Semiforme Darwini Hybonotum
L. KIMMERIDGIAN	Autissiodorensis Eudoxus Mutabilis Cymodoce Baylei	Autissiodorensis Eudoxus Mutabilis Cymodoce Baylei	Autissiodorensis Eudoxus Acanthicum Kitchini	KIMMERIDGIAN	Autissiodorensis Eudoxus Acanthicum Divisum Hypselocyclum Platynota	Beckeri Eudoxus Acanthicum Divisum Hypselocyclum Platynota	KIMMERIDGIAN	Beckeri Eudoxus Acanthicum Divisum Hypselocyclum Platynota

Explanation of table

The table shows the zonal and stage schemes in use in various areas of Europe. Correlations between adjacent columns are not to be assumed and the table shows only approximate equivalence.

BRITAIN. Based on Casey 1973, Cope 1967, 1978, 1980, Wimbledon 1980, Wimbledon & Cope 1978, Ziegler 1962.

E. GREENLAND. Based on Callomon & Birkelund 1980, 1982.

VOLGA BASIN. Based on Mesezhnikov 1982.

POLAND. Based on Kutek & Zeiss 1976.

S. GERMANY. Based on Zeiss 1968, 1983. But note that the Middle Tithonian of Zeiss 1983 is here grouped with the Lower Tithonian.

S. FRANCE, S. SPAIN. Based on Enay & Geyssant 1975.

References for tables

CALLOMON, J.H. & BIRKELUND, T. 1980. The Jurassic transgression and the mid-late Jurassic succession in Milne Land, central East Greenland. Geol. Mag., 117, 211-226.

CALLOMON, J.H. & BIRKELUND, T. 1982. The ammonite zones of the Boreal Volgian (Upper Jurassic) in East Greenland. in Embry, A.F. & Balkwill, H.R. (eds.). Arctic Geology and Geophysics. Mem. Can. Soc. Petr. Geol., 8, 349-369.

CASEY, R. 1973. The ammonite succession at the Jurassic-Cretaceous boundary in eastern England. in Casey, R. & Rawson, P.F. (eds.) The Boreal Lower Cretaceous. Geol. J. Spec. Iss., 5, 193-266.

COPE, J.C.W. 1967. The palaeontology and stratigraphy of the lower part of the Upper Kimmeridge Clay of Dorset. Bull. Br. Mus. nat. Hist. ser. Geol. 15, 1-79, pls. 1-33.

COPE, J.C.W. 1978. The ammonite faunas and stratigraphy of the upper part of the Upper Kimmeridge Clay of Dorset. Palaeontology, 21, 469-533, pls. 45-56.

COPE, J.C.W. 1980. Kimmeridgian correlation chart. in Cope, J.C.W. (ed.). A correlation of Jurassic rocks in the British Isles. Part Two: Middle and Upper Jurassic. Geol. Soc. Lond. Spec. Rept., 15, 76-85.

ENAY, R. & GEYSSANT, J. 1975. Faunes d'ammonites du Tithonique des chaînes bétiques (Espagne méridionale). in Colloque sur la limite Jurassique-Crétacé, Lyon 1973. Mém. Bur. Rech. geol. minières, 86, 39-55.

KUTEK, J. & ZEISS, A. 1975. Tithonian-Volgian ammonites from Brzostowka, near Tomaszow Mazowiecki, Central Poland. Acta geol. pol., 24, 505-542, pls. 1-32.

MESEZHNIKOV, M.S. 1982. Kimmeridgian and Tithonian (Volgian) stages. in Krymgolts, G. Ja. (ed.). The Jurassic Zones of the U.S.S.R., Nauka. Leningrad, 110-146 (In Russian).

WIMBLEDON, W.A. 1980. Portlandian correlation chart. in Cope, J.C.W. (ed.) A correlation of Jurassic rocks in the British Isles. Part Two: Middle and Upper Jurassic. Geol. Soc. Lond. Spec. Rept. 15, 85-93.

WIMBLEDON, W.A. & COPE, J.C.W. 1978. The ammonite fauna of the English Portland Beds and the zones of the Portlandian Stage. J. geol. Soc. London, 135, 183-90, pls. 1-3.

ZEISS, A. 1968. Untersuchungen zur Paläontologie der Cephalopoden des Unter-Tithon der Südlichen Frankenalb. Abh. Bay. Akad. Wissenschaft., n.s., 132, 1-190, pls. 1-27.

ZEISS, A. 1983. Zur Frage der Equivalenz der Stufen Tithon/Berias/Wolga/Portland in Eurasien und Amerika. Ein Betrag zur Klärung der weldweiten Korrelation der Jura/Kreide Grenzschichten im marinen Bereich. Zitteliana, 10, 427-438.

ZIEGLER, B. 1962. Die Ammoniten-Gattung Aulacostephanus im Oberjura. Palaeontographica, A119, 1-172, pls. 1-22.

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REPORT OF THE JURASSIC CORALS WORKING GROUP

L. Beauvais

PRESENTS MEMBERS : *Mrs BEAUVAIS, Mrs BENIGNI, Mr. ELIAS, Mrs ELIASOVA, Mr. ERRENST, Mr. GROMMANN, Mr. HUBER, Mr. KEUPP, Mr. LANG, Mr. SCHEER, Mrs SESTINI, Mrs SPIEGLER, Mr. STEIGER, Mr. STROMMEIER.*

I - To get a better understanding of the species bearing and to etablish stratigraphic scales based on Corals and Sponges, it has been decided that specialists will prepare cards for a computerized treatment.

Two models of cards are proposed

1) MODEL A : Data on the ecological and genetical variabilities of the species
2) MODEL B : Lists of the Corals and Sponges according to the stratigraphic units.

II - It has been asked to refer, for the geological and geographical localizations to :

Tectonic Maps of Europe (or Africa, America, Asia) 1/2.500.000

or International Map of Europe (or Africa, America, Asia) same scale

III - We must indicate for each locality its map references.

IV - For microfacies use Wilson terminology.

V - For each rubric give the maximum of data but do not use question marks. For example, in the chronostratigraphy rubric if you cannot give more than MALM, give MALM but not OXFORDIAN ?

VI - In a first step we have to prepare sheets on the A and B MODELS. These sheets are to be send to Mrs. BEAUVAIS.

VII - A Meeting will be held probably in October 1985, to select Key words for the final standardization of the cards and their informatic treatment.

MODEL A

LOCALITY :

State :
Region :
Outcrop :

GEOLOGICAL UNIT :

Lithostratigraphic Unit :
Age :
Biostratigraphy :
Chronostratigraphy :

MICROFACIES :

ECOLOGY :

CARACTERISTICS OF THE SPECIES :

Quantitative features :
Qualitative features :

AUTHOR :

REFERENCE :

MODEL B

LOCALITY :

State :
Region :
Outcrop :

GEOLOGICAL UNIT :

Lithostratigraphic Unit :
Age :
Biostratigraphy :
Chronostratigraphy :

MICROFACIES :

ECOLOGY :

LIST OF THE SPECIES :

For each species indicate new name and former one, frequency (very abundant, abundant, scarce, very rare), locality of the type species and localities where the species is found.

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Report of the Jurassic Brachiopods Working Group

Jean-Henri Delance

Now the jurassic brachiopods working group is instituted. It held its first session on thursday 6th september 1984 in Erlangen during the International Symposium on Jurassic stratigraphy. Indeed thirteen brachiopodists had answered to the coordinator's invitation (circular letter of last january) and eight other specialists had sent comments and proposals. That working group is an open group including the brachiopodists involved in the existing working groups on stages as well as other brachiopodists who are interested or are partly dealing with the stratigraphy of the jurassic system.

It appeared from a wide discussion that amongst common possible themes of research the most directly interesting could be the chronological distribution of the jurassic brachiopods. Indeed a strong possibility exist for the elaboration of brachiopod time-scales of good accuracy and of , at least, provincial extension, although sometimes, some difficulties can arise from the close relationships lying between brachiopod distributions, both in space and time, and facies repartitions. The ground of such zonations may be either species assemblages or morphologically singular species having wide ranges.

On these points several tentative zonations of the Jurassic, generally founded on species associations were already propounded in the last years (AGER, DELANCE et als., GOY, TCHOUMATCHENKO, VÖROS,...) without forgetting five communications for this symposium (GOY, COMAS-RENGIFO and GARCIA-JORAL ; PROSOROVSKAIA and ROSTOVT SEV ; SANDY, TCHOUMATCHENKO ; VORÖS). Most of them appear to be, either wholly or partly, dealing with the liassic subsystem and are mostly located in Europe. Thus members of the group involved in this topic are incitated to complete zonations in their field and to comment other existing zonations in order to set up brachiopod zones and also establish correlations between different provincial time scales. It seemed to the participants in the session that such a work (i.e. on european Lias) could possibly be achieved in the perspective of the next symposium on Jurassic (Portugal 1987).

On an other hand, brachiopodists more implicated in Middle and/or Upper Jurassic stratigraphy were encouraged to undertake completions and/or emendations of zonations for their part (e.g. Buckman's and Arkell's brachiopods zones for the english middle Jurassic need to be revisited). The participants in the session were thinking that a particular attention must be paied to the stratigraphical distribution of the brachiopods in the uppermost Jurassic (Ti thonian). And they claim for brachiopodists to advance in this field.

Concerning the functionning of the working group all participants agree with a no restricting organisation. In that perspective and for a best efficiency informations about works in progress (I.e. tentatives zonations, comments and proposal on existing time-scales) should be sent to the working group coordinator (Jean-Henri DELANCE, Université de Dijon - France) who shall dispatch them to other members with the careful assistance of the group secretary (Maria José COMAS-RENGIFO, Universitad Complutense de Madrid - Spain).

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Report of the Jurassic Micropalaeontology Working Group

J. Th. Groiss

About 20 micropalaeontologists attended this special session. Most of them work with foraminifera. Only some few of the participants work with other groups like ostracods or radiolarians.

The following topics were discussed:

1) A world wide scale of Upper Jurassic foraminiferal zones (proposal by Dr. A. Grigelis, Vilnius).
a) Key sections in large regions, study of distribution or foraminifera in these sections.
b) Description and distinction of local and regional foraminiferal zones, stratotypes and boundaries of the zones.
c) Correlation of these foraminiferal zones.
d) Standard scale of the Upper Jurassic foraminiferal zones.

Most of the participants believed that these items would be very usefull but at the present our knowledge about the stratigraphic distribution of the foraminifera is too small.

2) The proposal of Dr. Grigelis to organize a meeting about these problems in the USSR could be very helpfull.
3) Mr. P. Copestake (Britoil Plc., Stratigraphic Laboratory, 150 St. Vincent Street, Glasgow G2 5LJ/UK) was elected as a "Chairman". He will collect news and events of Jurassic micropalaeontology. All people who works with such problems are asked to contact him.
4) Most participants believed that it would be too early to establish an official working group within the International Commission on Stratigraphy. Some years of experience as an inofficial group would show the further doing.

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LOWER JURASSIC AND LOWER-MIDDLE JURASSIC BOUNDARY

THE EARLY JURASSIC FRESH WATER BIVALVE FAUNA FROM THE MENTOUGOU FORMATION IN WESTERN HILLS, BEIJING

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THE EARLY JURASSIC FRESH WATER BIVALVE FAUNA FROM THE MENTOUGOU FORMATION IN WESTERN HILLS, BEIJING

Liu Benpei, Yu Jingshan & Yang Shouren

The fossil fresh water bivalves reported here were collected from the Mentougou formation in Western Hills, Beijing. They occur in three horizons as follows in ascending order:

1. The basal part of the Lower Yaopo member. Particularly noticeable is the abundance of Naiadites? cf. krasnojarskiensis Lebedev, N.? mentougouensis Liu, Sibireconcha spp., associated with Tutuella spp. and Shaanxiconcha (=?Utschamiella) spp.

2. The lower part of the Lower Yaopo member. This horizon is characterized by the widespread presence of Shaanxiconcha spp. accompanied by Sibireconcha and Ferganoconcha.

3. The Upper Yaopo member. Only one specimen of Pseudocardinia? cf. angulata Kolesnikov was found this horizon.

The Naiadites? cf. krasnojarskiensis from Lower Yaopo member is recorded from Early Jurassic in Zulim-Yenisei Basin of USSR. The occurrence of Shaanxiconcha is of special interest, because it appears to have the Late Triassic aspect. The typical Middle Jurassic forms such as Margaritifera, Unio, Yananoconcha etc. are not know in this member. The Yaopo member, therefore, may be considered equivalent to the Early Jurassic in age.

Moreover, the biogeography of fresh water bivalves between North and South China may have existed from Early Jurassic.

The Jurassic strata of the Western Hills of Beijing has been studied for more than 60 years since the establishment of the so-called "Mentougou coal series" in 1920 by Ye Liang-fu et al., but no bivalve fossils have been reported from it. There are different opinions about the age of Mentougou formation according to the megaflora contained: Middle Jurassic, Early Jurassic or Early-Middle Jurassic. Based on our preliminary research of the bivalve fossils collected from the Mentougou formation will discuss in the following. We have the horizon of occurrence, the age and correlation of the fauna with other parts of China and of USSR, and the biogeographical distinction of fresh water bivalve fauna during the Early Jurassic.

1. Occurrence of the bivalves

Most of the data used in this paper were collected during 1961-1963 by teachers and students of the Beijing College of Geology and given to us as a gift recently by Prof. Chen Fen. The authors went to the field in September, 1981 to re-examine the stratigraphic profile and collected again fossil samples.

The Mentougou formation is divided into the Lower Yaopo, Upper Yaopo and Longmen members in ascending order. The bivalve fossils were found at three horizons of the Mentougou formation. The lowest horizon is at the bottom of the Lower Yaopo member occurring at Panjianzigou of the Datai coal mine and Qiaoyugou of the Muchengjian coal mine in the Mentougou area, corresponding to the "Sancaomei" bed below the first marker bed (K_1 sandstone) known in the mine district. This horizon consist of greyish black to yellowish green siltstone intercalated by coal beds, and is underlain by Nandaling formation which consists mainly of varied diabase. There is no obvious sedimentary hiatus between it and the underlying formation. The overlying sequence consists of yellowish green siltstone and fine sandstone with underwater sliding structures, yellowish green fine sandstone with trace fossils and ripple marks, and the higher overlying K_1 pebble-bearing gritstone (K_1 sandstone) with a washing plane below. This sequence represents a small sedimentary cycle of swamp lake -lake shore facies of the Mentougou formation after the eruption of volcanos during the Nandaling time. The horizon contains relatively abundant bivalves: Naiadites? cf. krasnojarskiensis

Lebedev, Naiadites? mentougouensis Liu, Sibireconcha jenissejensis Lebedev, Sibireconcha cf. jenissejensis Lebedev, associated with ?Tutuella rotunda Ragozin, ?Tutuella rotunda postilonga Liu, Shaanxiconcha (=?Utschamiella) cf. clinovata Liu et Li, Shaanxiconcha aff. longa (Hua), Shaanxiconcha triangulata Liu (=?Utschamiella cf. obrutschevi Ragozin), Pseudocardinia? cf. carinata Martinson, Pseudocardinia? cf. elongatiformis (Cherny.), Pseudocardinia? sp. etc. There are also plants and insects fossils associated with them.

The second horizon is found on the ridge of the Huangyanquan Hill northeast of Caojiafang, Shijiaying Commune, Fangshan County, equivalent to the "Wucaomei" bed at the lower part of the Lower Yaopo member. This horizon is characterized by abundant bivalve fossils: Shaanxiconcha clinovata Liu et Li, Shaanxiconcha shijiayingensis Yang, also containing Sibireconcha cf. jenissejensis Lebedev, Ferganoconcha sibirica Cherny, Ferganoconcha elongata (Ragozin), Unio sp. etc.

The third horizon is found in drill hole 0301 east of Zhaitang, Zhaitang Commune, Mentougou area, corresponding to the Upper Yaopo member. Only one specimen of Pseudocardinia? cf. angulata Kolesnikov was found at this horizon.

2. The age of the bivalve fauna

The lowest horizon contains 5 genus 12 species of bivalves, among which Naiadites? and Sibireconcha are dominated. Naiadites? krasnojarskiensis Lebedev is a typical bivalve of the Early Jurassic Makarov formation in the Julim-Yenisei Basin of USSR. Though the specimen of the proto-type of the USSR which hinge tooth is still unknown and doutful to altribute it to Naiadites. It has a peculiar distorted shell form, with which our specimen can be compared. Shaanxiconcha clinovata Liu et Li and Shaanxiconcha aff. longa (Hua) are occur in a large number in the Late Triassic Yanchang formation in northern China. It is also reported that Shaanxiconcha is found associated with Pseudocardinia? in the Early Jurassic Shalitashi formation of the Duwa area in front of the Kunlun Mountains and the Sangonghe formation of Manas River area in the Junggar Basin. It seems, therefore, the lowest horizon is to a large extent of Early Jurassic age.

The second horizon is dominated by Shaanxiconcha and Sibireconcha. Shaanxiconcha shijiayingensis Yang has a long sheeted attthe back of both the right and the left shell, and an obscure traces of sheeted tooth also occurs in the front. This bivalve a ssemblage does not contain Middle Jurassic elements such as Margaritifera, Yananoconcha and special Unio species. So the second horizon can be undoubtedly dated as of the Early Jurassic age.

At the shird horizon has been found only one bivalve fossil from a drill hole, which is temporarily identified as Pseudocardinia? cf. angulata Kolesnikov. It is at present difficult to discuss the upper age limit of the Mentougou formation. So it may be temporarily defined as Early-Middle Jurassic.

3. Biogeographical province of fresh water bivalve during the Early Jurassic

It is of special interest to point out that in the Early Jurassic fresh water bivalve fauna of South China, the Naiadites? type has not been found yet. Sibireconcha and Shaanxiconcha are not abundant, and the naiad assemblage is also not identical. It is likely that the fresh water bivalves palaeobiogeographic distinction between North and South China may have already existed from Early Jurassic. The Palaeo-Qinling to Palaeo-Kunlun Mountains about mark a main palaeoclimatic and palaeobiogeographic boundary between the North and South China during the Early Mesozoic.

The Early Jurassic fresh water bivalve fauna also possibly occurs in Europe. There are Anodonta liasokeuperina in Germany (Werber 1968) and other elements in Poland (Prof. Pinkovesky, personal communication). It is very interesting that the future research will explain the palaeobiogeographical relation of fresh water bivalve fauna between Europe and China.

4. The age problem of Early Mesozoic coal-bearing strata in North China

In recent years, many Chinese palaeontologists and geologists consider that the most important Early Mesozoic coal-bearing strata of North China belong to the same horizon, which represent only the Middle Jurassic.

Based on the record data of bivalve fossils from Western

Liaoning, Northern Hebei, Beijing, Northern and southeastern Shanxi, Northern Shaanxi and Junggar Basin of Xinjiang ect., it is considered in this paper that from the Late Triassic to the early Middle Jurassic is a continuous coal-bearing stage in North China. The main coal-bearing horizon are different from place to place due to differing structural conditions and palaeogeographic environments. It should be pointed out that there seems to be generally a time-transgression (diachronous) with a gradual rising of horizons from east to west (Table).

The sequence, lithology and coal-bearing character of the Lower-Middle Jurassic in the Beijing region and in Western Lioaning are extremely alike. No bivalve fossils, except Ferganoconcha, is reported from the Beipiao formation of Western Lioaning, which is generally considered to be of Early Jurassic according to its megaflora fossils.

Both in the Western Hills of Beijing and the Datong coalfield in Northern Shanxi, it can be seen that is a trend of northwestward overlapping for various coal horizon of the Mentougou formation and the Datong formation. This Time-transgressive phenomenon is even more prominent on a wider scope. The authors think that correlation can be made between the main coal horizons of different districts based on bivalve fossils. For example, the Heifeng formation in southeastern Shanxi may be correlated with Yan'an formation, and not with the horizon in the Mentougou formation, through the occurence of such bibalves as Margaritifera shanxiensis Yu, Margaritifera aff. isfarinsis (Cherny.), Yananoconcha hengshanensis Yu et Zhang, Yananoconcha zaoyuanensis Yu et Zhang, Yananoconcha spp. and Ferganoconcha spp.

Therefore, further discovery and study of the fresh water bivalve fossils in the Triassic and Jurassic of North China will be helpful in the designation of the main coal-bearing epoch and in the explanation of coal accumulation history in the Early Mesozoic.

Table 1. Correlation of the Early Mesozoic Coal-bearing Formations in N. China

	Junggar Basin in Xinjiang	N. Shaanxi	S.E. Shanxi	N. Shanxi	Western Hills in Beijing	N. Hebei	W. Liaoning
J_2	Qigu f.	Anding f.		Tianchihe f.	Houcheng f.	Houcheng f.	Tuchengzi f.
	Toudunhe f.	Zhilo f. ○		Ungang f. ○	Tiaojishan f.	Tiaoji-shan f.	Lanqi f.
	Xishanyao f. ●	Yan'an f. ●	Haifeng f. ○		Jioulongshan f.	"Mentougou f." ○	Haifanggou f. ○
J_1	Sangonghe f. ○	Fuxian f. ○		Datong f. ●	Mentougou f. ●		Beipiao f. ●
	Badaowan f. ●			Yuending-zhuang f. ○	Nandaling f.		Xinglonggou f.
					Xingshikou f. ○		Kuntoupoluo f. ○
T_3	Haojiagou f. ●	Yanchang f. ●	Yanchang f. (lower part)				Laohugou f. ○
	Huangshanjie f.						

● mainly coal-bearing horizons ○ local coal-bearing horizons

Selected references

Chen Fen et al., 1980, The Jurassic Mentougou-Yudaishan Flora from Western Yanshan, North China. Acta Palaeontologica Sinica, vol. 19, no.6, pp.423-432 (in Chinese, with English abstract).

Chen Jinhua, 1982, Mesozoic Transgressions, Regressions and Bivalve Proninces in China. Acta Geol. Sinica, vol.56, no. 4, pp.334-346 (in Chinese, with English abstract).

Chen Pei-ji, 1979, An Outline of Palaeogeography During the Jurassic and Cretaceous Periods of China-with a Discussion on the Origin of Yangtze River. Acta Scientiarum Naturalium Universitatis Pekinensis, no.3, pp.90-109 (in Chinese, with English abstract).

Gu Zhiwei, 1982, Distribution and Development of Nonmarine Mesozoic Bivalves and Formations in China. Scientia Sinica (series B), vol.25, no.4, pp.438-452.

Liu Benpei et al., 1980, Triassic Lamellibranchiata. In: The Mesozoic Stratigraphy and Palaeontology from Shaan-Gan-Ning (Ordos) Basin. vol.2, pp.1-27 (in Chinese).

Liu Benpei et al., 1982, Discovery of Bivalve Fauna from the Mentougou Formation in Western Hills, Beijing with Notes on the Age of Early Mesozoic coal-bearing Stage in North China. Acta Geol. Sinica, vol.56, no.4, pp.364-372 (in Chinese, with English abstract).

Ma Qihong et al.,1976, The Mesozoic Lamellibranchiata of Yunnan. In: The Mesozoic Fossils of Yunnan, pp.161-386. Science Press, Beijing (in Chinese).

Wang Hongchen (chief compiler), Atlas of the Palaeogeography of China (in press).

Xu Ren et al., 1979, The Late Triassic Baoding Flora of China. pp.1-101. Science Press, Beijing (in Chinese).

Ye Liangfu et al., 1920, The Geology of Hsi-Shan or the Western Hills of Peking. Memoirs of the Geology Survey of China, ser.A, no.1.

Yu Jingshan et al., 1980, Jurassic Lamellibranchiata. In: The Mesozoic Stratigrapgy and Palaeontology from Shaan-Gan-Ning (Ordos) Basin. vol.2, pp.27-47 (in Chinese).

Крымгольц,Г.Я. и. др., 1972, Юрская Система, Стратиграфия СССР. Издательство НЕДРА.

Лебедев, И.В., 1958, Мезозойские пелециоподы из Чулымо-Енисейской Впадины. Труды ВНИГРИ, вып.124, стр.41-94.

Лебедев, И.В., 1959, Пелециподы Юрских и Меловых отложений Кузнецкого и Чулымо-Енисейского Бассейного. Вопросы Геологии Кузбасса.

THE HETTANGIAN AMMONITE ZONES AND SUBZONES OF THE NE OF THE PARIS BASIN

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THE HETTANGIAN AMMONITE ZONES AND SUBZONES OF THE NE OF THE PARIS BASIN

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1. INTRODUCTION

The outcrop of Hettangian aged strata in the NE of the Paris Basin extends about 200 km from the Southern Eifel (Germany) via the Luxembourg Gudland towards Belgium in the west (Fig.1). To the south the Hettangian aged strata are exposed in Luxembourg and Lorraine at the eastern margin of the Paris Basin.The basins of Luxembourg and Lorraine are separated by a stable tectonic high, the sill of Sierck. During the Hettangian the depot-center with maximum thicknesses is situated in the NE of the Pari Basin, called "Gulf of Luxemburg". With reference to the general regressive stage in the Upper Triassic the Hettangian transgression in the NE of the Paris Basin develops with shallow marine sediments of the Lorraine facies (MULLER 1974). Into this clay-marl-limestone interstratification the offshore bars of the marin calcareous Luxembourg sandstone are lenticularly inserted (MULLER 1980; BERNERS 1983).The ammonite fauna allow to indicate various diachronous shiftings between the Lorraine facies and the Luxembourg sandstone facies (GUERIN-FRANIATTE 1982).

2. LOWER HETTANGIAN

In the southern parts of Belgium and in the western Luxembourg Gudland marine blue marls of Pre-planorbis age are usually inserted between the red marls of Levallois (Uppermost Trias?) and the first Psiloceras bearing beds. They reach maximum thicknesses (7,8 m) in the well Villers-devant-Orval (Belgium).The thickness diminishes to the east. In the well Arlon (Belgium) 3,6 m, at Schwebach (W.Gudland) 5 m occur. In the southern Gudland (BERNERS 1984) they don't exceed 2 m in thickness. Till these days neithe in the NE-Gudland nor in the southern Eifel Pre-planorbis beds

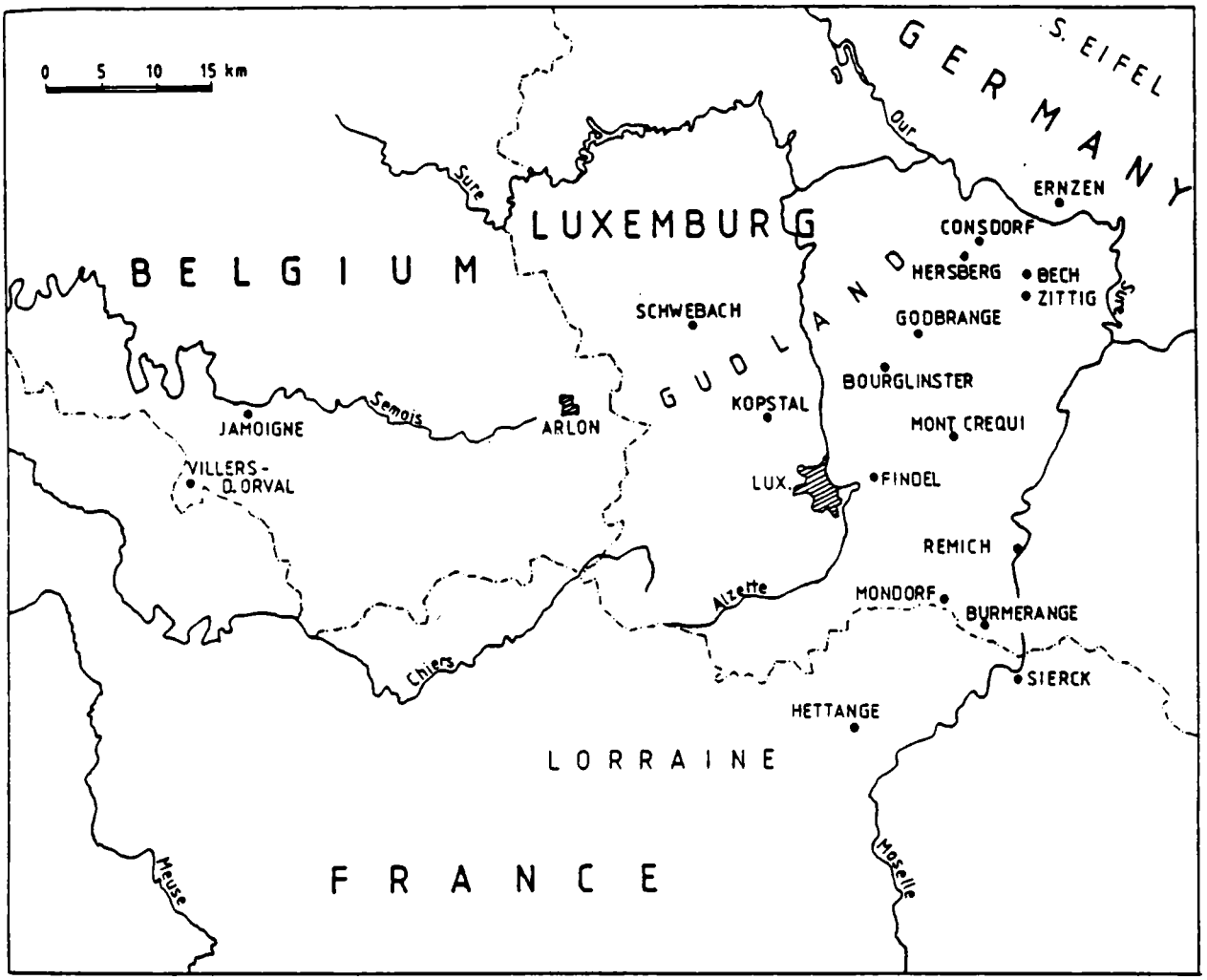

Fig.1. Location map of the NE of the Paris Basin.

are known.

In Great Britain Pre-planorbis beds are well known from numerous localities, containing a rich fauna of Lamellibranchs (DEAN, DONOVAN & HOWARTH 1961). South of the sill of Sierck, in Lorraine at the eastern margin of the Paris Basin, Pre-planorbis are absent. They are known from wells in the Pays de Bray anticline (MAUBEUGE 1960) and in the Ardèche area, where some 10 m are developed, showing fossiliferous beds (Lamellibranchs, Gastropods) at the top (ELMI & MOUTERDE 1965).

In the wells Arlon and Villers-devant-Orval GUERIN-FRANIATTE & MULLER (1978a, pl.1) describe for the first time an ammonite-bearing niveau within the Pre-planorbis beds. These ammonites belong to the genus Schlotheimia and occur 0,7 and 0,5 m below the first Psiloceras bearing beds. The niveau with Psiloceras is developed in the blue marls of the Lorraine facies as well as in first sand

lenses of the Luxembourg sandstone facies (Central Gudland:Findel, Bourglinster).P.psilonotum (Quenstedt) is the dominant form.Sometimes a smooth Psiloceras more evolute than P.psilonotum and similar to the British form P.planorbis occurs in the southern Eifel and in the well Arlon. In these areas P.aff.planorbis replaces P.psilonotum.
Ribbed specimens often are found together with the smooth ones. Psiloceras plicatulum (Quenstedt) is characterized by closely spaced folds or a gentle ribbing, while Psiloceras plicatum (Quenstedt) shows blunt ribbs.
Near the Luxembourg airport, at Findel in the Central Gudland, a differing species of Psiloceras, showing sigmoidal ribbs, has been collected (BERNERS,GUERIN-FRANIATTE & MULLER 1984,pl.1,fig. 1). The Psiloceras bearing beds represent, possibly together with the subjacent marine blue marls, the Psilonotum-Subzone according to the name of the species everywhere abundant in the Paris Basin (GUERIN-FRANIATTE 1982).

Superjacent numerous Caloceras, very evolute and usually ribbed, form remarkable layers in the central Gudland and southern Eifel. The whorl of these specimens normally has a round section.C.pirondi (Reynès) and C.belcheri (Simpson) were frequently, C.torus ('Orbigny) and C.wrighti Spath usually and C.langei (Jüngst) rarely found. GUERIN-FRANIATTE & MULLER (1979,fig.4) collected a new species in the Luxembourg sandstone at Kopstal (W-Gudland),called C.luxemburgense.The whorl of this specimen shows an oval section and is similar to forms of C.johnstoni (Sowerby).Also at Findel, the corresponding niveaus are developed in the Luxembourg sandstone facies.
The niveaus with Caloceras represents the Pirondi-subzone (GUERIN-FRANIATTE 1982),because Caloceras pirondi is the abundant form in the whole Paris Basin area. This subzone corresponds to the Johnstoni subzone, established by other workers in areas surrounding the Paris Basin. C.johnstoni ,being redefined by DONOVAN (1952) cannot be found in the Paris Basin. A further subdivision of the Caloceras-subzone in the Luxembourg area as well as in the Paris Basin is not possible.

In the NE of the Gudland,at Hersberg, a first Waehneroceras has

been collected in the niveau with Caloceras. The specimen W.aff. hircinum (Quenstedt) is similar to forms occuring rarely in the Lower Hettangian of Wurtemberg.

Both, the Psilonotum-subzone and the Pirondi-subzone, form the Planorbis-zone.

3. MIDDLE HETTANGIAN

The first sandlenses of the Luxembourg sandstone facies are established during Lower Hettangian time in the central parts of the Gudland (MULLER 1980).During Middle Hettangian time the sandstone facies gets more important and extends to the eastern and especially southern parts of the Gudland (region of Consdorf,Zittig,Bourglinster in the NE; Mont Crequi,Burmerange in the SE). Waehneroceras portlocki (Wright) is very frequent and characterizes the Portlocki-subzone. This dominant species is accompanied by W.maillardi (Elmi & Mouterde) and W.gottingense (Lange) in the southern Eifel, as well as W.striatum (Lange) in the well Villers-devant-Orval. In the well Arlon W.crassicosta Lange , a further german species, has been collected.
In the central part of the Gudland, respectively in the middle of the Eifel depression, a special fauna has been recognized at Findel (BERNERS, GUERIN-FRANIATTE & MULLER 1984).Very large specimens of Waehneroceras are preserved, corresponding with species of the Austrians Alps, W.aff.polystreptum (Waehner) and W.aff.rahana (Waehner).A new species of Waehneroceras is similar to W.anisophyllum (Waehner) or W.panzneri (Waehner),though its size is really larger.Together with these Tethys-species also W.maillardi, being typical in the Ardèche and the Paris Basin, occurs (BERNERS, GUERIN-FRANIATTE & MULLER 1984). A further ammonite with affinities to north-alpine genera,W.aff.latimontanum (Waehner),has been collected near Kopstal in marls,being inserted in the Luxembourg sandstone facies (GUERIN-FRANIATTE & MULLER 1979).

In the NE-Gudland Psilophyllites hagenowi (Dunker) occurs at Godbrange in the Luxemburg sandstone facies (GUERIN-FRANIATTE & MULLER 1978b,fig.1-7). In Hettange and St.Menge,as well as in Jamoigne, Psilophyllites has been mentionned in former times by TERQUEM

& PIETTE (1865).Since this time they have not been recognized in the NE of the Paris Basin.

A niveau with Alsatites is well developed in the central Gudland,especially in the Luxembourg sandstone facies at Findel.Together with the dominant species A.gallbergensis Lange , A.aff. sironotus (Quenstedt),A.quedlinburgensis Lange have been collected (BERNERS, GUERIN-FRANIATTE & MULLER 1984).
The Luxembourg sandstone facies in the southern Eifel, the E-Gudland up to Hettange-Grande is characterized by Alsatites. In the W-Gudland (Schwebach) marls of the Lorraine facies show a similar Alsatites fauna. Alsatites liasicus (d'Orbigny),being frequent in the eastern margins of the Paris Basin (Lorraine),rarely occurs north of the sill of Sierck in the Luxembourg area.The German genera dominate at the whole southern border of the Ardenne as well as in the Eifel depression. A.laqueus (Quenstedt) occurs in the wells Arlon and Villers-devant-Orval, accompanied by the genus Saxoceras. In the well Villers-devant-Orval a Waehneroceras with mesogean affinities, W.aff. aphanoptychum (Waehner) appears with Alsatites.

At Findel,the alpine genus Discamphiceras accompanies Alsatites.

The Waehneroceras and Alsatites bearing beds correspond with the Liasicus-zone.

4. UPPER HETTANGIAN

The Luxembourg sandstone facies shifted during Upper Hettangian time to the west,as well as to the south up to Hettange-Grande (Fig.2).
Schlotheimia characterizes the Lorraine facies in the eastern Gudland from Burmerange/Mondorf in the south, via Bech in the NE-Gudland to Ernzen in the southern Eifel. On the other hand, in central and SW parts of the Luxembourg Gudland the Luxembourg sandstone facies reaches at this time thicknesses of more than 100 m.Further to the west, near the Belgian frontier,Schlotheimia characterizes the marls of the Lorraine facies below the Luxembourg sandstone. In this area the Luxembourg sandstone facies appears within the Angulata-zone and is established till Lower Sinemurian times (MUL-

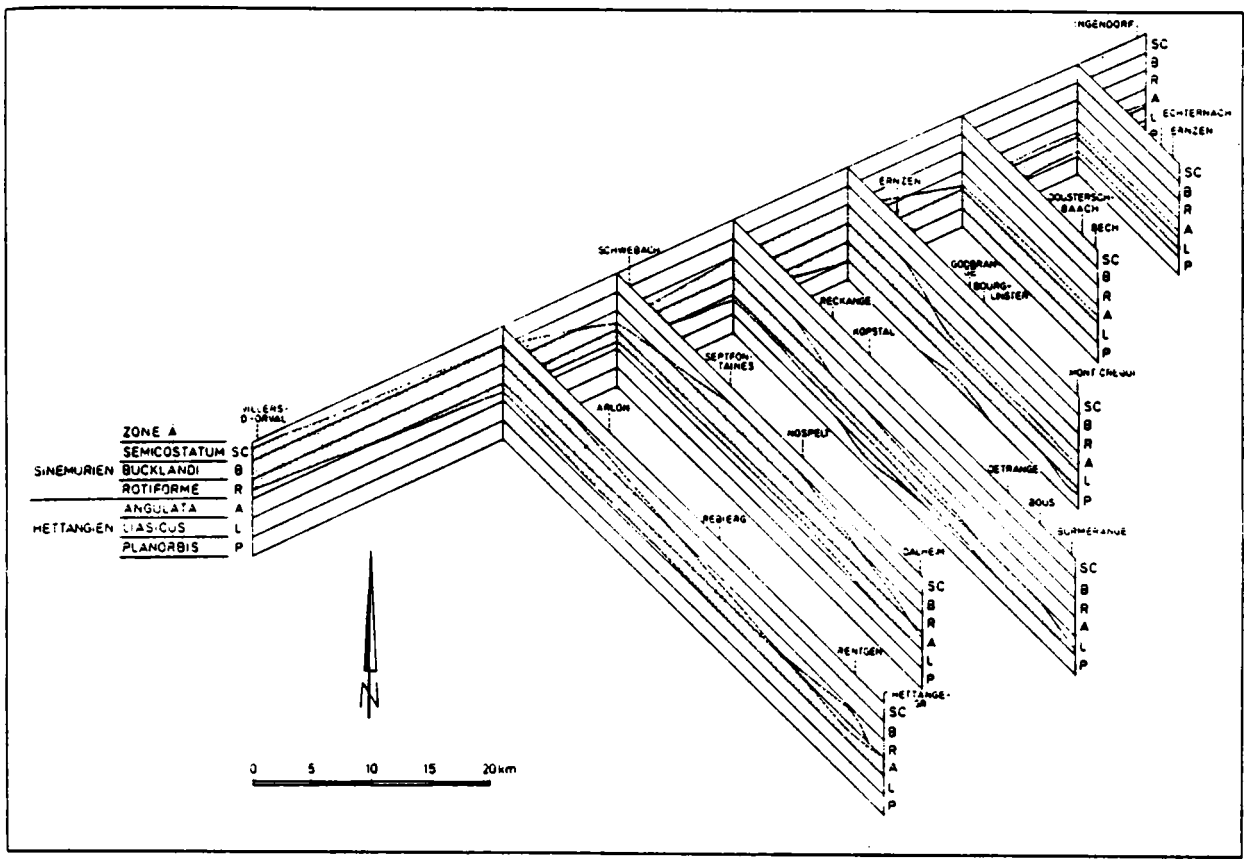

Fig.2. Diachrony of the Luxembourg sandstone formation,compared to the Hettangian and Sinemurian zones in Luxembourg and the neighbouring regions.

LER 1974).

Schlotheimia angulata (Schlotheim) is the dominant species,accompanied by S.densicostata Lange and S.eugemethes Lange.In the Mondorf/Remich area sometimes S.aff.similis Spath ,at Bech S.lymensis Spath and at Ernzen S.extranodosa (Waehner) has been collected. In the Luxembourg Gudland,as well as in the whole E and NE of the Paris Basin, it is not possible, to make any further subdivisions of the Angulata-zone. For instance in the well Villers-devant-Orval, this zone is developed with a thickness of 19 m,but no species clearly characterizes the lower or upper parts of the Angulata-zone.

5. CONCLUSIONS

In the NE of the Paris Basin the Lower Hettangian (Planorbis-zone) comprehends a fauna of Psiloceras and Caloceras. Smooth as well as ribbed Psiloceras occur together in the older Psilonotum-subzone. Above, the Pirondi-subzone is characterized by a fauna of Caloceras,

especially species with round whorls sections.
The Middle Hettangian (Liasicus zone) comprehends a fauna of Waehneroceras (Portlocki subzone), and above a niveau with Alsatites (Liasicus subzone). The first Waehneroceras appears together with Caloceras in the Lower Hettangian. Another species of Waehneroceras reaches up to the niveau with Alsatites. In central parts of the Luxembourg Gudland Psilophyllites appears in the Portlocki subzone and Discamphiceras in the Liasicus subzone.
During the Upper Hettangian (Angulata zone) the established fauna of Schlotheimia allows no further subdivisions. These biostratigraphic features of the NE of the Paris Basin can be related to the Hettangian beds within the whole Paris Basin area (Tab.1).

Zones	Subzones	Index-fossils
Angulata		Schlotheimia angulata
Liasicus	Liasicus Portlocki	Alsatites liasicus Waehneroceras portlocki
Planorbis	Pirondi Psilonotum	Caloceras pirondi Psiloceras psilonotum

Tab.1. Subdivisions of the Hettangian in the Paris Basin (GUERIN-FRANIATTE 1982).

In the NE of the Paris Basin, the most unusual observation concerns small specimens of Schlotheimia collected in S-Belgium below the first Planorbis bearing beds. They are older than those, described by WAEHNER (1886) and LANGE (1956) from the Fonsjoch (Austria). These are accompanied by a fauna of Psiloceras and Caloceras (Lias alpha 1 I). It is remarkable, that the first and oldest species of Schlotheimia appears during the the Lower Hettangian not in mesogean area, but in NW Europe. The Schlotheimiidae of the Middle and Upper Hettangian cannot be related to the Psiloceratidae of the Lower Hettangian. The Schlotheimiidae may have their own evolution at the base of the Hettangian, parallel to those of the Psiloceratidae.

In the NE of the Paris Basin, especially in the rapidly subsiding basin of Luxembourg the ammonites allow a subdivision into zones and subzones that are similar to those of the E of the Paris Basin. Some of these species are known in Suabia and in Wurtemberg. They may have entered the Paris Basin through the Burgundy Gate, south

of the Vosges. A few British species (P.aff.planorbis) may have entered the Paris Basin from the north together with the abundant North-German species (C.langei,A.gallbergensis, numerous Waehner-oceras) through the marine inlet of the Eifel depression (BERNERS 1983). The NE of the Paris Basin seems to have been a cross-roads for the different ammonite faunas. Also exotic species, showing affinities to mesogean forms, like Waehneroceras and Discamphiceras are to be quoted. As comparable forms were reported from the E of the Paris Basin and from the south of Great Britain, these forms have the value of stakes.

6. REFERENCIES

Arkell,W.J.,Kummel,B. & Wright,C.W.(1957).-Mesozoic Ammonoidea; in Treatise on Invertebrate Palaeontology(Moore R.C.), Mollusca 4.Geol.Soc.America&Univ.Kansas Press:80-492.

Berners,H.P.(1983).-A Lower Liassic offshore bar environment,contribution to the sedimentology of the Luxemburg Sandstone; Ann.Soc.géol.Belgique,106,87-102.

Berners,H.P.(1984).-Der Einfluß der Siercker Schwelle auf die Faziesverteilung meso-känozoischer Sedimente am NE-Rand des Pariser Beckens;Diss.R.W.T.H.Aachen.

Dean,W.T.,Donovan,D.T. & Howarth,M.K.(1961).-The Liassic ammonite zones and subzones of the north-west European Province; Bull.Brit.Mus.(Nat.Hist.)4(10):437-505,pl.63-75.

Donovan,D.T.(1952).-The Ammonites of the Blue Lias of the Bristol district.Part I: Psiloceratidae and Schlotheimidae.Ann. Mag.Nat.Hist.(12)5:629-6555,pl.22-23.

Donovan,D.T.,Callomon,J.H. &Howarth,M.K.(1981).-Classification of the Jurassic Ammonitina;in The Ammonoidea (House & Senior ed.).Acad.Press:101-155.

Elmi,S.&Mouterde,R.(1965).-Le Lias inférieur et moyen entre Aubenas et Privas(Ardèche).Trav.Lab.Géol.Fac.Sc.,Lyon,N.S.12: 143-246,10 pl.

Guérin-Franiatte,S.(1982).-Une échelle biostratigraphique réaliste pour le Lias inférieur du Bassin parisien.9e Réun.ann.Sc. Terre,Paris,Soc.géol.Fr.édit.:300.

Guérin-Franiatte,S.& Muller,A.(1978a).-Découverte en Luxembourg belge de Schlotheimiidae primitives(Ammonites) dans les

Pre-Planorbis Beds (Hettangien inférieur).Ann.Soc.géol. Belgique,101:399-403.

Guérin-Franiatte,S. & Muller A.(1978b). - Découverte de Psilophyllites dans le Grès de Luxembourg (Hettangien).Bull. Inf.Géol.Bass.Paris,15(2):71-73.

Guérin-Franiatte,S. & Muller,A. (1979). - Présence d'un niveau à Caloceras (Ammonites de l'Hettangien inférieur) à Kopstal dans le Grès de Luxembourg.Description d'une espèce nouvelle : Caloceras luxemburgense n. sp..C.R.som.Soc. géol.Fr.,3:125-128.

Lange, W. (1951). - Die Schlotheimiinae aus dem Lias alpha Norddeutschlands.Palaeontographica,100(A):1-128,20pl..

Lange, W. (1952). - Der untere Lias am Fonsjoch (östliches Karwendelgebirge) und seine Ammonitenfauna.Palaeontographica, 102(A):49-162,pl.8-18.

Maubeuge, P.L. (1960). - Données stratigraphiques nouvelles sur le Rhétien dans le Bassin de Paris.Bull.Acad.roy.Belgique (Cl.Sc.),Bruxelles:79-87.

Muller,A. (1974). - Die Trias-Lias Grenzschichten Luxemburgs.Publ. Serv.géol.Luxemb.,23:1-89.

Muller,A. (1980). - Luxembourg.In:Géologie des pays européens: France,Belgique,Luxembourg,Paris(Dunod):577-594,7pl.,3tab.

Terquem, O. & Piette, E. (1865). - Le Lias inférieur de l'Est de la France comprenant la Meurthe, la Moselle, le Grand-Duché de Luxembourg, la Belgique et la Meuse.Mém.Soc. géol.Fr,8(2):322-394.

Wähner, F. (1886). - Beiträge zur Kenntnis der Tieferen Zonen des Unteren Lias in den Nordöstlichen Alpen.Beitr.Paläont. Österr.Ung.u.Orients,Wien,4:34-125,pl.15-30.

Berners, H.P., Guérin-Franiatte S. & Muller, A. (1984). - L'ensablement de l'Hettangien au Luxembourg: la coupe-type du Findel/Aéroport de Luxembourg.1ère Réun.Centre intern. Et. Lias,Lyon,11p. dactyl.,3pl. (in press).

ON LOWER LIAS AMMONITE STRATIGRAPHY - PRESENT STATE AND POSSIBILITIES OF REVISION

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ON LOWER LIAS AMMONITE STRATIGRAPHY - PRESENT STATE AND POSSIBILITIES OF REVISION

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Abstract: Whereas the zonal standard subdivision of the Lower Lias is used over large areas, there exist still considerable regional differences on the level of subzones. Revisions are necessary both, of systematics and stratigraphy. These revisions should be in close interrelation because of the strong variability of many species in the Lower Lias.

INTRODUCTION

In this contribution to Lower Lias stratigraphy there will be given first some examples of present state of knowledge and then there will be regarded general aspects, especially of revision.

The nine ammonite standard zones of the Lower Lias proposed 1961 by DONOVAN for North-West Europe have been generally adopted and are used also in other regions of the world. Sometimes standard zones are replaced by local zones, especially if two or three standard zones cannot be distinguished in a region.

Stronger regional differences exist still on the level of subzones and horizons, partly caused by real differences, partly by different state of knowledge (fig. 1). Though DONOVAN 1961 has made an attempt to come to a uniform subdivision also on the level of subzones in NW Europe, the differences persisted.

	Echelle stratigraphique proposée (Ardèche - Europe du NW)			Europe du NW (Donovan, 1961)		Somerset (Donovan, 1952, 1956 d'après Spath, 1942)		Dorset (Lang, 1924)	Bristol (Tutcher, 1918)	Glamorganshire (Truemann)	Allemagne N Lange, (1924, 1925)	Allemagne N Lange, (1941, 1951)	Austria, 1961, 1966	Lange
	Zones	Sous-zones	Horizons	Zones	Sous-zones	Zones	Sous-zones	Zones	Zones	Niveaux	Zones	Zones		
Supérieur	Anguiatus	Compianata	—	Anguiatus	Compianata	Anguiatus	Anguiatus	Marmorea	Anguiatus	angulata beds	Stenorhyncia z 2c Germanica z 2b Amblygonia z 2a	Stenorhyncia Germanica Amblygonia	Supérieur	z 2 (Sup.)
		Extranodosum			Extranodosum									
Moyen	Liasicus	Liasicus	Hadroptychum Liasicus	Liasicus	Laqueus	Angulatus	Laqueus	(2) Liasicus	Liasicus		Proarietites z 1d	Costatum		
		Laqueus						Laqueus						
	Portlocki	—	—		Portlocki			Hagenowi	Megastomum	Waehneroceras beds	Hagenowi z 1c	Angersbachense Schroederi Hagenowi		
								Portlocki			? (lacune)			
Inférieur	Johnstoni	Belcheri				Planorbis	Johnstoni	Johnstoni	Johnstoni	johnstoni beds	Johnstoni z 1b	Torus	Inférieur	z 1 (Inférieur)
		Johnstoni			Johnstoni									
	Planorbis		Plicatulus	Planorbis	Planorbis		Planorbis	« Planorbis »	« Planorbis » ?	planorbis beds ?	Psilonotus z 1a	Psilonotus		
			Psilonotus (1)					« Ostrea »	Ostrea hassica Pleuromya tatei	Ostrea beds				

Fig. 1. Examples of regional subdivisions in the Hettangian of NW Europe. Adopted from ELMI & MOUTERDE 1965.

HETTANGIAN

In the Hettangian of NW Europe there exist partly strong regional differences of faunas, especially in the Liasicus and the Angulata Zones. In the time since the last colloquy on the Jurassic at Luxembourg 1967 the number of detailed studies on ammonite stratigraphy in the Hettangian remained low in comparison with the progress in other parts of the Jurassic. Therefore the number of open questions has not diminished considerably since then.

If one compiles the important sections in NW Europe which the subdivisions are based on, one can recognize generally the following sequence of ammonites in the Hettangian:

ELMI & MOUTERDE 1965	Associations
ANGULATA	Schl. depressa (present in South Germany and Lorraine; hiatus in NW Germany and ?England)
	Schl. complanata (Schl. pseudomoreana in England: ?upper part)
	Schl. extranodosa (hiatus in South Germany and ?Lorraine)
	Schl. amblygonia (known only in North-West Germany)
LIASICUS	Alsatites + Waehneroceras s. l. (strong regional differences of subdivision)
PORTLOCKI	Waehneroceras s. l. (upper part with Psilophyllites hagenowi)
JOHNSTONI	Caloceras + Waehneroceras s. str. (= Curviceras Blind)
	Caloceras without Waehneroceras (not known in Germany)
PLANORBIS	Psiloceras s. str. (+ Neophyllites)
	?Neophyllites without Psiloceras (not confirmed till now)

Tab. 1. Sequence of ammonite assemblages in the Hettangian of NW Europe.

This sequence of ammonite assemblages was already known in general 1967. New studies of the present author have shown that the assemblage with Schlotheimia depressa is so different from that of Schlotheimia complanata that it can be regarded as a separate subzone. It is known only from S Germany and from Lorraine thus far. The assemblage with Schlotheimia pseudomoreana in England is still poorly known. Therefore it is difficult to judge if there exist stronger differences to the fauna of the complanata Subzone.

The sequence of table 1 is reflected best in the proposal of zonal subdivision made by ELMI & MOUTERDE 1965 on base of studies in South France, in the Ardèche region. The boundaries between the units are not known in all detail thus far. There occur considerable differences of fauna between different re-

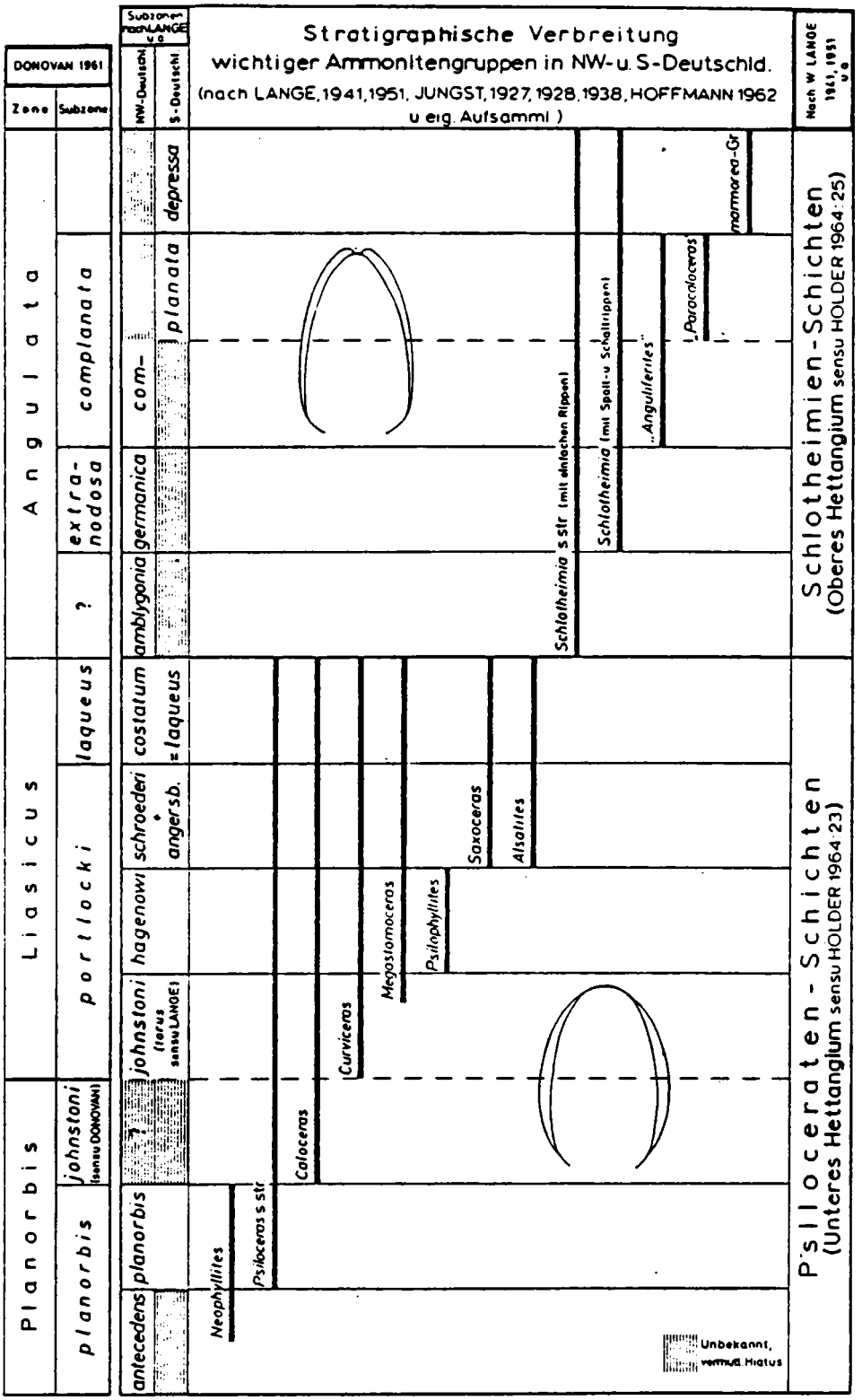

Fig. 2. Stratigraphic range of important groups of ammonites in the Hettangian of NW and S Germany. Adopted from BLOOS 1979.

gions, as already mentioned, the relations of which are not sufficiently known. E. g. it is not known if Waehneroceras s.l. (that means the Storthoceras group of LANGE) or Alsatites appear everywhere at the same stratigraphic levels for the first time. Therefore more exact comparisons are necessary, mainly on base of species and not only of genera.

If one regards the stratigraphic range of the major ammonite groups in the Hettangian of NW Europe (fig. 2) one can recognize a continuous development from the Planorbis to the Liasicus Zones. New groups appear successively and persist till the top of the Liasicus Zone. At the boundary Liasicus/Angulata Zones there is a strong break of fauna. In the Angulata Zone the development repeats: new groups appear successively and persist mostly to the top of the zone.

In the Tethyan province of Europe the stratigraphic subdivision of the Hettangian is by far less known as in the NW European province. WAEHNER 1886 and LANGE 1952 have distin-

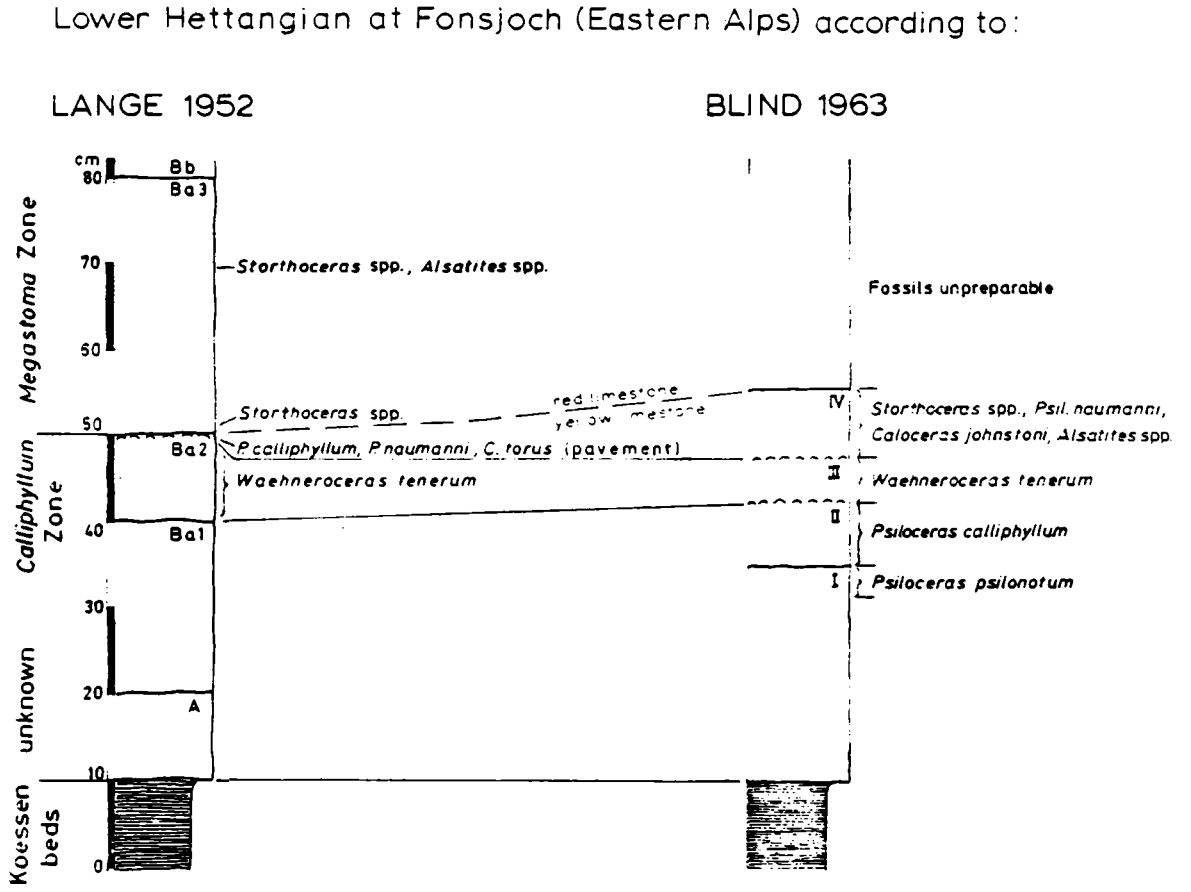

Fig. 3. Lower Hettangian at Fonsjoch (Eastern Alps, Tethyan province) according to LANGE 1952 and BLIND 1963. Note the differences of the ammonite distribution.

guished three zones in the Eastern Alps:

Zone of Schlotheimia marmorea

Zone of Psiloceras megastoma

Zone of Psiloceras calliphyllum.

BLIND (1963) subdivided the Calliphyllum Zone into three further units whereas the Megastoma Zone remained undivided (fig. 3).

Also in the zone of Schlotheimia marmorea the sequence of ammonites is unsufficiently known. BLIND (1963) tried to subdivide the zone at the locality of Breitenberg, but this attempt remained unsatisfying because of the unsufficient material. Additionally some of BLIND's determinations are que-

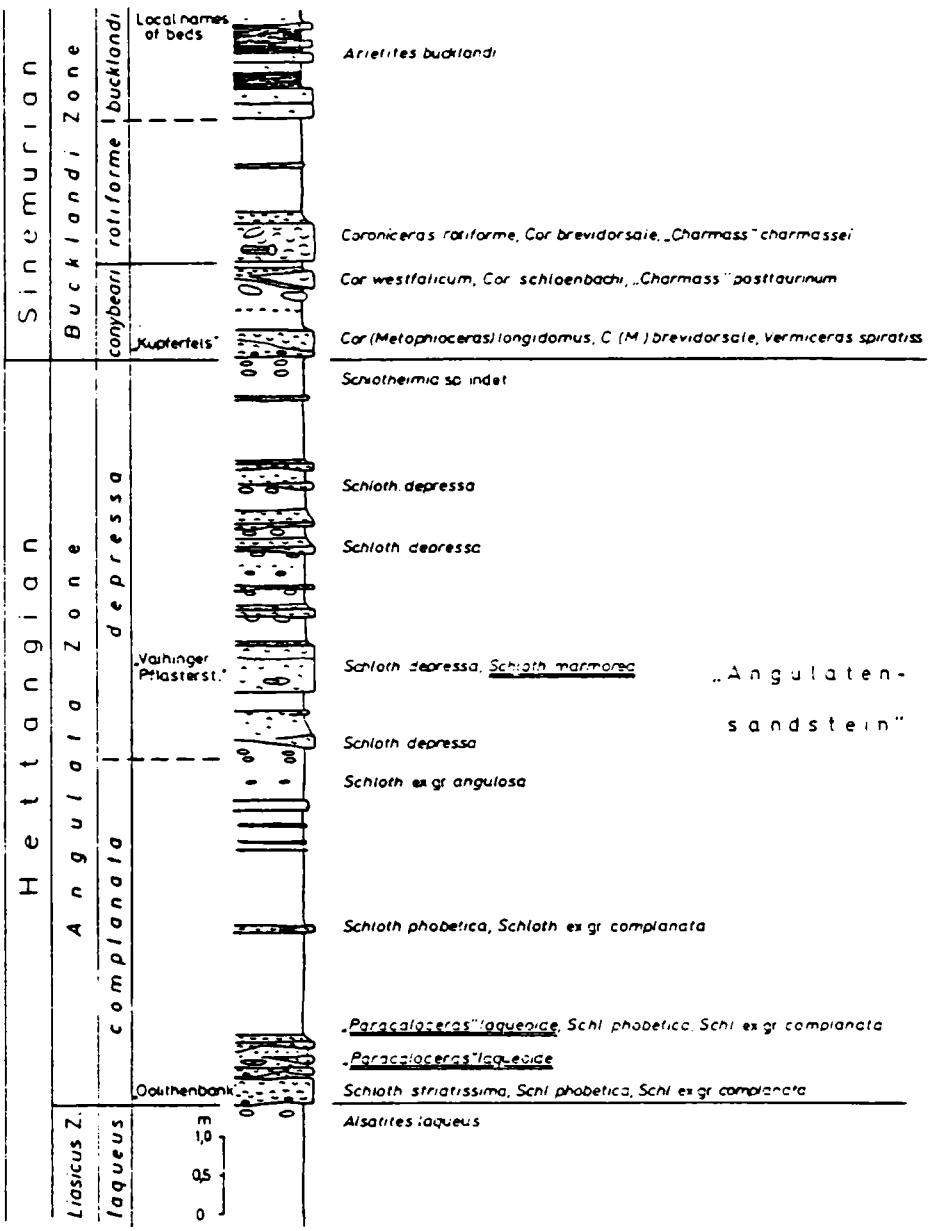

Fig. 4. Angulata Zone and lower Bucklandi Zone at Stuttgart-Vaihingen (SW Germany). Adopted from BLOOS 1983.

stionable and lead to wrong stratigraphic conclusions (GUEX & TAYLOR 1976, GUEX 1981; see also BLOOS 1979 and 1981).

A subdivision of the zone seems to be indicated by the fact that Schlotheimia extranodosa appears - according to WÄHNER 1886 - already below Schlotheimia marmorea, similar as in the NW European province. Already WÄHNER has recognized similarities between the fauna of the Marmorea Zone and the Angulata Zone of S Germany. These similarities could be now confirmed. They concern Schlotheimia marmorea itself, but also Schlotheimia depressa, Schlotheimia exechoptycha, Schlotheimia donar, and "Paracaloceras" laqueoides (HYATT); the last two occur in the complanata Subzone of S Germany (fig. 4).

In regard of the unsufficiently known Hettangian ammonite sequence in the Tethyan province of Europe comparisons with other parts of the world presenting similar faunas are difficult. One of the most complete sequences of well preserved Hettangian ammonites outside of Europe is exposed in the New York canyon in North America (Nevada); the fauna as far as published shows Tethyan character (GUEX 1980).

SINEMURIAN

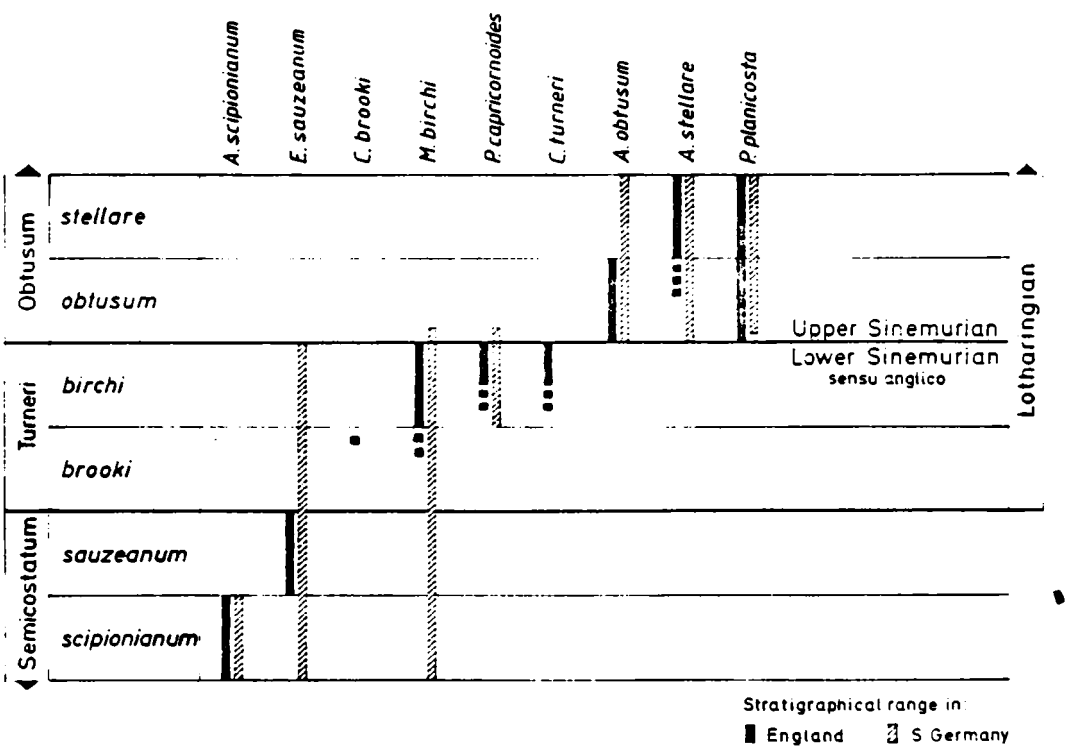

Fig. 5. Stratigraphic range of index species in the boundary region lower/upper Sinemurian in England and S Germany (according to W. D. LANG 1924, L. F. SPATH 1956, O. H. WALLISER 1956). Not to scale.

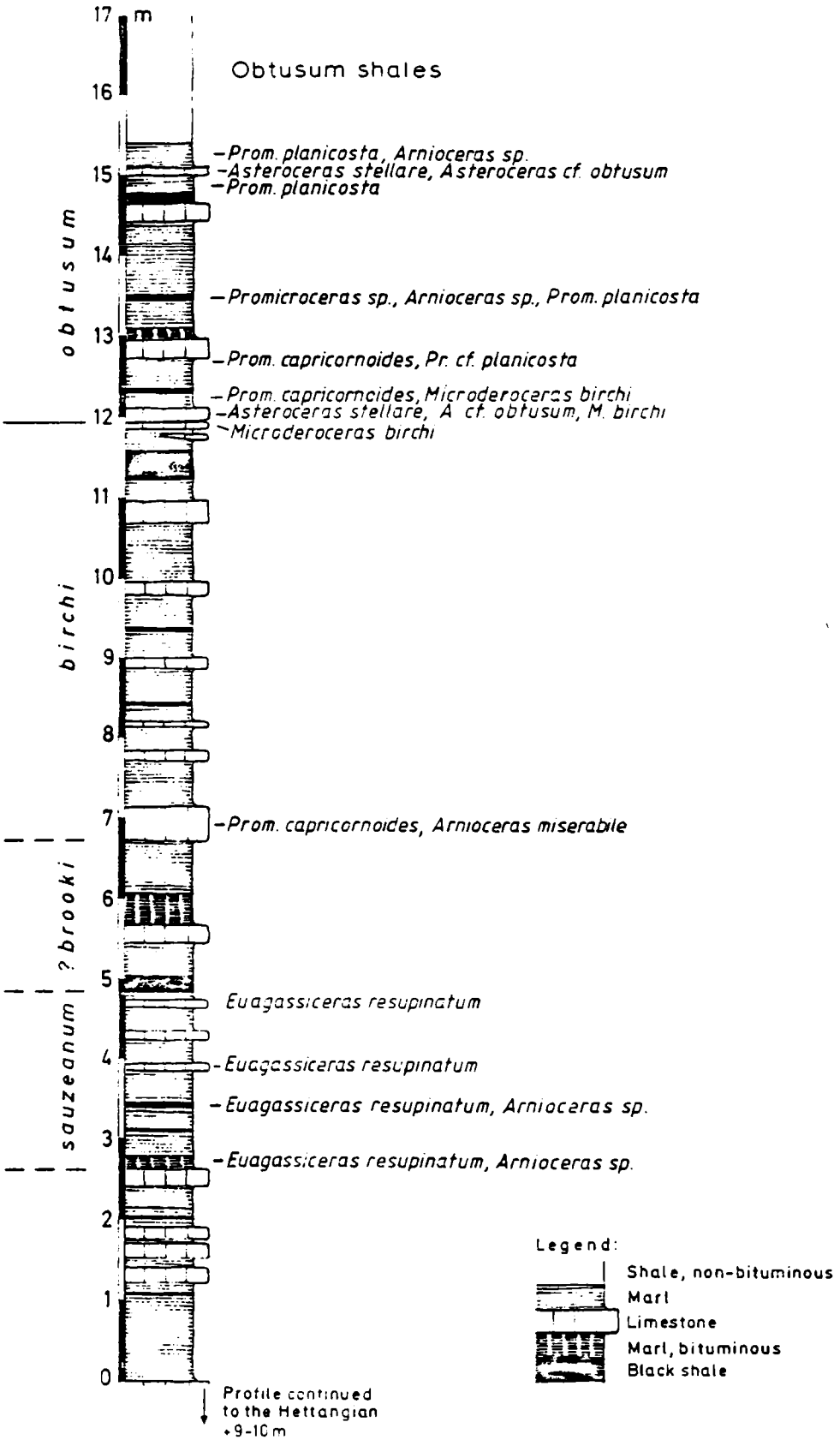

Fig. 6. Boundary region lower/upper Sinemurian in a section of SW Germany (Hildrizhausen, Württemberg).

In the Sinemurian the situation is similar as in the Hettangian. Most efforts were made in the upper part in the last years.

In the NW European province in the Sinemurian exist also different regional subdivisions on the subzonal level as in the Hettangian. Best agreement exists in the lower part (Bucklandi and Semicostatum Zones) and in the upper part (Oxynotum and Raricostatum Zones).

In the Turneri and Obtusum Zones further subdivisions are difficult outside of Britain because the index species are either rare or their stratigraphic range is different in different regions. On the European continent not even the zonal boundary Semicostatum/Turneri Zones can be recognized with some certainty (fig. 5). In contrary, at the boundary Turneri/Obtusum Zones there is a more distinct change of fauna though there occurs some overlap of index species (fig. 5, 6). During the colloquy at Luxembourg 1962 the upper substage of the Sinemurian was taken in the range of the Lotharingian. This was not generally adopted till now, probably by reason of the difficulties with the base of the Turneri Zone.

In the Sinemurian the Jurassic transgression went on and therefore in many parts of the world the sequence of Jurassic ammonites begins in the Sinemurian. Especially the upper part is well represented by Paroxynoticeras and Paltechioceras (see e. g. FERRETTI 1975). A correlation between the Tethyan and the NW European province seems possible on the level on zones.

GENERAL ASPECTS OF REVISION

A striking feature in the Lower Lias is the different stratigraphic range of ammonite species in different regions. This requires restudy of the occurrence; it might be that species are rare in some horizons and therefore have been overlooked. But in other cases the different range can be caused by different interpretation of species by different authors, and therefore artificial. Therefore stratigraphic revision should include also critical revision of doubtful systematics.

Systematical revision with the aim of more uniform interpretations seems only to be useful if it is possible to restrict the subjective factor. Otherwise the revision is only a new opinion besides others and increases the uncertainties.

Not even statistical treatment of not horizonted material can reduce the subjective factor considerably in cases of large variability and, additionally, of occurrence of homeomorphous forms. Both is found in the Lower Lias rather frequent. The best indications what characters are unsignificant variations and what are diagnostic ones, can give the comparison of populations collected bed by bed. This shows that best results can be expected from a close interrelation of stratigraphical and systematical revision.

If horizonted material has shown the main characters of a systematical unit, also not horizonted specimens in collections can be identified and then increase the base of investigation. A restudy of - often not horizonted - type material sometimes reveals a surprising shift of interpretation of a systematical unit during long times.

Of course a revision which includes not only the usual troublesome work of systematics but also the providing of horizonted material in sufficient quantity and quality requires considerable more in regard of time, means, availability of suitable exposures etc. Therefore often it cannot be realized if the scope of work is too extended. The wide extension of scope is characteristic of many works in the past and a main reason for the more or less strong separation of systematical and stratigraphic studies.The documentation of a single stratigraphic boundary or unit, zone or subzone, by a rich and well documented material may improve the knowledge of stratigraphy more than extensive work with less thorough study in detail. The experience in different parts of the Jurassic in the last years has this confirmed.

Work of this kind will be concentrated in first line on horizons which offer open problems. To find these problems and to precise the questions and also to find the best way to solve them, compilations are useful, especially compilations of sections in which indications of collected fauna are given. The compilation should also include the whereabouts of the collected material and a survey of the litterature. An excellent example of such compilatory work provided COPE et al. 1980 from Britain. Another very good example has given GUERIN-FRANIATTE 1966 within her large work on the Arietitidae of France.

But not only horizons with obviously open problems may need revision. Also horizons which seem to be free of questions at first glance may reveal surprising results. Short time ago the present author has revised the conybeari Subzone (Bucklandi Zone, Lower Sinemurian) in SW Germany. QUENSTEDT hundred years ago has known four species in that horizon. All revisions since then did not increase the knowledge considerably. The subzone remained undivided. Now there were found at least 13 species in a vertical sequence of four distinct ammonite assemblages.

One of these assemblages is that with which the Sinemurian begins in NW Germany and which formerly seemed to be restricted to this region. It is the horizon of Coroniceras westfalicum LANGE, introduced as westfalicum Zone. In reality the horizon is developped also in South Germany and in England; there are indications also in France. In England the ammonite assemblage was already described 1930 by TRUEMAN, but under different names and without reference to NW Germany.

The mentioned revision is an example that detailed stratigraphic revision must not lead to an endless increase of local stratigraphic units and systems the relation of which is puzzling more or less. In contrary it shows that units which first seemed to be local, really are more widespread. Therefore revision may lead to an integration of local subdivisions into a more general scheme. This is an experience not only in the Lower Lias but also in other parts of the Jurassic in the last years.

Ammonite assemblages as mentionned above can precise stratigraphic subdivision and correlation, and also stabilize stratigraphic standards. It can be assumed that an assemblage normally is more restricted to a distinct time than an isolated species or - still by far more - a genus which not rarely offers the problem of early forerunners. In cases of conflict between associations and early forerunners of an "index genus" the assemblages normally prevent an unbearable unstability of stratigraphy. E.g. the base of the Sinemurian is surely better defined in NW Europe by the assemblage of the basal conybeari Subzone than by the genera (or subgenera) Vermiceras and Metophioceras because most probably at least a part of the Hettangian "Paracaloceras" must be transferred to these "Sinemurian" Arietitidae (DONOVAN & FORSEY 1973).

REFERENCES

BLIND, W. (1963): Die Ammoniten des Lias Alpha aus Schwaben, vom Fonsjoch und Breitenberg (Alpen) und ihre Entwicklung.- Palaeontographica, A, 121: 38-131; Stuttgart.

BLOOS, G. (1979): Über den Jura am Grossen Hassberg (Unterfranken, N-Bayern) mit Bemerkungen zum Rät.- Stuttgarter Beitr. Naturk., B, 44, 53 p.; Stuttgart.

-- (1983): The zone of Schlotheimia marmorea (Lower Lias) - Hettangian or Sinemurian? - Newsl. Stratigr., 12: 123-131; Berlin & Stuttgart.

COPE, J.C.W., GETTY, T.A., HOWARTH, M.K., MORTON, N., TORRENS, H.S. (1980): A correlation of Jurassic rocks in the British Isles. Part one: Introduction and Lower Lias.- Geol. Soc. London, Special Report 14, 73 pp.; London.

DONOVAN, D.T. (1961): in DEAN, W.T., DONOVAN, D.T. & HOWARTH, M.K.: The Liassic zones and subzones of the North-West European Province.- Bull. Brit. Mus. (nat. Hist.), 4: 435-505; London.

DONOVAN, D.T. & FORSEY, G.F. (1973): Systematics of Lower Lias Ammonitina.- Univ. Kansas paleont. Contr., 64: 1-18; Kansas.

ELMI, S. & MOUTERDE, R. (1965): Le Lias inférieur et moyen entre Aubenas et Privas (Ardèche).- Trav. Lab. Géol. Fac. Sci. Lyon, n. sér., 12: 143-246; Paris.

FERRETTI, A. (1975): Ricerche biostratigrafiche sul Sinemuriano-Pliensbachiano nella gola del F. Bosso (Appennino Marchigiano).- Riv. Ital. Paleont, 81: 161-194; Milano.

GUERIN-FRANIATTE, S. (1966): Ammonites du Lias inférieur de France. Psiloceratacea: Arietitidae. 455 pp.; Paris.

GUEX, J. (1980): Remarques préliminaires sur la distribution stratigraphique des ammonites hettangiennes du New York Canyon (Gabbs Valley Range, Nevada).- Bull. Soc. vaud. Sci. nat., 358: 127-140; Lausanne.

-- (1982): Quelques cas de dimorphisme chez les ammonoidés du Lias inférieur.- Bull. Soc. vaud. Sci. nat., 360 (1981) 239-248; Lausanne.

GUEX, J. & TAYLOR, D. (1976): La limite Hettangien - Sinémurien, des Préalpes au Nevada.- Eclogae geol. Helv., 69: 521 - 526; Bâle.

LANG, W.D. (1924): The Blue Lias of the Devon and Dorset coasts Proc. Geol. Assoc. London, 35: 169-185; London.

LANGE, W. (1925): Zur Paläogeographie und Ammonitenfauna des Lias α, nebst einer Revision der Nürtinger Psilonotenfauna.- Z. deutsch. geol. Ges., 77: 439-528; Stuttgart.

-- (1941): Die Ammonitenfauna der Psiloceras-Stufe Norddeutschlands.- Palaeontographica, A, 93: 1-192; Stuttgart

-- (1951): Die Schlotheimiinae aus dem Lias alpha Norddeutschlands.- Palaeontographica, A, 100: 1-128; Stuttgar

-- (1952): Der Untere Lias am Fonsjoch (östliches Karwendelgebirge) und seine Ammonitenfauna . - Palaeontographica, A, 102: 49-162; Stuttgart.

SPATH, L.F. (1956): The Liassic ammonite faunas of the Stowell Park Borehole.- Bull. geol. Surv. Gr. Br., 11: 140-164; London.

TRUEMAN, A.E. (1930): The Lower Lias (Bucklandi Zone) of Nash Point, Glamorgan.- Proc. Geol. Assoc. London, 41: 148-159; London.

WÄHNER, F. (1886): Beiträge zur Kenntnis der tieferen Zonen des unteren Lias in den nordöstlichen Alpen. 3. Theil.- Beitr. Paläont. Österr.-Ungarns Orients, 4: 135-226; Wien.

WALLISER, O.H. (1956): Chronologie des Lias α 3 zwischen Fildern und Klettgau (Arietenschichten, Südwestdeutschland).- N. Jb. Geol. Paläont., Abh., 103: 181-222; Stuttgart.

THE PLIENSBACHIAN OF SPAIN: AMMONITE SUCCESSIONS, BOUNDARIES AND CORRELATIONS

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THE PLIENSBACHIAN OF SPAIN: AMMONITE SUCCESSIONS, BOUNDARIES AND CORRELATIONS

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ABSTRACT

A General outline of Pliensbachian of Spain is given on the base of Ammonoid successions from Betic, Iberic and Cantabrian Ranges, and on some data from neighbouring areas (Pyrenees, Costero-Catalan Range, Majorca Northern Mountains, etc.), completed with a facies distribution. Differences in Pliensbachian Ammonite spectra between Betics (S. Spain) and different Ranges sorrounding the Iberian Meseta, i.e.: Cantabrian, Pyrenees, Costero-Catalan (regarded as different paleogeographic areas within the same realm), appear remarkable.

The existence of some Ammonite common taxa in diferent areas gives support to biostratigraphic correlation. The Lower Carixian boundary is delineated between levels with Paltechioceras and that with Gemmellaroceras, Apoderoceras and P. gr. talylori. Lower Domerian boundary is drawn at the first record of either F. portisi (Betic Range) or M. occidentale (Cantabrian and Iberian Ranges). This last species appears just above layers with Oistoceras. Lower Toarcian boundary is marked at the first record of Dactylioceras (D. polymorphum and related forms).

INTRODUCTION

In Spain, Pliensbachian extends through a wide extension along the eastern margin of the Iberian Meseta, as well as some scattered outcrops along the southern edge of Pyrenees, the Costero-Catalan Range and Balear Islands (Fig. 1). The current state of knowledge of different areas is highly unequal especially as far as detailed faunal successions is concerned. So that, the present paper is based mainly on data obtained from Cantabrian and Iberian Ranges, as well as the Subbetic Zone of the Betic Range.

The Pliensbachian of different spanish ranges has been the subject of many local papers describing stratigraphic sequences and faunistic succession and some monographs mainly focused on Ammonite Systematics. Among the first

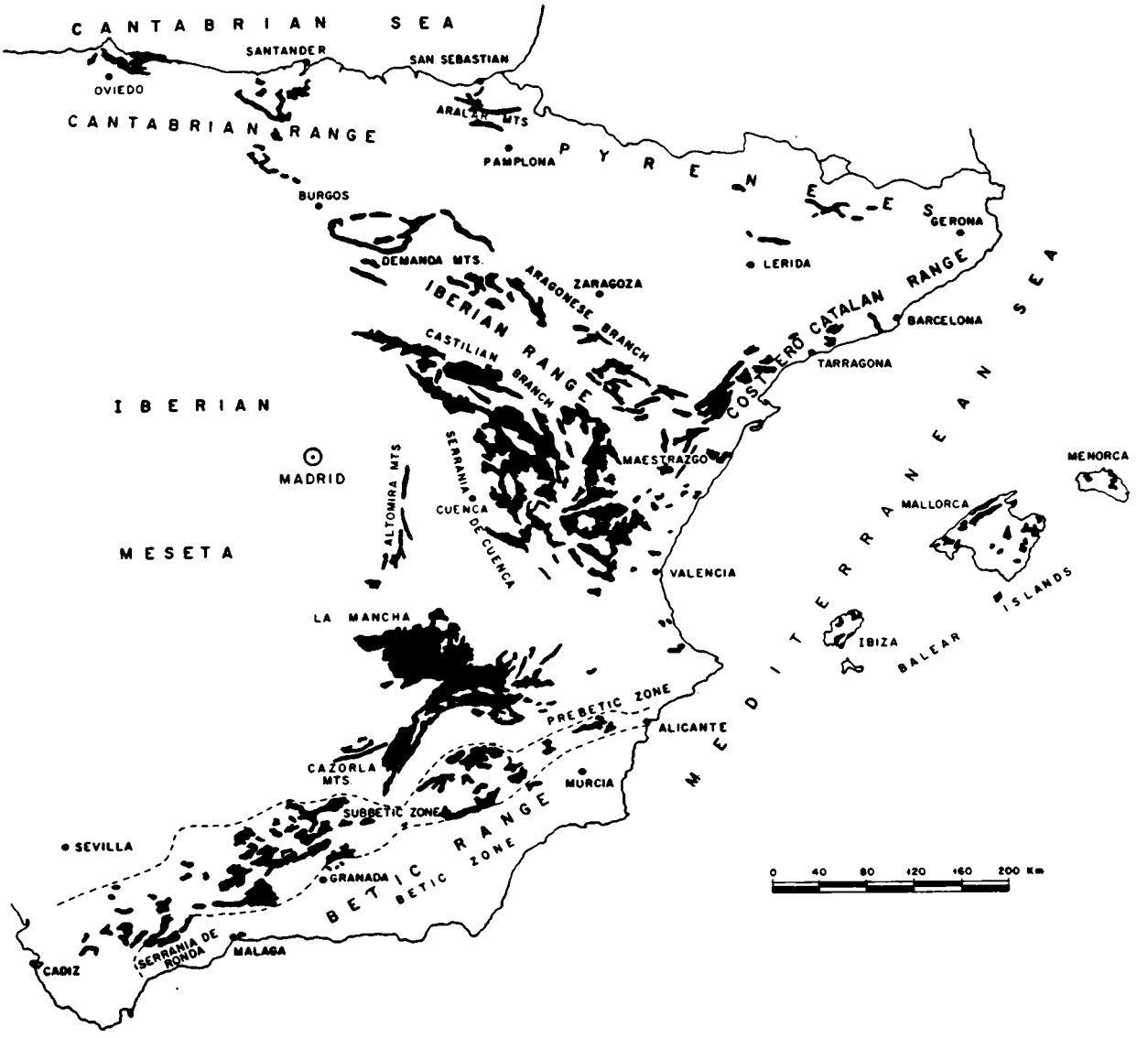

Fig. 1.- Geographical extent of Liassic outcrops in Spain.

ones, it is worth noting that of DUBAR et al. (1967), RIVAS (1972, 1979) and BRAGA et al. (1979) for the Subbetic Zone (Betic Range); MENSINK (1965), BEHMEL & GEYER (1966), MOUTERDE (1971), GOY (1974) and COMAS-RENGIFO & GOY (1978) in the Iberian Range; DAHM (1965), SUAREZ VEGA (1974) and BRAGA et al. (1984) in the Cantabrian Range and CADILLAC et al. (1982) in the Costero-Catalan Range. Among the recent monographs, there should be noted these COMAS-RENGIFO (1982) and BRAGA (1983), dealing on Pliensbachian of Iberian and Betic Range, respectively.

The important faunal differences among regions during Pliensbachian has led to the definition of separate biochronological scales for the Betic Range and the rest of the studied areas. A recent intent of correlation bet-

ween Betic and Iberian Ranges successions is due to BRAGA et al. (1983). This tentative biozonation is here completed and precised on the base of new data, coming from the best known areas, as well as from the eastern Cantabrian Chain.

FACIES DISTRIBUTION

Carbonate platform constitute the main dominant facies at the lowermost Pliensbachian in the Betic Range. Some local records of flint limestones are ocassionally detected, suggesting the beginning of the break up of the platform, with the setting of deeper areas. Flint limestones are then recorded in this moment along the Betic "Dorsal" (sensu DURAND DELGA & FOUCAULT,1967), where pelagic facies are being first found in Upper Hettangian. In Middle Carixian, the block dislocation of the inicial platform leads to the disappearance of the generalized carbonate shelf conditions. These, however, still persist throughout the Prebetic Zone and in some blocks of Subbetic Zone. Bioclastic Cephalopod facies, associated to limonitic crusts and crinoid calcarenites, dominate in the remaining parts of the basin, whereas in the Betic "Dorsal" it is still detected the deposition of flint limestones.

The same sedimentary pattern as in Middle Carixian is maintained during Lower Domerian. Basin facies, represented by marls and marly-limestones alternations are developed in some scattered points from Upper Carixian on. In the Domerian-Toarcian transition a reduction of remanent platforms is observed. Basin facies (marls and marly-limestones) are then generalized in the Subbetic Zone and the Betic "Dorsal".

As far as the rest of Peninsular Spain is concerned, two main types of deposits can be distinguished at the base of Carixian; in the Cantabrian Range and the NE. end of Demanda Mountains, deposits comprise mainly Ammonite-bearing marls and limestones alternations, whereas in the rest of Iberian Range, major part of Pyrenees and Costero-Catalan Range, shallow, (mostly) intertidal dolomites and limestones dominate. In Lower to Middle Carixian transition, the Cantabrian Range and NE. Demanda Mountains facies show little change. At the same time Ammonite-bearing marls and marly-limestones facies are deposited throughout most of the Aragonese Branch and Costero-Catalan Range. The deposition of the only Ammonite-bearing marly deposits known

from the Lias of Majorca, takes place as well during this interval.

Marly deposits become generalized during Lower Domerian in the Iberian Chain except for its southern part, and in Lérida Pyrenees. In the southern Iberics, as well as in the Costero-Catalan Range in turn, limestones are the customary facies suggesting a presumably moment more restricted environment. From that point, a certain trend to shallowing upwards along the eastern margin of Iberian Meseta is observed. This is represented by bioclastic limestones deposits, displaying sometimes, ranging up to uppermost Pliensbachian in the northern part of Iberian Range, i.e.: Demanda Mountains and the major part of Aragonese Branch, and to Lower Toarcian (Tenuicostatum Zone, Mirabile Subzone) in the rest of Iberian Range and in Lérida Pyrenees. In the Costero-Catalan Range and Majorca the open platform marly deposits are not recorded again up to the Dogger.

AMMONITE FAUNAL SUCCESSIONS

Pliensbachian outcrops of Betic Range, as well as those extended along the northern and eastern margin of Iberian Meseta give the most complete (and the best known) Ammonite successions.

In Pyrenees, Costero-Catalan Range and southern Iberica (i.e.: Serranía de Cuenca, Valencia,Maestrazgo), Pliensbachian sediments correspond generally to shallow water deposits (tidal flat or restricted platform), where Ammonites are rarely preserved, or in the only, sporadic, moments of open platform conditions, which during the Carixian happens usually outside the Iberian Chain. In Majorca Isle, the only reference to Pliensbachian Ammonites comes from Soller Area (La Muleta outcrop) in the northern mountains, no other record of Pliensbachian Ammonites either from Levante Mountains or from any other balearic Isle being known up to the present.

Carixian

In Betics, Lower Carixian Ammonoid fauna are scarce and poorly diversified (Fig. 2), the Ammonite record comprising mainly the genera Gemmellaroceras, Platypleuroceras ? sp., Coeloceras, "Miltoceras", Polymorphites and scarce Phylloceratina in isolated areas. During Middle Carixian the Cephalopod record is more important in the Subbetic Zone, the genera Tropidoceras and Metaderoceras forming the bulk of Ammonite record, together with spora-

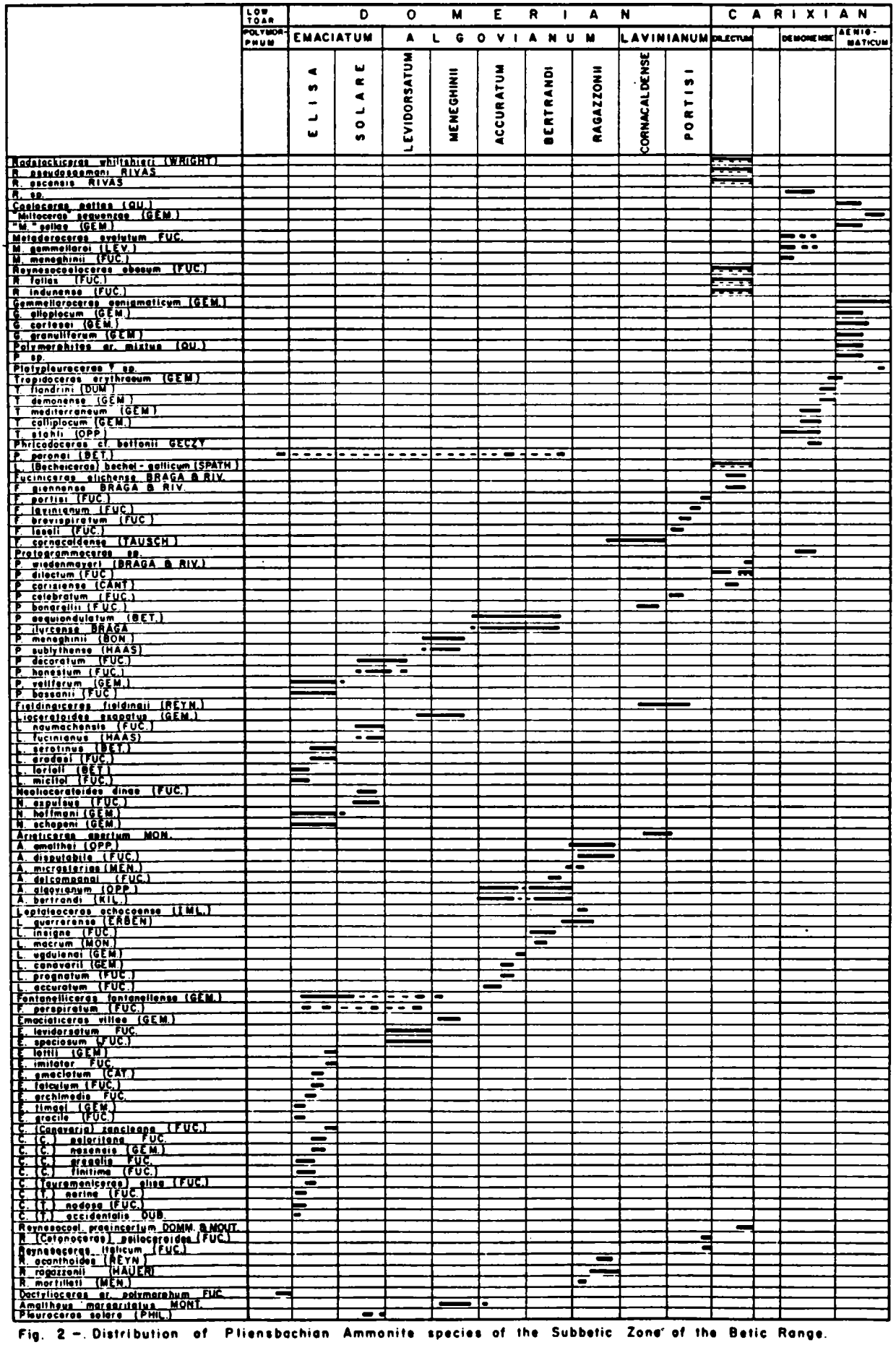

Fig. 2 -. Distribution of Pliensbachian Ammonite species of the Subbetic Zone of the Betic Range. Zonal scheme after RIVAS (1979) and BRAGA (1983).

dic representatives of Phricodoceras, Protogrammoceras, Radstockiceras and Dubariceras. In Upper Carixian the Ammonite record is once more scarce, the distribution of taxa showing a similar pattern than in Lower Carixian. Protogrammoceras and Fuciniceras are usually a common taxa in the region extended southwards from Jaén, generally associated to marly-limestones and marls. In the Huéscar region, representatives of Radstockiceras and L. (Becheiceras), Reynesocoeloceras, Phylloceratina and Lytoceratina have also been found, coming from a limestone bank (1).

Pliensbachian Ammonites in the Iberian Range are generally scarce, the number of available specimens being still very low, with the exception of the northern part and eastern Aragonese Branch. Representatives of Polymorphitidae (Platypleuroceras, Polymorphites, Uptonia) and Oxynoticeratidae, almost exclusively represented by the genus Radstockiceras, dominate in Lower Carixian (Fig. 3). In the Middle Carixian, Polymorphitidae, represented by very few Tropidoceras and Acanthopleuroceras, are still present. Eoderoceratidae (the genus Metaderoceras only) in turn, are quite abundant, with the first Liparoceratidae and Dactylioceratidae and some occasional representatives of Radstockiceras. Liparoceratidae (genera: Liparoceras and Aegoceras), form the main stock during Upper Carixian, showing a large geographic distribution throughout the whole Iberian Range, except for its southernmost part. Representatives of Dactylioceratidae (genera: Aveyroniceras, and Prodactylioceras) are common in uppermost Carixian, especially in the northern part of Iberics.

The faunistic succession in the Cantabric Range appears, on general grounds, very similar to that of Iberian Range (Fig. 4). Lower and Middle Carixian remains still poorly known in eastern part, the only findings up to the present comprising, respectively, the genera Polymorphites and Uptonia on one hand, and Tropidoceras and Acanthopleuroceras on the other hand. In its western part, the genera Phricodoceras and Apoderoceras, still not recorded from Iberian Range, followed by Platypleuroceras, Polymorphites and Uptonia, have been identified by SUAREZ VEGA (1974).

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(1): In Text-Fig. 2, those taxa collected from condensed levels are represented by a double line.

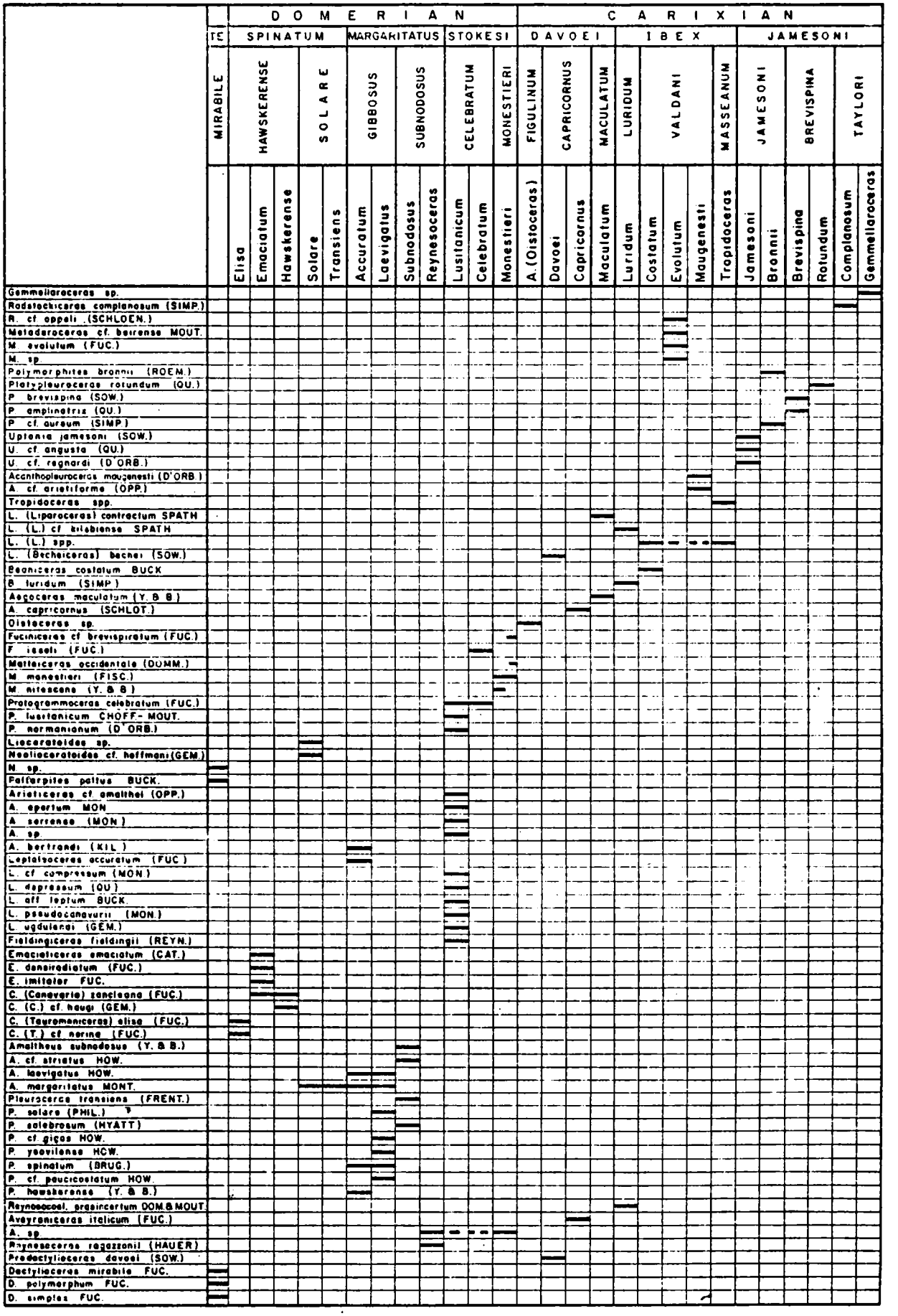

Fig. 3.- Distribution of Pliensbachian Ammonite species of the Iberian Range. Zonal scheme after COMAS - RENGIFO (1982).

In Eastern Pyrenees (Catalonia), in the outcrops North from Camarasa (Lérida), Metoxynoticeras sp. juv. has been cited by PEYBERNES (1978), in his opinion suggesting Lower Carixian age. Above this record, there have been found Beaniceras cf. costatum BUCK., Tropidoceras gr. stahli (OPP.), Liparoceras from the Ibex Zone, Middle Carixian, and Prodactylioceras davoei (SOW.) and Aegoceras lataecosta (SOW.), from Davoei Zone, Upper Carixian. Further East in Pyrenees (Ampurdán Region outcrops, Gerona), the genus Acanthopleuroceras has been recorded by LLOMPART & ROSELL (oral comm.) within the marly facies of Carixian age. In the Spanish Western Pyrenees, in the high Bidasoa Valley (Navarra), the presence of "Polymorphites jamesoni SOW., Liparoceras striatum ZIETEN, Microceras capricornu SCHLOTH., Coeloceras cf. centaurus D'ORB., and Phylloceras loscombi SOW." has been cited by DUBAR (1930), within the marly-limestones of Middle Lias.

In Costero-Catalan Range, the presence of scarce Ammonites has been reported by ROBLES OROZCO (1975) from the marly intervals of Pliensbachian deposits. On the other hand, CADILLAC et al. (1982) report, from the locality of Engrillo (Tarragona), the most complete Ammonite succession, including: Polymorphites sp. (Lower Carixian), followed by Platypleuroceras sp. (Jamesoni Zone, Brevispina Subzone), and Uptonia jamesoni (SOW.), (Jamesoni Subzone). No Ammonite characteristic of Middle Carixian has been found, but only the Upper Carixian species Aegoceras maculatum (Y. & B.) from Davoei Zone, ? Capricornus Subzone. The presence of Polymorphites, Platypleuroceras rotundum (QU.) and Uptonia jamesoni (SOW.), has been also remarked by the same authors in some near outcrops northwards from that ones, such as Vandellós and Tivisa (Tarragona).

In Majorca Isle, Uptonia jamesoni (SOW.) is, up to the present, the only Ammonite taxa cited in the literature. Some recent new findings include representatives of the genus Tropidoceras, from lower Ibex Zone of La Muleta Section (Sóller).

Domerian

In the Betic Range Hildoceratidae are far the most abundant Ammonite group (more than 90% of recognized individuals). The record of Dactylioceratidae and Amaltheidae appears remarkably discontinuous, the remaining groups being scarce (see details of faunistic succession in Figure 2)).

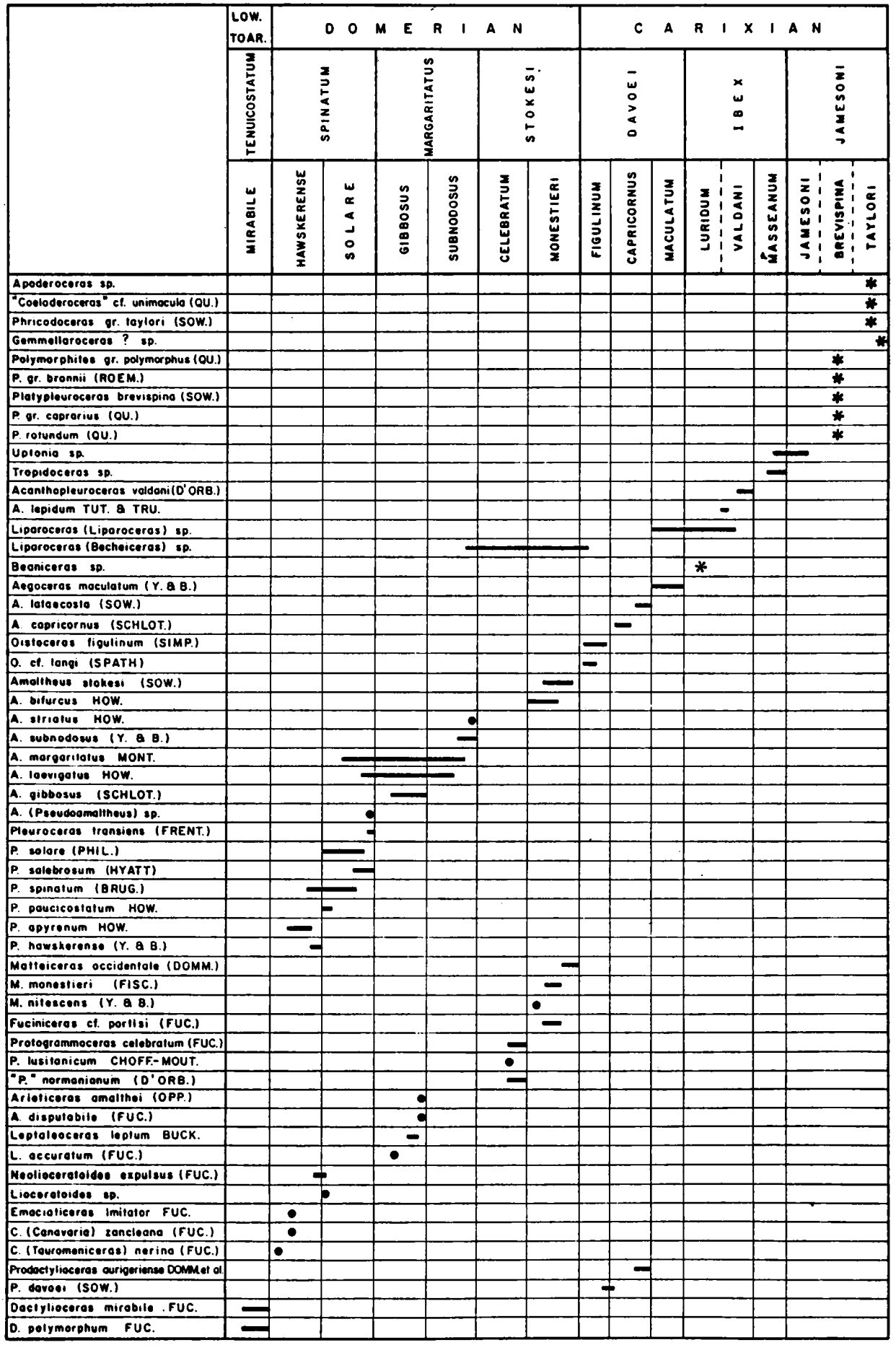

Fig. 4.- Distribution of Pliensbachian Ammonite species of the Cantabrian Range. Asterisks, data from SUAREZ-VEGA (1974). Zonal scheme modified after BRAGA et al. (1984).

In Cantabrian and Iberian Ranges, Ammonites successions are basically similar, with a higher share of Hildoceratidae and Amaltheidae (particularly abundant in Cantabrics) than Dactylioceratidae, Liparoceratidae and other groups. On the other side, the number of common taxa with the Betic Range is higher than recorded in the Carixian (BRAGA et al., 1983). Ammonoid successions for both Ranges are exposed in Fig. 3 and 4.

References to Domerian Ammonite taxa from the rest of Spain are very scarce. The species "Amaltheus margaritatus MONTF. and Grammoceras ruthenense REYNES" have been reported from western Pyrenees by DUBAR (1930), in levels equivalent to black shaley limestones from the French Basc Country. A further reference, to Canavaria sp. (Upper Domerian), from the same area (Aralar Mountains) is due to DUVERNOIS et al. (1972). Similarly, the genus Arieticeras has been recently cited by PEYBERNES (1978) from eastern Pyrenees (Catalonia), who reports it from Middle Domerian.

In the Costero-Catalan Range the species Amaltheus margaritatus MONTF. has been reported by BATALLER (1922) from Prat de Compte (Tarragona). A reference to Protogrammoceras sp., Fuciniceras sp. and Reynesoceras sp. from the Lower Domerian of Engrillo (Tarragona) is due to CADILLAC et al. (1982).

BOUNDARIES AND CORRELATIONS

Due to the lack of a concrete, standard definition of lower boundary of Pliensbachian, the general criteria established by SCHLATTER (1977) and URLICHS (1977) for the stratotype have been followed here. According to the first author the species Apoderoceras nodogigas (QU.) would be placed at the beginning of Pliensbachian in the type locality, its stratigraphic position being there slightly lower than that of Phricodoceras taylori (SOW.). In England, according to DEAN et al. (1961), the Pliensbachian would start with Taylori Subzone, which is characterized by the presence of the genus Apoderoceras. As far as Spain is concerned, on one hand the stratigraphic distribution of Echioceratidae is still not well known and, on the other hand, both Apoderoceras and Phricodoceras gr. taylori (SOW.) have been found up to the present only in Asturias (Cantabrian Range), an Ammoniteless interval of more than 15 m. appearing between the last representatives of Echioceratidae and the first Phricodoceras, which makes characterization of the boundary somewhat uncertain.

The definition of Lower Toarcian boundary is still open to discussion, the customary criteria for the mediterranean area being to make it coincide

with the first record of Dactylioceratidae. For North western European Province, after DEAN et al. (op. cit.), the proposal of HOWARTH (1973, 1980) appears as more adequate. On the one hand, the genus Dactylioceras is markedly scarce in England, at the base of Tenuicostatum Zone, Paltus Subzone of this author (a single finding of D. pseudocommune FUC., in Paltus Horizon). On the other hand, as it happens in Spain, the genera Pleuroceras and Dactylioceras have not yet been found together in England whereas in Germany both forms have been reported together (SCHMIDT-EFFING, 1972; SCHLATTER, 1982). It appears, therefore, safer to regard the first record of Dactylioceratidae as indicative of the base of Toarcian instead of considering the last Pleuroceras record as indicative of the end of Pliensbachian.

The Carixian-Domerian boundary is delineated by SCHLATTER (1977), in the type section of Pliensbachian and by DEAN et al. (op. cit.), in NW. Europe, at the first record of Amaltheus stokesi (SOW.). In Monte Domaro, in turn, it would appear still unclear (CITA, 1962). In Betic Range it is located by BRAGA (1983) at the first occurrence of Fuciniceras portisi (FUC.), whereas in Cantabrian and Iberian Ranges it is placed at the first record of Matteiceras occidentale (DOMM.), as stated by SUAREZ VEGA (1974), COMAS-RENGIFO (1982) and BRAGA et al. (1984). The same criteria has been applied by DOMMERGUES & MOUTERDE (1980) and by DOMMERGUES (1984) for Portugal, Causses and Burgundy.

The assumed Pliensbachian biogeographic pattern makes correlations between Mediterranean (Betic Range) and Boreal realms (Cantabrian, Iberian, Costero-Catalan Ranges, etc.) difficult. A remarkable difference between global composition of faunes in different regions is detected, as exposed in the faunal distribution schemes (Figs. 2-4). Eoderocerataceae dominate in Subboreal areas whereas in Betic Range they are important only during Lower and Middle Carixian, being subsequently replaced by Hildoceratidae. Nevertheless, some biochronologically significant taxa, recorded in both realms, supply a certain basis for correlation, either directly or indirectly (Fig. 5).

No taxa allowing a reliable direct correlation between Betic and Iberian Range has been found in Lower Carixian. Gemmellaroceras, a genus commonly found in Betic Range, being a matter of discussion whether its stratigraphical position in both realms coincides or not.

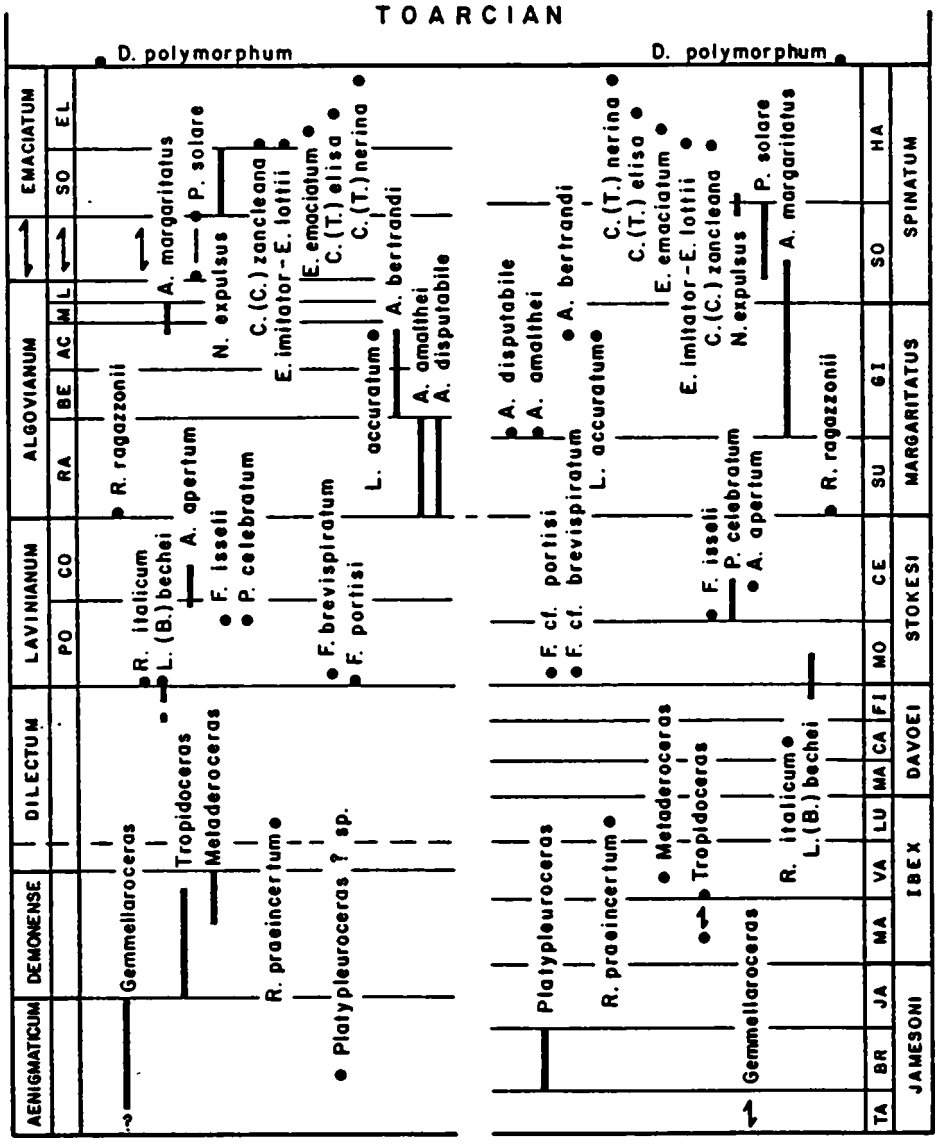

Fig. 5.- Elements of correlation between the mediterranean and the subboreal realms of Spain.

In Betic Range, its first appearance has been recorded right below that of Platypleuroceras ? sp., whilst in Cantabrics it could be associated to Apoderoceras and Phricodoceras gr. taylori (SOW.), or else, come from immediatly lower levels (cf. SUAREZ VEGA, 1974).

Tropidoceras and Metaderoceras are commonly found in both realms, but are represented by different groups of species, the correlation being consequently uncertain. Reynesocoeloceras praeincertum DOMM. & MOUT. is also found in both realms in Luridum Zone in Iberian Range, but without any significant accompanying fauna in Betic Range.

Some forms close to Fuciniceras portisi (FUC.) located at the base of Domerian in Betic Range (and reported by DOMMERGUES et al., 1983 associated

to A. stokesi (SOW.) from Hamuhàza, Hungary), have been found in Cantabrian Range slightly above the record of Matteiceras occidentale (DOMM.) i.e. the index species for lowermost Domerian of western basins of Subboreal realm (Portugal, Cantabrian Range, Iberian Range).

Fuciniceras iseli (FUC.), Protogrammoceras celebratum (FUC.) and Arieticeras apertum (MON.) appear eventually valuable for correlation, despite the long span showed by these taxa in Betic Range, which contrasts with their punctual record in Spanish Subboreal regions.

The record of Pleuroceras solare (PHIL.) appears reduced to a single horizon in Subbetic Zone, at the beginning of Emaciatum Zone, its correlation being possible with any moment of the wide vertical range of this taxa in Subboreal areas.

Finally, correlation between some levels in uppermost Domerian appears possible, in base of the occassional record of several species, typical of Mediterranean Upper Domerian, such as Emaciaticeras imitator FUC., E. lottii (GEM.), E. emaciatum (CAT.), Canavaria zancleana (FUC.), C. (Tauromeniceras) elisa (FUC.), C. (T.) nerina (FUC.).

The first record of Dactylioceras is generally accepted in both realms for the beginning of Toarcian.

CONCLUSIONS

Lithostratigraphic correlation between Mediterranean and Subboreal realms appear not possible, despite the remarkable continuity of outcrops. From paleogeographic point of view, a certain continuity between platforms of separate Spanish Pliensbachian basins can be stated. Continuity appears clear between carbonate plataforms at the southern Iberian and northern Betic Range (Prebetic Zone at least), though North and Southwards from them Cephalopod faunas are strikingly different, corresponding most probably to different paleobiogeographic realms, Subboreal and Mediterranean respectively. Those biogeographic differences could be therefore, conditioned by the presence of ecological barriers within carbonate platforms.

As far as faunal composition in Betic Range is concerned, Eoderocerataceae (Eoderoceratidae, Polymorphitidae, Acanthopleuroceratidae, Coelocerati-

dae) dominate during Lower and Middle Carixian, and Hildoceratidae during Domerian, though Eoderoceratacea may be locally abundant in certain levels.

Eoderoceratacea are the dominant group, during the whole Pliensbachian, in Subboreal basins, though levels with a high share of Hildoceratidae may be eventually found, specially in Lower Domerian.

This would give further support to the use of separate biochronological scales in both realms, without practically any common index. Punctual correlations may be sometimes made in certain levels during Pliensbachian. However exact correlation for all biochronological units appears still problematic.

REFERENCES

BATALLER, J.R. (1922): El Jurásico de la provincia de Tarragona. Trab. Mus. Nac. Cienc. Nat., ser. Geol., 29: 117 pp.

BEHMEL, H. & GEYER, O. (1966): Beiträge zur Stratigraphie und Paläontologie des Jura von Ostspanien. III: Stratigraphie und Fossilführung im Unterjura von Albarracin (Prov. de Teruel). N. Jb. Geol. Paläont. Abh., 124 (1): 1-52.

BRAGA, J.C. (1983): Ammonites del Domerense en la Zona Subbética (Cordilleras Béticas, Sur de España). Tes. Doct. Univ. Granada, 382 pp.

BRAGA, J.C., COMAS-RENGIFO, M.J., GOY, A. & RIVAS, P. (1983): Comparaciones faunísticas y correlaciones en el Pliensbachiense de la Zona Subbética y Cordillera Ibérica. Bol. R. Soc. Esp. Hist. Nat. (Geol.), 80: 221-244.

BRAGA, J.C., COMAS-RENGIFO, M.J., GOY, A. & RIVAS, P. (1984): Le Pliensbachien dans la Chaîne Cantabrique orientale entre Castillo Pedroso et Reinosa (Santander, Espagne). Cahiers de l'Institut Catholique de Lyon (in litt.)

BRAGA, J.C., LINARES, A., MOUTERDE, R. & RIVAS, P. (1979): El Jurásico de las zonas externas de las Cordilleras Béticas. III.3. El Domerense en la Zona Subbética. II. Col. Estr. y Pal. del Jurásico de España (Granada, 1979). Publ.: Cuad. Geol. Univ. Granada, 10: 389-396.

CADILLAC, H., CANEROT, J. & FAURE, Ph. (1982): Le Jurassique inférieur aux confins des Ibérides et des Catalanides (Espagne). Estudios Geol., 37: 187-198.

CITA, M.B. (1962): Contribution à la connaissance du Domérien-type. Coll. Jurassique, Luxembourg, 1962. C.R. & Mem., 173-188.

COMAS-RENGIFO, M.J. (1982): El Pliensbachiense de la Cordillera Ibérica. Tes. Doct. Univ. Complutense de Madrid, 594 p. (in litt.)

COMAS-RENGIFO, M.J. & GOY, A. (1978): El Pliensbachiense y Toarciense en la Rambla del Salto (Sierra Palomera, Teruel). Grupo Esp. Mesozoico; Jur. Cord. Ibér., IV: 11 p.

DAHM, H. (1965): 1. Stratigraphie und Paläogeographie im Kantabrischen Jura (Spanien). Beih. Geol. Jb., 44: 13-54.

DEAN, W.T., DONOVAN, D.T. & HOWARTH, M.K. (1961): The Liassic Ammonite zones and subzones of the North-West European province. Bull. Brit. Mus. (Nat. Hist.) Geol., 4 (10): 435-505.

DOMMERGUES, J.L. (1984): L'evolution des Ammonitina au Lias moyen (Carixien-Domerien basal) en Europe Occidental. These Univ. Claude Bernard, Lyon, 303 p.

DOMMERGUES, J.L., FERRETI, A., GECZY, B. & MOUTERDE, R. (1983): Elements de corrélations entre faunes d'Ammonites mésogéennes (Hongrie, Italie) et subboréales (France, Portugal) au Carixien et au Domérien inférieur. Géobios, 16 (4): 471-499.

DOMMERGUES, J.L. & MOUTERDE, R. (1980): Modalités d'installation et d'évolution des Harpocératinés (Ammonitina) au Domérien inférieur dans le Sud-Ouest de l'Europe (France, Portugal). Géobios, 13 (3): 289-325.

DUBAR, G. (1930): Lias et Jurassique du Batzan (Haute vallée de la Bidasoa, Espagne). Bull. Soc. géol. France, (4), 10: 589-603.

DUBAR, G., FOUCAULT, A. & MOUTERDE, R. (1967): Le Lias moyen des environs de Huescar (Province de Grenade, Espagne). Bull. Soc. géol. France, (7), 9: 830-834.

DURAND-DELGA, M. & FOUCAULT, A. (1967): La Dorsal Bétique, nouvel élément paléogéographique et structural des Cordillères Bétiques au Sud de la Sierra Arana (Prov. de Grenade, Espagne). Bull. Soc. géol. France, (7), 9: 723-728.

DUVERNOIS, Ch., FLOQUET, M. & HUMBEL, B. (1972): La Sierra d'Aralar. Pyrénées Basques Espagnoles. Stratigraphie - Structure. These 3e cycle. Geologie. Univ. Dijon, 272 p.

GOY, A. (1974): El Lías de la mitad Norte de la Rama Castellana de la Cordillera Ibérica. Tesis Doct. Fac. Geología, Univ. Complutense, XV + 940 p. (unpubl.). Abstract: Publ. Dpto. Paleont. Univ. Compl. Madrid, 14: 35 p.

HOWARTH, M.K. (1973): The stratigraphy and Ammonite fauna of the Upper Liassic Grey Shales of the Yorkshire Coast. Bull. Brit. Mus. (Nat. Hist.) Geol., 24 (4): 237-277.

HOWARTH, M.K. (1980): Toarcian Correlation Chart. In: COPE, J.C.W. (Ed.). "A correlation of Jurassic rocks in the British Isles. Part One: Introduction and Lower Jurassic". Spec. Rep. geol. Soc. London, 14: 53-59.

MENSINK, H. (1965): Stratigraphie und Paläogeographie des marinen Jura im den nord westlichen Iberischen ketten (Spanien). Beih. geol. Jb., 44: 55-102.

MOUTERDE, R. (1971): Une coupe du Lias à Obon aux confins des provinces de Teruel et de Saragosse. Cuad. Geol. Iber., 2: 345-354.

PEYBERNES, B. (1978): Le Jurassique des Pyrennées Navarro-Languedociennes. Groupe Franç. Juras., Exc. 1978. Troisieme journée: Le Jurassique des Sierras marginales Catalanes (Sierras de Montroig et de San Giordi), avec la collaboration de Ph. FAURE (Lias), 17-22.

RIVAS, P. (1972): Estudio paleontológico-estratigráfico del Lías en el sector Central de las Cordilleras Béticas. Tesis Univ. Granada, 254 + 242 p. (unpubl.).

RIVAS, P. (1979): El Jurásico de las zonas externas de las Cordilleras Béticas. III. 2_1. Zonación del Carixiense en la Zona Subbética. II Col. Estr. y Pal. del Jurásico de España (Granada, 1979). Publ.: Cuad. Geol. Univ. Granada, 10: 383-388.

ROBLES OROZCO, F. (1975): Síntesis de la evolución estratigráfica y tectónica de los materiales secundarios del bloque del Cardó y sectores adyacentes (Provincia de Tarragona). Ac. Geol. Hisp., 10 (2): 59-66.

SCHLATTER, R. (1977): The biostratigraphy of the Lower Pliensbachian at the

SCHLATTER, R. (1977): The biostratigraphy of the Lower Pliensbachian at the type locality (Pliensbach, Württemberg, SW. Germany). Stuttgarter Beitr. Naturk., Ser. B, 27: 29.

SCHLATTER, R. (1982): Zur Grenze Pliensbachian - Toarcian im Klettgau (Kanton Schaffhausen, Schweiz). Eclogae geol. Helv., 75 (3): 759-771.

SCHMIDT-EFFING, R. (1972): Die Dactylioceratidae eine Ammoniten-Familie des unteren Jura. Münst. Forsch. Géol. Paläont., 25/26: 1-255.

SUAREZ-VEGA, L.C. (1974): Estratigrafía del Jurásico en Asturias. Cuad. Geol. Ibér., 3: XVI + 370 p.

URLICHS, M. (1977): Stratigraphy, Ammonite Fauna and some Ostracods of the Upper Pliensbachian at the type locality (Lias, SW. Germany). Stuttgarter Beitr. Naturk., 28: 13 p.

BIOSTRATIGRAPHIC SKETCH OF THE LOWER LIASSIC OF THE BETIC CORDILLERAS

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BIOSTRATIGRAPHIC SKECTCH OF THE LOWER LIASSIC OR THE BETIC CORDILLERAS

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The ammonite-bearing Lower Liassic sediments of the Betic Cordilleras are practically restricted to the sporadic outcrops of the "Dorsal Betique" units (including the "Praedorsal units") while the carbonate platform facies are common in the rest of the External Zones of the Cordillera.
Using the data obtained from the study of eight sequences, the following synthetic succesion of ammonite assemblages has been built up:

A. Consisting of scarce remains of **Psiloceras**.
B. Relatively rich assemblage of early **Waehneroceras**.
C. Consisting mainly of Middle Hettangian **Waehneroceras**, **Discamphiceras** and **Alsatites**.
D. Upper Hettangian **Schlotheimia**, **Kammerkaroceras**, **Vermiceras (Vermiceras)**, **Vermiceras (Paracaloceras)**.
E. Lower Sinemurian (s.s.) **Vermiceras (Vermiceras)**, **Coroniceras**, **Ectocentrites**, **Geyeroceras** and **Phylloceras**.
F. Upper Sinemurian ? (s.s.) **Arnioceras**, **Tmaegoceras** and **Tragolytoceras**.
G. Consisting of **Arnioceras**. **A. ceratitoides** is the most representative species.
H. Assemblage consisting of Lower Lotharingian **Arnioceras**, **Asteroceras**, **Hypasteroceras** and **Epophioceras**.
I. Upper Lotharingian **Paltechioceras** and **Epideroceras**.

The scarcity and discontinuity of the ammonite record make a fuller description of the succession impossible. The lack of some of the most characteristic genera used in the north-european biostratigraphy and the markedly mediterranean character of the fauna make it difficult to correlate our assemblages with the better know zones of the standard european stratigraphy.

INTRODUCTION

This article is intented as a summary of the results obtained so far in the fossil bearing sequences of the Lower Liassic in the Betic Cordilleras and is justified by the current lack of knowledge of the ammonite fauna of this age in the Betic Region and indeed of the Western Mediterranean generally. In it, we attempt a biostratigraphical outline of the temporal distribution of these fauna.

Although the existence of ammonites in the Lower Liassic is known from references to them in regional geological works, until recently, no biostratigraphical studies based upon them have been carried out.

The data presented in this paper are based primarily on two studies by BRAGA et al (1984a and b) and on unpublished data from the Ronda region (Gaucín). In all, complete data from seven sequences and partial data from another in the Sierra Harana have been used.

Detailed sampling has established the discontinuity of the ammonite record in all the sequences studied. These fauna are found only in a few specific levels, so that it is impossible to obtain continuous succesions.

Because of the isolation of the sequences and the sedimentary complexity of the units in which they occur, the fossil bearing levels are not always the same and this makes correlation, even between nearby areas, difficult.

Further difficulties are presented by the generally poor state of preservation of the fauna. Ammonite remains frequently occur in breccias and "rosso ammonitico" breccia. Moreover, the materials studied have undergone strong tectonization.

The fauna found throughout the Lower Liassic are characteristically mediterranean, resembling those described by classic authorities in Italy (CANAVARI, FUCINI, PARONA, BONARELLI, etc.) and in the Alps (NEUMAYR, WAEHNER, LANGE, etc.).

This mediterranean character means that there are few species in common with NW Europe. Hence, both the interest of a biostratigraphical study and the difficulty in establishing direct correlations with the standard scale. It is not even possible in the case of certain ammonite assemblages to establish their chronostratigraphic position (see below).

The generic terminology used in this study follows that proposed by DONOVAN et al (1980) as far as possible. Although, in certain cases it is open to criticism, its comprehensiveness makes it useful, bearing in mind that our material does not allow precise paleontological analysis, ultil studied now being made on well preserved fauna and from continuous sequences (not condensed), GUEX (1980-83), produce information on the systematic relationships between the fauna of the Lower Liassic.

GEOGRAPHICAL AND GEOLOGICAL LOCATION

In the Betic Cordilleras the pelagic Lower Liassic sequences with cephalopods form part of isolated and tectonically separated units bordering the contact between the Internal and External Zones (fig.1).

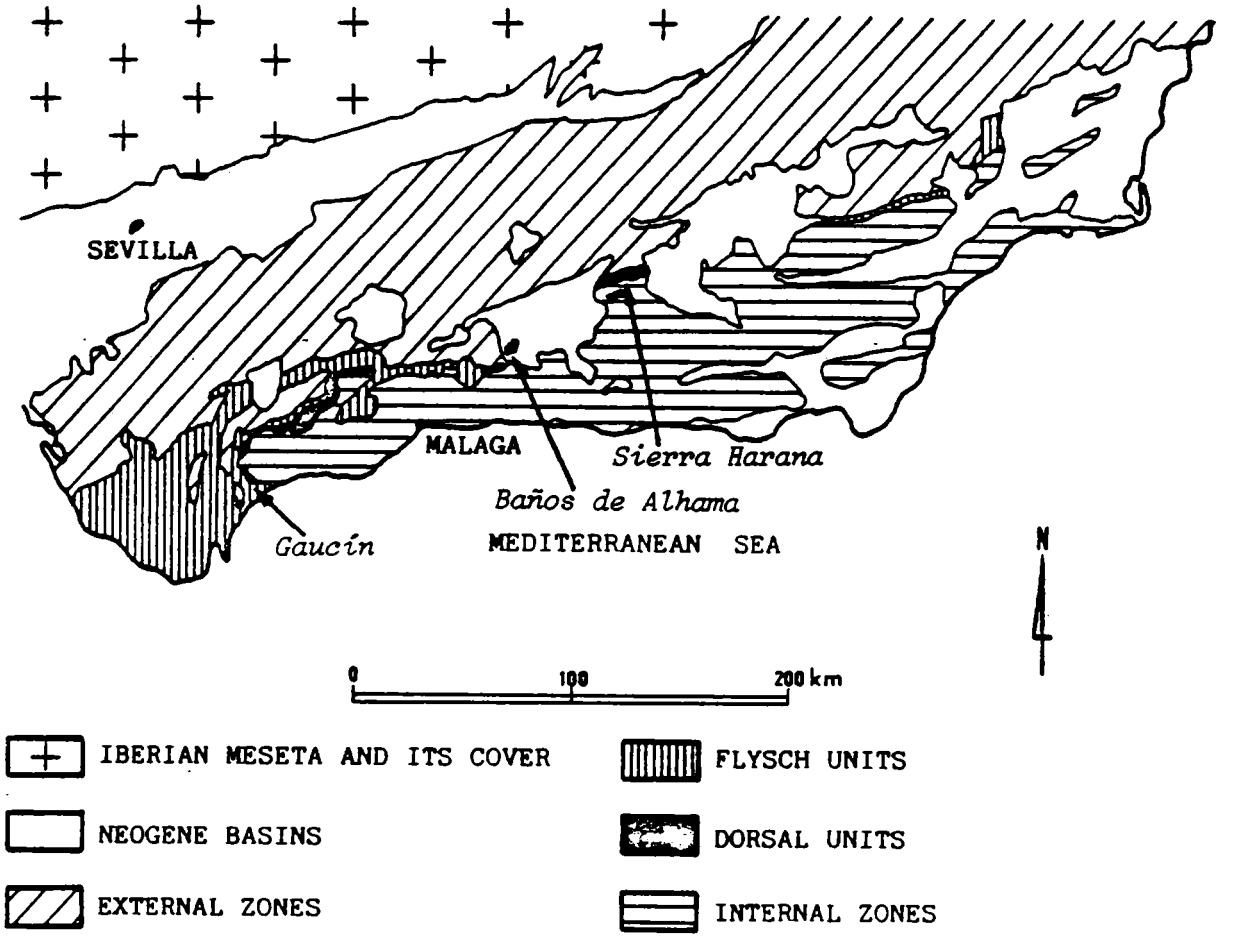

Fig.1.- Geographical and geological location

The denomination of these units, their tectonic subdivision and their paleogeographical position differ according to author and school. Two tectonic terms implying very different paleogeographical realities are commonly used in describing these units.

- "Betic Dorsal" was introduced by DURAND-DELGA & FOUCAULT (1967) in the Sierra Harana and later extended to the rest of the Cordillera. In general the authors who employ this term maintain that the Dorsal Units occupy a position paleogeographically intermediate between the Internal Zones (Malaguides in particular) and the Cretaceous-Tertiary Flysch, recognizing an innermost Internal Dorsal, an External Dorsal and an outermost Pre-Dorsal Zone, this last has characteristics transitional between the External Dorsal and the Flysch Trough.

  A pelagic Lower Liassic with ammonites has only been recognized in the units attributed to the External Dorsal.

- The term "Rondaides" was introduced by BLUMENTHAL (1927) to designate what

is known as the Nieves Unit (DÜRR,1967). On account of their tectonic position and the alpine facies of their Lower Liassic. The Rondaides would be a western equivalent of the Alpujarrides defined in the Central sector of the Cordillera, but differs from them in having post-Triassic materials in its stratigraphic sequence. FELDER (1978) extended the term ot the rest of the tectonic units termed Betic Dorsal by other authors.

In general those authors who favour the term Rondaides maintain that these units represent, to a greater or lesser degree the cover detached from the Alpujarrides or Malaguides units. According to certain authors (WILDI, 1979 and MARTIN ALGARRA, 1980a and b) the Triassic-Jurassic sequences of the units in question present an evolution of austroalpine-type suggesting some sort of connection with at least some of the Alpujarrides Units, having a similar evolution in the Triassic.

Of the eight Liassic stratigraphic sequences studied here, three are in the Sierra Harana, two in Alhama de Granada and the other three in the Gaucín region (fig.1). All belong to the Rondaides or the Betic Dorsal in the loose sense of the term. The first five would belong to the External Dorsal and the last three to the Pre-Dorsal. Since however, sequences assigned to the Pre-Dorsal and those to External Dorsal, have not clear stratigraphic differences the validity of this paleogeographical distinction in doubtful, at least during the Liassic.

SEQUENCES AND FAUNAL SUCCESSIONS

The faunal successions of each sequence are described by areas on account of the discontinuity between the outcrops studied.

Sierra Harana

Various sequences have been studied in this region (BRAGA et al 1984b), all in the same Unit (Rio Blanco Unit, FOUCAULT & PAQUET, 1970) though they vary in their development. The two most important are:

1.- Collado Rojo Sequence (SA)

The following faunal levels may be distinguished:

a. **Schlotheimia** sp.

b. The most important species is **Arnioceras ceratitoides** (QUENSTEDT), accompanied by **Arnioceras anomaliferum** FUCINI.

c. **Arnioceras** cf. **oppeli** GUERIN-FRANIATTE, together with **Partschiceras** sp.

d. An association formed primarily by **Arnioceras pluriplicatum** FUCINI, **Arnioceras dimorphum** PARONA, **Epophioceras landrioti** (D'ORB.) and

Asteroceras cf. **suevicum** (QUENSTEDT).

e. A single exemplar of **Tmaegophioceras laeve** (GEYER).

f. **Paltechioceras** sp., represented by specifically indeterminable fragments.

2.- El Mesto Sequence (MS)

This occurs to the East of the former sequence and the following levels may be recognized:

a. An association in which **Arnioceras ceratitoides** (QUENSTEDT) predominates, accompanied by **Arnioceras anomaliferum** FUCINI, **Angulaticeras** sp., **Lytoconites hierlatzicus** (GEYER) and **Lytoceras etruscum** FUCINI.

b. As in the former sequence, this level contains only **Arnioceras** cf. **oppeli** GUERIN-FRANIATTE and **Partschiceras** sp.

c. An association composed of **Arnioceras pluriplicatum** FUCINI, **Arnioceras dimorphum** PARONA and **Geyeroceras cyclindricum** (SOWERBY).

In another section of the Sierra Harana (BRAGA et al,1984b) **Arnioceras mendax** FUCINI and **Tragolytoceras adnethicum** (HAUER) have been found below a level containing **Arnioceras ceratitoides** (QUENSTEDT).

Alhama de Granada

Two sequences have been studied in this region (BRAGA et al,1984a)

1.- Northern Sequence (BA.B)

a. The first fossil bearing level contains **Discamphiceras kammerkarense** (GUEMBEL) and **Waehneroceras** gr. **frigga** (WAEHNER).

b. A level with few exemplars of **Waehneroceras anisophyllum** (WAEHNER) and **Waehneroceras megastoma** (GUEMBEL).

c. An association with **Arnioceras mendax** FUCINI, as the most important form, with **Tragolytoceras adnethicum** (HAUER) and **Geyeroceras cylindricum** (SOWERBY).

d. The last fossil-bearing level of this sequence contains **Arnioceras ceratitoides** (QUENSTEDT).

2.- Southern Sequence (BA.A)

This is the most representative of the zone and one of the most complete, in terms of faunal levels, of those known of this age in the Betic Cordilleras. The following levels may be distinguished:

a. **Waehneroceras toxophorum** (WAEHNER) and **Alsatites sublaqueus** (WAEHNER) are the most important elements in this association.

b. Al level with **Discamphiceras kammerkarense** (GUEMBEL) and **Alsatites** sp.

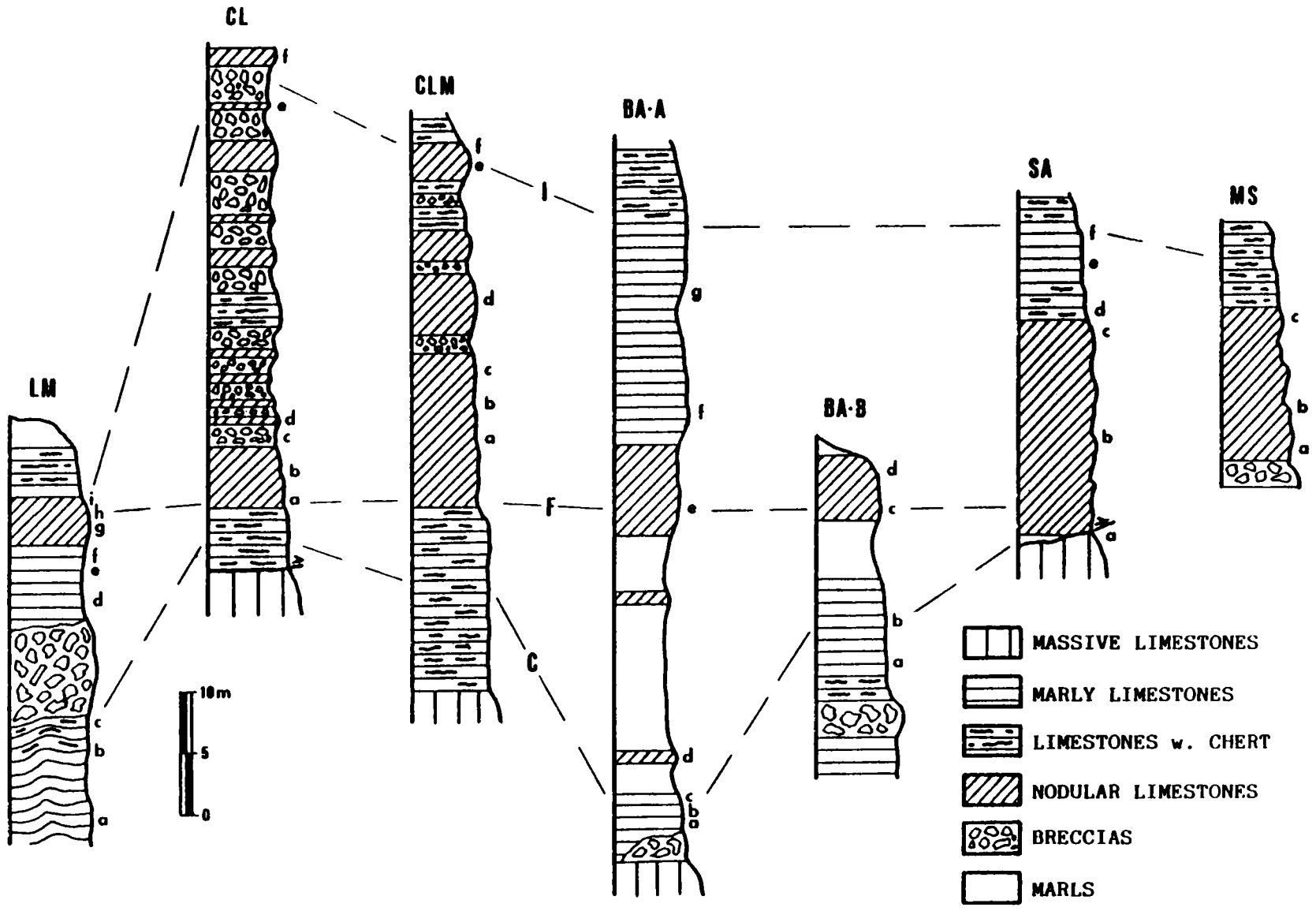

Fig.2.- Sequences, faunal levels and correlations. (The letters refer to the text).

c. An association with abundant **Vermiceras**: **V. (Paracaloceras) coregonense** (SOWERBY) and **V. (Vermiceras) supraspiratum** (WAEHNER) accompanied by **Schlotheimia marmorea** (OPPEL) and **Kammerkaroceras emmrichi** (GUEMBEL)

d. An association scarce in fauna, consisting of **Vermiceras (Paracaloceras) euceras** (GUEMBEL), **Vermiceras (Paracaloceras) coregonense** (SOWERBY), **Schlotheimia marmorea** (OPPEL) and **Schlotheimia** cf. **angulosa** LANGE

e. **Arnioceras mendax** (FUCINI) and **Tragolytoceras adnethicum** (HAUER).

f. **Arnioceras ceratitoides** (QUENSTEDT) occuring frequently throughout various levels associated with **Hypasteroceras ? laevissimum** (QUENSTEDT) and **Geyeroceras cylindricum** (SOWERBY).

g. The final fossil level, composed of **Angulaticeras boucaultianum** (D'ORB.) and **Arnioceras** sp.

The Gaucín Region

There are three sequences, all in blocks (Olistholites?) enclosed by Cretaceous-Tertiary turbidites in the Pre-Dorsalian Betic Units.

1.- Cerro de La Laguna Sequence 1 (CL)

This has been established in the NW part of the hill with the following levels:

a. A level with **Arnioceras mendax** FUCINI together with **Geyeroceras cylindricum** (SOWERBY) and **Tragolytoceras** sp.

b. A very poor assemblage consisting of **Arnioceras ceratitoides** (QUENSTEDT).

c. In this, the most representative form is **Arnioceras dimorphum** PARONA, found together with **Asteroceras** sp., **Geyeroceras cyclindricum** (SOWERBY) and ill defined and preserved forms attributable to **Arnioceras pluriplicatum** FUCINI.

d. **Arnioceras** gr. **pluriplicatum** FUCINI is the only form found in this level.

e. **Paltechioceras boehmi** (HUG), together with other **Paltechioceras** sp. forms.

f. **Epideroceras** gr. **grande** DONOVAN occur with **Paltechioceras** sp. and **Paltechioceras** cf. **bavaricum** (BO.)

2.- Cerro de La Laguna Sequence 2 (CLM)

This section occurs inmediately to the South of the previous sequence, but is not visibly continuous with it and its faunal levels are slightly different.

a. A level with **Arnioceras ceratitoides** (QUENSTEDT) and **Geyeroceras cylindricum** (SOWERBY).

b. **Hypasteroceras exiguum** (FUCINI) and **Arnioceras pluriplicatum** FUCINI.

c. A very poor level with only some remains of **Arnioceras** gr. **pluriplicatum** FUCINI.

d. An ill-defined level with remains of **Arnioceras** sp.

e. A level with **Paltechioceras** cf. **bavaricum** (BO.) and **Paltechioceras** sp.

f. The sequence ends in a level with **Paltechioceras** gr. **aplanatum** (HYATT) and **Zetoceras oenotrium** (FUCINI).

3.- Arroyo de Limas Sequence (LM)

This occurs to the South of the village of Gaucín, near the bridge over the River Genal. Although the study of this sequence and its fauna is incomplete, we ofter the preliminary results for interest's sake. So far, the following faunal levels have been established:

a. A level with small and badly preserved remains of **Psiloceras** gr. **naumanni** (NEUMAYR).

b. An assemblage with the first record of **Waehneroceras**, represented by **Waehneroceras** gr. **tenerum** (NEUMAYR) and **Waehneroceras** gr. **gernense** (NEUMEYR) together with **Caloceras** sp.

c. Abundant **Waehneroceras anisophyllum** (WAEHNER) and some exemplars of **Discamphiceras** sp.

d. A very localized level with ill-preserved remains of **Vermiceras (Vermiceras)** sp. and **Schlotheimia** sp.

e. **Vermiceras (Vermiceras) solarioides** (COSTA), well preserved, together with **Coroniceras** sp. and **Ectocentrites petersi** HAUER.

f. A level with **Coroniceras rotiforme** (SOWERBY) and **Ectocentrites petersi** HAUER.

g. **Vermiceras (Vermiceras) ultraspiratum** FUCINI and **Ectocentrites petersi** HAUER. **Ectocentrites** sp. occurs thourght the last three assemblages.

h. A level very poor in fauna characterized by scarce exemplars of **Arnioceras** sp. and **Tragolytoceras adnethicum** (HAUER).

i. An ill-defined level with **Paltechioceras** sp.

BIOCHRONOLOGY, AGE AND CORRELATIONS

The data already demonstrate the impossibility of carrying out formal biozoning in the Lower Liassic of the Betic Cordilleras. It is possible, however, to establish a succesion of discontinous faunal assemblages characterized by the presence of taxa, whose frequency and distribution are biochronologically significant.

The discontinuous character of the successions does not permit the establishment of precise boundaries between successive assemblages, nor can they be used to characterize determined intervals precisely.

We have sofar established the following assemblages:

A.- **Psiloceras**.- Characterized by ribbed forms of this genus (**Psiloceras** gr. **naumanni**).

B.- **Waeheneroceras** gr. **tenerum**.- In this assemablage the first appearence of **Waehneroceras** species occurs (**Waehneroceras** gr. **gernense**).

C.- **Waehneroceras**.- It is a recognizable level in the sequences studied in which **Alsatites** and **Discamphiceras** are also characteristic.

Various species of **Waehneroceras** have been identified, whose relative positions are difficult to determine, since the sequences have hardly any species in common.

D.- **Schlotheimia- Vermiceras (Paracaloceras)**.- This assemblage is characterized by **Schlotheimia** forms (**S. marmorea** and **S.** cf. **angulosa**) with **Vermiceras (Paracaloceras) ligusticum** , **Vermiceras (Paracaloceras) coregonense**, **Vermiceras (Vermiceras) supraspiratum** and **Kammerkaroceras emmrichi**.

E.- **Coroniceras-Vermiceras (Vermiceras)**.- This low diversified assemblage has been found in only one sequence. **Coroniceras rotiforme** and **Coroniceras** sp. occur with **Vermiceras (Vermiceras) solarioides** and **Ectocentrites petersi**.

Above the level bearing **Coroniceras**, there is another isolated one with **Vermiceras (Vermiceras) ultraspiratum**.

F.- **Arnioceras mendax**.- In this assemablage besides the index species, there are other significant species, such as **Tmaegoceras crassiceps** and **Tragalytoceras adnethicum**.

G.- **Arnioceras ceratitoides**.- It is a broad level, in which the second most characteristic species is **Arnioceras anomaliferum**.

Above this level, in the Sierra Harana, there is a level containing **Arnioceras** cf. **oppeli**.

H.- **Asteroceras-Arnioceras**.- Above the forms already quoted appear other **Arnioceras** species (**Arnioceras pluriplicatum, Arnioceras dimorphum**) and sporadic exemplars of **Hypasteroceras exiguum** and **Epophioceras landrioti**.

I.- **Paltechioceras**.- In the Sierra Harana the first **Paltechioceras** is preceeded by a level with **Tmaegophioceras laeve**.

The succession of species of **Paltechioceras** is ill-defined; **Paltechioceras boehmi** occuring earlier and **Paltechioceras** cf. **aplanatum** later, At one point above the level with **Paltechioceras boehmi**, **Epideroceras** gr. **grande** has been found.

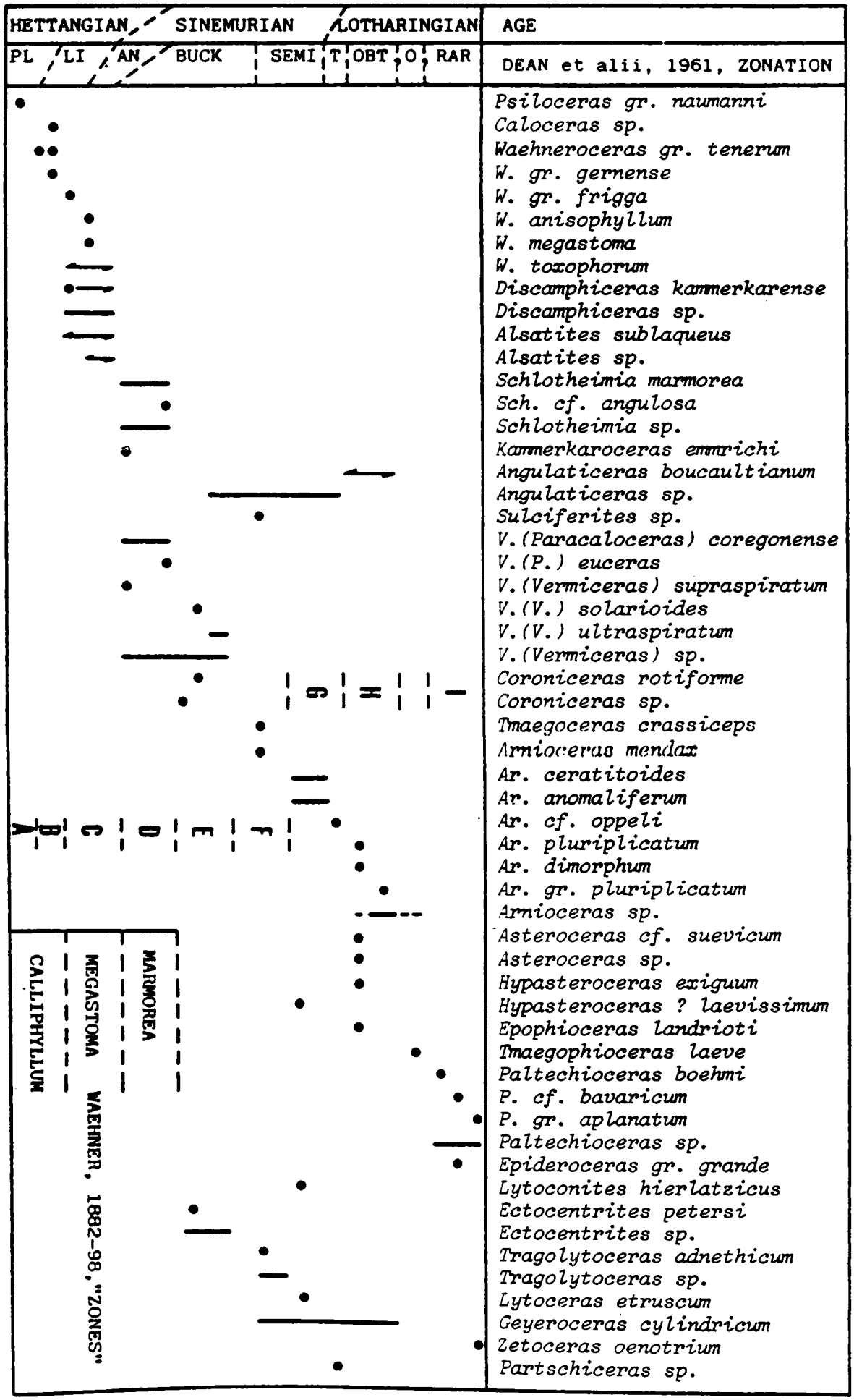

Fig. 3. - Distribution of the species and faunal assemblages. (Capital letters refer to the assemblages).

As has already been suggested (BRAGA et al 1984a, b), these assemblages can only be correlated with any degree of precision with the biochronological divisions established for the thetysic regions.

The Lower assemblage with **Psiloceras** may be considered to correspond with WAEHNER (1882-1898) and LANGE's (1952) Calliphyllum Zone. The assemblage B contains species considered as belonging to the upper part of the former zone.

The level with **Waehneroceras** (C) corresponds to these author's Megastoma Zone, and that containing **Schlotheimia-Vermiceras** with their Marmorea Zone. Correlation of these alpine zones with standard zoning is problematical. The Calliphyllum Zone corresponds broadly speaking with the Planorbis Zone of DEAN et al (1961). According to LANGE (1941) it would correspond to Psilonotum and Torus Zones, i.e. approximately to DEAN et al (op.cit.) Planorbis Zone.

In LANGE's opinion the Megastoma Zone would correspond to Schroederi, Angerbachense and Costatum Zones, that is, again broadly speaking, with DEAN et al's Liasicus Zone.

LANGE (1952) considers **Schlotheimia** a genus characteristic of α 2, not only in the Mediterranean, but also in NW Europe, as do DEAN et al, which allow a loose correlation between the Angulata and Marmorea Zones.

Nevertheless, GUEX (1982), relying on data obtained in Nevada (USA), considers the Calliphyllum Zone to correspond to the Planorbis and part of the Johnstoni Zones; the Megastoma Zone with part of the Johnstoni up to the beginning or Conibeary Zone. As a result the Marmorea Zone would correspond to Conibeary Zone.

Clearly, biostratigraphic correlation between the two palaeogeographic realms is very imprecise.

The subsequent **Coroniceras-Vermiceras (Vermiceras)** assemblage, characterized by **Coroniceras rotiforme**, corresponds to the Rotiforme Subzone.

The association of **Arnioceras** with **Tmaegoceras crassiceps** allows us to correlate this assemblage with the Lower part of Semicostatum Zone (BRAGA et al 1984a).

The levels, in which **Arnioceras** occurs alone may be correlated with the Semicostatum Zone and possibly with part of the Turneri Zone.

The presence of **Asteroceras** and **Epophioceras** in the following assemblage (H) allows it to be correlated with the Obtusum Zone.

Finally, the assemblage with **Paltechioceras** may be correlated with the Raricostatum Zone, though not precisely, nor do the fauna present make it possible to establish the Upper limit of the Lotharingian.

REFERENCES

BLUMENTHAL,M. (1927). Versuch einer tektonische Gliederung der Betischen Kordillern von Central und Südwest Andalusien. **Eclo.Geol.Helv.**, 20, 487-532.

BRAGA,J.C.; MARTIN-ALGARRA,A. & RIVAS,P. (1984a). Ammonites du Lias inferieur (Sinemurian-Lotharingian) de Sierra Harana (C. Bêtique, Espagne). **Reun. Const. CIEL**, Lyon, May 1984.

BRAGA,J.C.; MARTIN-ALGARRA,A. & RIVAS,P. (1984b). Hettangian and Sinemurian of Baños de Alhama de Granada. Reference section for the West-Mediterranean Hettangian (Betic Cordilleras, Southern Spain). **Geobios**, 17/3, 8p.

DEAN,W.T.; DONOVAN,D.T. & HOWARTH,M.K. (1961). The Liassic ammonite zone and Subzones of the northwest European province. **Bull.Br.Mus.(Nat.Hist.) Geol.**, 4(10), 435-505.

DONOVAN,D.T.; CALLOMON,J.M. & HOWARTH,M.K. (1980). Classification of the Jurassic Ammonoidea. In "The Ammonoidea". Ed. House, M.; Raup Senior J.R.; **Syst.Ass.Spec.**, vol. nº 18, 101-155.

DURAND DELGA,M. & FOUCAULT,A. (1967). La Dorsal Betique, nouvel element paleogeographique et structural des Cordilleras Betiques au sud de la Sierra Arana (prov. Grenade, Espagne). **Bull.Soc.Geol.France** (7), IX, 723-728.

DÜRR,St. (1967). Geologie der Serrania de Ronda und ihrer sudwestliche Austaufer (Andalusien). **Geol.Romana**, VI, 1-73.

FELDER, T. (1978). Zur Geologischen Entwicklung der Betischen Internzonen der Westlichen Serrania de Ronda. **Mitt.Geol.Inst.Eidg. Tech. Hochschule Univ. Zürich**, 222 p.

GUEX,J. (1980). Remarques préliminaires sur la distribution stratigraphique des ammonites hettangiennes de New York Canyon (Gabbs Valley Range, Nevada). **Bull.Geol.Lausanne**, 250, 127-140.

GUEX,J. (1982). Quelques cas de dimorphisme chez les ammonoides du Lias inferieur. **Bull.Geol.Lausanne**, 258, 239-248.

LANGE,W. (1941). Die Ammonitenfauna der Psiloceras-stufe Norddeutschlands. **Palaeontogr.**, 93(A), 1-192.

LANGE,W. (1952). Der untere Lias am Fonsjoch ((Ostliches Karwendelgebirde) und seine ammonitenfauna. **Palaeontogr.**, 102(A), 162p.

MARTIN-ALGARRA,A. (1980a). Las unidades del contacto entre las Zonas Internas y Externas al SE de Ronda (Cordilleras Béticas, Andalucia). **Tesis Licenciatura, Univ.Granada** (unpublished). 139p.

MARTIN-ALGARRA,A. (1980b). Rasgos de la sedimentación y su evolución a lo largo del Mesozoico en el dominio de la unidad de las Nieves (Cordilleras Béticas, Andalucia). **IX Congr.Nac.Sedimentol.** Salamanca 3-12 Sept. Octubre 1980 (in press).

WAEHNER,F. (1886-1888). Beitrage zur Kenntniss de tieferen Zonen des Unteren Lias in den Nordostlichen Alpen. **Beitr.z.Palaont.Osterreichs-Ungarns, Wien**, vol.IV, 135-226; (1888) 241-268.

WILDI,W. (1979). Evolution de la plate-forme carbonatée de type austro-alpin de la Dorsale calcaire (Rif Interne, Maroc Septentrional) an Mesozoique. B.S.G.F. (7), 21, 1, 49-56.

FORAMINIFERAL BIOSTRATIGRAPHY IN THE LOWER JURASSIC

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FORAMINIFERAL BIOSTRATIGRAPHY IN THE LOWER JURASSIC

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Detailed biostratigraphical studies of Lower Jurassic foraminifera were initiated in West Germany (Bartenstein & Brand 1937) and many papers on this aspect have since been published, especially in Britain, France, West Germany, Denmark and Sweden. Synthesis of all available data has led to the recent establishment of a foraminiferal zonation (Copestake and Johnson 1984). The data base now available enables recognition of stages, ammonite zones and subzones; this is of particular value in situations where ammonites are lacking, e.g. subsurface exploration wells, Triassic/Jurassic boundary in Britain. Further study, especially from poorly documented areas outside Europe is now required to monitor worldwide distributions.

INTRODUCTION

Foraminifera are of great value in subdividing and correlating the Lower Jurassic. Although this fossil group was dominantly of benthonic habit at this time (planktonic species are not recorded until the Middle Jurassic), species show very consistent stratigraphic ranges over wide geographical areas. This is probably due to regionally uniform palaeoenvironments and stable tectonics relative to later parts of the Jurassic. This has led to the development of relatively thick, complete sequences of argillaceous facies (the Lias), which are particularly widespread in Northern Europe. This, the "Boreal" facies is widespread in the Northern Hemisphere, extending from Alaska in the west, through N.W. Europe, Eastern Europe and east to Russia. In Europe it extends to the Mediterranean area where it is replaced by a Tethyan biofacies of larger foraminifera. South of the Mediterranean, the

Boreal biofacies re-appears and is known as far north as offshore Morocco (Riegraf et al. in press) and Algeria (Maupin and Vila 1976). Brief published accounts from Australia (Quilty 1981) and Papua New Guinea (Haig 1979) and information from Argentina (Kielbowicz, pers. comm.) indicate a great southwards extension of the Boreal biofacies in the Southern Hemisphere. The present account refers only to these Boreal assemblages.

This review outlines our present state of knowledge and suggests avenues of future research regarding Lower Jurassic foraminiferal biostratigraphy.

The ammonite zonation referred to is that of Dean, Donovan & Howarth (1961), with subsequent emendations (Howarth 1973, 1978; Cope et al. 1980).

Previous Work

From the very first record of Lias foraminifera by Strickland in 1846 to the 1930's, all publications on these forms were taxonomic. Major contributions to systematics were made particularly by Bornemann (1854), Terquem (1858, 1862, 1864, 1866a, 1866b), Issler (1908) and Franke (1936), together with numerous smaller papers by workers in Britain and Germany.

The stratigraphic value of Jurassic foraminifera was not appreciated until oil exploration in Germany stimulated production of important biostratigraphic studies by Bartenstein & Brand (1937) and Wicher (1938). The former authors erected the first zonation scheme (see figure 1), discussed important zonal species, and made comparisons with the limited available data from other countries. Subsequent works thereafter laid greater emphasis on the stratigraphic value of Lias foraminifera, including detailed studies in England (Barnard 1948, 1950a, 1950b, 1956, 1957, 1960), Denmark (Norvang 1957, Bang 1968, 1971, 1972), France (Colloque sur le Lias Francais 1961) and Sweden (Norling 1972). Actual zonation schemes were published by Bartenstein & Brand (1937) (for the whole Lias of N.W. Germany, based on outcrop and boreholes), Barnard (1948) (two broad zones for the Hettangian and Sinemurian of England), Bang (1971) (for the Hettangian - Pliensbachian of Denmark, based on boreholes, but not dated by ammonites), Norling (1972) (borehole and limited outcrops in Southern Sweden; Hettangian-Toarcian) and Horton & Coleman (1978) (local assemblage zones for the Lower Toarcian only of Eastern England) (see figure 1).

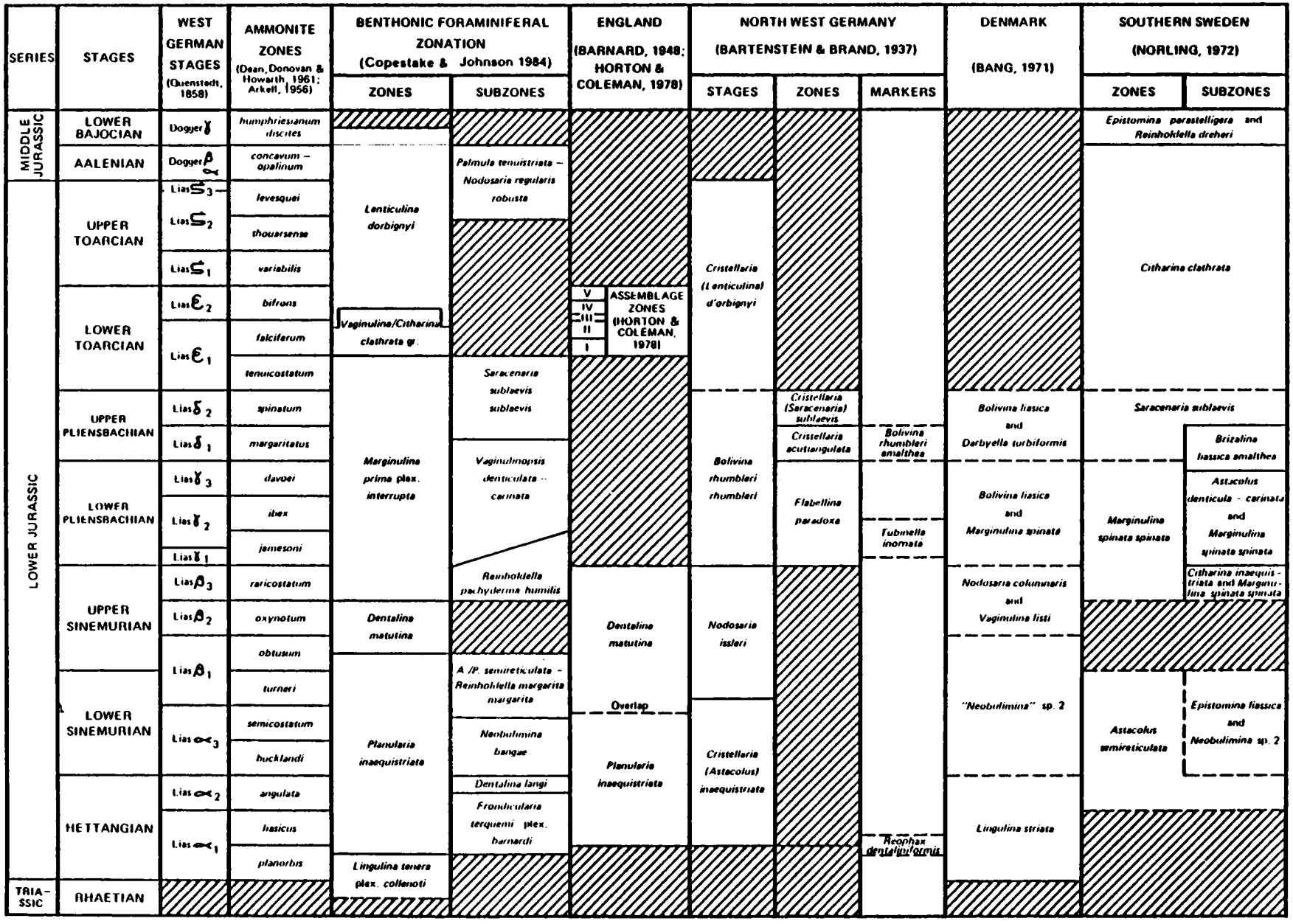

Figure 1: Published Lower Jurassic foraminiferal zonations

Ruget (1980) suggested a broad 3-fold subdivision of the Lower Jurassic based on foraminifera, equating with the Lower, Middle and Upper Lias. This scheme allegedly applied to N.W. Europe, although was clearly only based on data from France and Spain.

The drawbacks of these previous zonations is that they were proposed for single countries only and much of the data (e.g. for Denmark and Sweden) are from boreholes and not tied to ammonite records.

Since the early 1970's, further detailed work was stimulated in Britain by study of the Mochras Borehole. This, a 4281' (1305m), complete argillaceous section, is the second thickest in Northern Europe. Study of this, plus subsequent examination of other British sections, many being studied for the first time (e.g. Scotland, Yorkshire coast, east Midlands, Gloucestershire, South Wales, Somerset coast, Northern Ireland plus several subsurface boreholes), led to production of a useful data base of foraminiferal distribution against ammonite zones. Details of selected species were published in 1981 (Copestake & Johnson 1981). During this work, compilations of the total worldwide ranges of known stratigraphically important species were made, based upon the British data plus all available published data from other countries. This has led to the erection of a Boreal Zonation, based mainly on the most detailed data, i.e. from northern Europe (Copestake & Johnson 1984, in press). This zonation utilises the most consistently occurring short ranging and widespread species and thus draws together the previously erected schemes for individual countries (fig. 2). These schemes have much in common, and it is clear that many species have consistent ranges in several countries.

These ranges, plus those of other species, are constantly being reviewed as more sections are studied. It is hoped that presentation of this review will stimulate workers in other countries, particularly those from which no published data are currently available.

FORAMINIFERAL ZONATION

Index Taxa

The scheme utilises the total ranges, concurrent ranges, and abundance

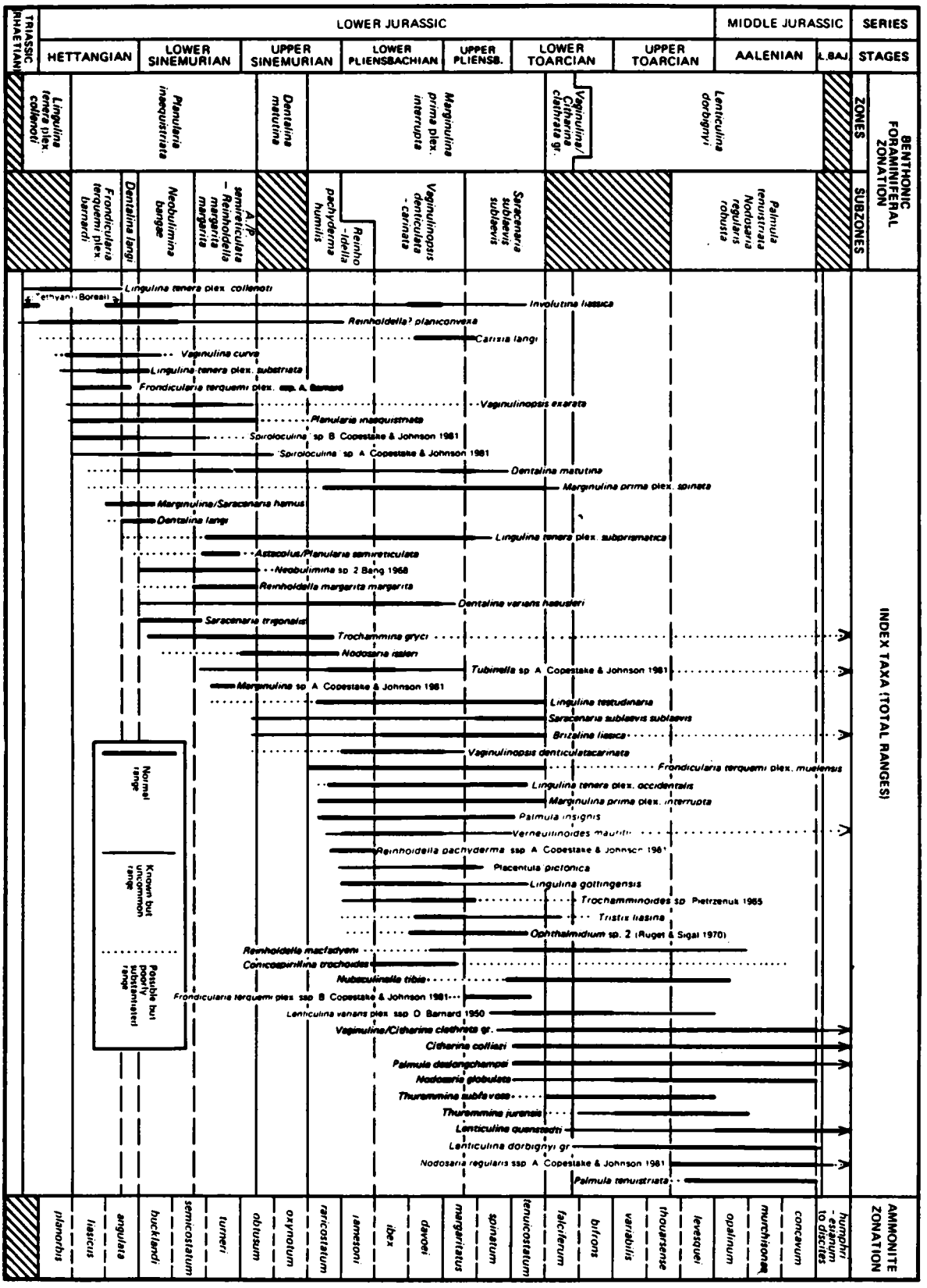

Figure 2: Boreal Lower Jurassic foraminiferal zonation and total ranges of index species (after Copestake & Johnson 1984)

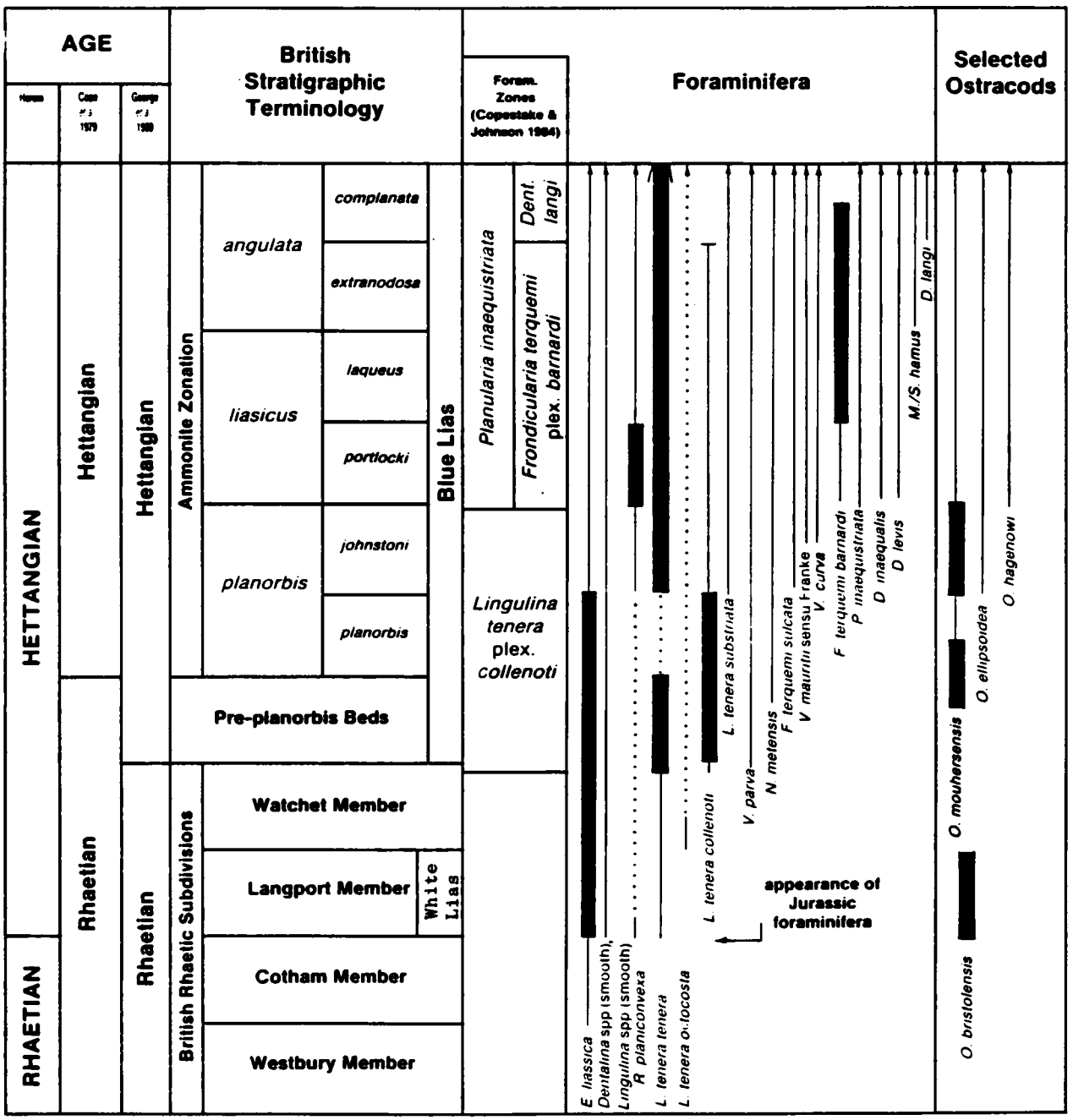

Figure 3: Distribution of foraminifera around the Triassic/Jurassic boundary in south west Britain

acmes of 55 taxa. Other taxa are also proving useful and will be incorporated once their ranges are fully documented. Space does not allow illustration of the index forms here, though most are well known and have been figured previously (e.g. Franke 1936, Bartenstein & Brand 1937, Barnard 1950, Norvang 1957, Colloque sur le Lias Francais 1961, Klingler 1962, Norling 1972, Ruget 1976, Copestake & Johnson 1981, in press). Nodosariid foraminifera are numberically dominant in the Lower Jurassic, and thus most index forms belong to this group. Evolution within variable species plexuses of this group is of particular value, such as the Lingulina tenera (Bornemann), Frondicularia terquemi d'Orbigny and Marginulina prima d'Orbigny plexuses.

Other groups are of value, however, such as the Epistominidae (particularly Reinholdella (true Epistomina not appearing until the Middle Jurassic), Miliolina (species of Ophthalmidium, "Spiroloculina" and Tubinella) and Buliminacea (Brizalina liasica (Terquem) and Neobulimina sp. 2 Bang).

Degree of Resolution

Some species are long ranging (e.g. Involutina liassica (Jones); Rhaetian - Lower Toarcian), while others are restricted to one or two ammonite zones (e.g. Dentalina langi Barnard; late angulata - early bucklandi Zones), Marginulina turneri Copestake; turneri Zone, Saracenella aragonensis Ruget, tenuicostatum Zone). Concurrent ranges and species acmes also enable recognition of ammonite zones and subzones (e.g. late raricostatum zone marked by the concurrent ranges of Marginulina prima interrupta Terquem, Nodosaria issleri Franke, above the appearance of Vaginulinopsis denticulatacarinata (Franke); portlocki Subzone of liasicus Zone marked by abundance level of Reinholdella planiconvexa (Fuchs)) (see fig. 2).

PRACTICAL UTILITY OF LOWER JURASSIC FORAMINIFERA

Ammonites, where found, do offer a greater degree of resolution in the Lower Jurassic. Thus, the main biostratigraphical value of the foraminifera is in situations in which ammonites are not recovered. Such circumstances are more common than is generally realised. Two such applications are discussed here.

1. Subsurface hydrocarbon exploration

Geological subdivision and correlation of hydrocarbon exploration, appraisal and development wells constitutes the major practical industrial application of micropalaeontology. Samples are typically small, and comprise small chippings (termed ditch cuttings) resulting from fragmentation of the rock by the drill bit. Fragmentation destroys large fossils such as ammonites, but microfossils are unaffected and often abundant. Ammonites do occur occasionally in cores, though cores themselves are rare, and most of these are taken in potential reservoir rocks, which in the Jurassic usually means sandstones, a rock type usually lacking in ammonites.

In the N.W. European offshore area, Lower Jurassic sequences are widespread. Exploration wells have penetrated sequences in the Viking Graben (Dunlin Group of Deegan & Scull 1977), Inner Moray Firth (Lady's Walk Shale of Neves & Selley 1975), Norwegian-Danish Basin and offshore Denmark (Gassum Formation), Southern North Sea, offshore Netherlands, British Southwest Approaches (e.g. BNOC 72/10-1A) and Celtic Sea. Wells penetrating the Lias in all these areas are dated and correlated using such age diagnostic foraminifera as have been discussed previously. In many cases it is possible to identify ammonite zones and occasionally subzones in these wells using foraminiferal appearances, acmes, concurrent ranges and extinctions. Age assignations are assisted by study of ostracods and palynomorphs.

2. Triassic/Jurassic boundary in England

The Somerset coast around Watchet has been proposed (George *et al*. 1969) as the type area for the base of the Jurassic, because the base of the type Hettangian at Hettange-Grande (France) is marked by an unconformity. Placement of this boundary in Britain is a problem, however, owing to lack of Late Triassic (Rhaetian) ammonites, such as occur in the type Rhaetian of Austria.

George *et al*. (*ibid*) thus suggested a lithostratigraphic pick for the boundary, at the base of the distinctive Paper Shale (Richardson 1911) marking the base of the Pre-Planorbis Beds (basal unit of the Blue Lias). This view was not accepted by Cope *et al*. (1980) who, to be consistent with other

intra-Jurassic stage boundaries, preferred to place the boundary at the point of entry of the first ammonite Psiloceras planorbis in the succession, at the top of the Pre-Planorbis Beds. The latter beds would then, by exclusion, fall in the Rhaetian. Unfortunately, this boundary does not coincide with other palaeontological changes. On a macrofaunal level, marine bivalves typical of the Jurassic appear above the Cotham Member, near the base of the White Lias (Langport Member) (Poole 1979). The Cotham/Langport Member contact represents a tectonic horizon (slumping and erosion) and marks the major horizon of marine influx.

Palynologically, a boundary is difficult to pick, the palynofloras being transitional in the Rhaetic-Blue Lias (Fisher & Dunay 1981). Orbell (1973) identified two zones over this section, a lower Rhaetipollis Zone and on upper Heliosporites Zone; he recognised these zones throughout Europe and suggested that the zonal boundary become the Triassic/Jurassic boundary. He stated this contact to occur within the Cotham Member in Britain. However, Fisher & Dunay (1981) have identified elements of the lower zone (their R. germanicus Assemblage Zone) as high as the planorbis Zone of the Jurassic. These authors conclude that there are no major palynofloral breaks that can be correlated precisely with the Triassic/Jurassic boundary.

To hopefully provide additional palaeontological information, the foraminifera, not previously studied across this boundary in Britain, were examined by the author from localities in South Wales (Lavernock), Somerset (Watchet) and inland Dorset. More limited data have also been obtained from the Dorset coast, Warwickshire and several British Geological Survey boreholes (Wilkesley, Platt Lane, Stowell Park, Burton Row, Cockle Pits, Mochras). The overall foraminiferal sequence from these localities is shown in figure 3. The base of the White Lias heralds the influx of characteristic Jurassic foraminifera such as Lingulina tenera tenera (Bornemann) and Reinholdella planiconvexa (Fuchs) plus abundant Eoguttulina liassica (Terquem). The ostracod Ogmoconcha bristolensis (Anderson) also appears here. Other Jurassic taxa appear within the Watchet Member, with a significant event at the top of this unit (just below the Pre-Planorbis Beds) marked by an influx of L. tenera tenera plus the appearance of L. tenera collenoti (Terquem). This defines the base of the L. tenera collenoti Zone (Copestake and Johnson 1984). The Pre-Planorbis Beds contain abundant L. tenera collenoti, L.

tenera tenera and Eoguttulina liassica plus appearances of further Jurassic species namely Vaginulina parva Franke and Nodosaria metensis Terquem. The upper Pre-Planorbis Beds also contain the appearance (in abundance) of the ostracod Ogmoconchella mouhersensis (Apostolescu), a species common in the Hettangian-Lower Sinemurian (disappearing at the top of the Lower Pliensbachian). Notably, the incoming of the first ammonite Psiloceras planorbis, defining the base of the planorbis Zone, does not coincide with any microfaunal change, as is the case with the associated macrofauna and palynoflora. The next significant incomings are seen in the johnstoni Subzone. Several additional microfaunal events characterise the rest of the Hettangian (see fig. 3), most of these occurring elsewhere in Western Europe; these enable characterisation of all the ammonite subzones of this stage.

In summary, therefore, two major microfaunal breaks are seen below P. planorbis, and one above at the planorbis/johnstoni Subzone boundary. The lowest event, at the base of the Langport Member (White Lias) contains the first incoming of Jurassic foraminifera (e.g. L. tenera tenera). Above this, a more pronounced Jurassic influx (flood of L. tenera collenoti, L. tenera tenera, appearance V. parva) occurs, defining the L. tenera collenoti Zone. The two events together comprise a significant influx of Jurassic foraminifera which occurs below the first ammonites and below the suggested boundaries of George et al. (1969) and Cope et al. (1980). The lower of the two events does, however, fall close to the boundary suggested by Poole (1979), namely at the Cotham/Langport Member contact; the microfaunal evidence does, therefore support the latter placement for the Triassic/Jurassic boundary in Britain, in the suggested type area.

CONCLUSIONS

(1) A reasonably large body of data exists on foraminiferal ranges in N.W. Europe; a zonation framework has been proposed.

(2) The present state of knowledge in this area enables recognition of stages, ammonite zones and subzones, plus their boundaries. By extrapolation, this enables detailed correlations to be made where ammonites are not recovered.

(3) In contrast, relatively little published information exists outside the main European region; the available data, though limited, do however, indicate the worldwide occurrence of typically European microfaunas.

RECOMMENDATIONS FOR FURTHER STUDY

(1) Detailed study of additional, complete ammonite-dated sequences, particularly outside Europe.

(2) Synthesis with distribution data for other fossil groups as has been recently undertaken in the Cretaceous. This would include comparisons of appearance, abundance and extinction levels.

(3) Comprehension of these worldwide palaeontological patterns in terms of geological/palaeontological events (climatic, plate tectonic, transgressive/regressive).

REFERENCES

Bang, I. 1968 Biostratigraphical investigation of the pre-Quaternary in the Oresund Boreholes mainly on the basis of foraminifera. In: Larsen, G. et al. Dan. Geol. Unders. Rapp. No. 1, 86-88.

_____ 1971. Jura aflejringerne i Ronde Nr. 1 (2103-2164m). Biostratigrafi pa grundlag af foraminiferer. Dan. Geol. Unders. 3 Rapp. No. 39, 74-80.

_____ 1972. Jura-biostratigrafi i Novling Nr. 1 pa grundlag af foraminiferer. Dan. Geol. Unders. 3 Rapp. No. 40, 119-123.

Barnard, T. 1948. The uses of foraminifera in Lower Jurassic stratigraphy. Int. Geol. Congress "Report of the 18th Session, Great Britain 1948" 15, 34-41. London.

_____ 1950a. Foraminifera from the Lower Lias of the Dorset Coast. Q. Jl. geol. Soc. London 105 (3), 347-391.

Barnard, T. 1950b. Foraminifera from the Upper Lias of Byfield, Northamptonshire. Q. Jl. geol. Soc. London 106 (1), 1-36.

_____ 1956. Some Lingulinae from the Lias of England. Micropaleontology. 2 (3), 271-282.

_____ 1957. Frondicularia from the Lower Lias of England. Micropaleontology 3 (2), 171-181.

_____ 1960. Some species of Lenticulina and associated genera from the Lias of England. Micropaleontology 6 (1), 41-55.

Bartenstein, H. & Brand, E. 1937. Mikropalaontologische Untersuchungen zur Stratigraphie des norwestdeutschen Lias und Doggers. Senckenb. Natur. Ges., Abh. 439, 1-224.

Bornemann, J.G. 1854. Uber die Liasformation in der Unigegend von Gottingen und ihre organischen Einschlusse. A.W. Schade, Berlin.

Colloque sur le Lias Francais. 1961. Mem. Bur. Rech. Geol. Min. 4.

Cope, J.C.W. et al. 1980. A correlation of Jurassic rocks in the British Isles. Part One : Introduction and Lower Jurassic. Geol. Soc. Lond., Special Report No. 13, 1-73.

Copestake, P. & Johnson, B. 1981. Jurassic. The Hettangian to Toarcian. In: Jenkins, D.G. & Murray, J.W. A Stratigraphical Atlas of Fossil Foraminifera, 81-105. Ellis Horwood.

_____ & _____ 1984. Lower Jurassic benthic foraminifera from North Wales (U.K.) and their application to a worldwide biozonation. In: Oertli, H.J. Proceedings Second Int. Symposium on Benthic Foraminifera, Pau, France.

_____ & _____ in press. Foraminifera from the Hettangian-Toarcian of the Mochras Borehole, North Wales, U.K. Pal. Soc. Monograph.

Dean, W.T., Donovan, D.T. & Howarth, M.K. 1961. The Liassic Ammonite Zones and Subzones of the North-West European Province. Bull. Br. Mus. Nat. Hist. (Geol.) 4, 435-505.

Deegan, C.E. & Scull, B.J. (compilers) 1977. A standard lithostratigraphic nomenclature for the Central and Northern North Sea. Rep. Inst. Geol. Sci. 77/25; Bull. Norw. Petrol. Direct. 1, 36pp.

Fisher, M.J. & Dunay, R. 1981. Palynology and the Triassic/Jurassic boundary. Rev. Palaeobot. Palynol. 34, 129-135.

Franke, A. 1936. Die foraminiferen des deutschen Lias. Abh. Preuss. Geol. Landesanst; N.F. (169), 1-140.

George, T.N. et al. 1969. Recommendations on Stratigraphical Usage. Proc. Geol. Soc. London. (1656), 139-166.

Haig, D. 1979. Early Jurassic foraminiferids from the Western Highlands of Papua New Guinea. N. Jb. Geol. Palaont. Mh., 4, 208-215.

Horton, A. & Coleman, B.E. 1978. The lithostratigraphy and micropalaeontology of the Upper Lias at Empingham, Rutland. Bull. Geol. Surv. G.B. No. 62, 1-12.

Howarth, M.K. 1973. The stratigraphy and ammonite fauna of the Upper Liassic Grey Shales of the Yorkshire coast. Bull. Br. Mus. Nat. Hist. (Geol.) 24, 235-277.

_____ 1978. The stratigraphy and ammonite fauna of the Upper Lias of Northamptonshire. Bull. Br. Mus. Nat. Hist. (Geol.) 29, 235-288.

Issler, A. 1908. Bietrage zur Stratigraphie und Mikrofauna des Lias in Schwaben. Palaontographica 55, 1-103.

Klingler, W. 1962. Lias Deutschlands. In: Leitfossilien der Mikropalaontologie, 73-122.

Maupin, C. & Vila, J.-M. 1976. Microfossiles du Lias superieur au Djebel Youssef (Hautes Plaines Setifiennes, Algerie). Revue de Micropalaeont. 19, 162-165.

Neves, R. & Selley, R.C. 1975. A review of the Jurassic rocks of north-east Scotland. Proc. Jurassic Northern North Sea Symposium Stavanger 5, 1-29.

Norling, E. 1972. Jurassic stratigraphy and foraminifera of Western Scania, Southern Sweden. Sver. geol. Unders. Afh. Ser. Ca (47), 1-120.

Norvang, A. 1957. The Foraminifera of the Lias series in Jutland, Denmark. Mede. Dansk. geol. Foren. 13 (15), 1-135.

Orbell, G. 1973. Palynology of the British Rhaeto-Liassic. Bull. Geol.Surv. Gt.Br. 44, 1-44.

Poole, E.G. 1979. The Triassic-Jurassic Boundary in Great Britain. Geol.Mag. 116 (4), 303-311.

Quilty, P.G. 1981. Early Jurassic foraminifera from the Exmouth Plateau, Western Australia. Jour. Paleont. 55, (5), 985-995.

Richardson, L. 1911. The Rhaetic and contiguous deposits of West, Mid and part of East Somerset. Q. Jl. geol. Soc. Lond. 67, 1-74.

Riegraf, W., Luterbacher, H. & Leckie, R.M. (in press). Jurassic foraminifera from Site 547B, DSDP Leg 79, off Morocco. Intl. Reports DSDP Project.

Ruget, C. 1976. Revision des foraminiferes de la collection Terquem 1-Lias : Dentalina, Marginulina, Nodosaria. Cahiers de Micropaleontologie 4, 1-118.

_____ 1980. Evolution et biostratigraphie des Lagenides (Foraminiferes) dans le Lias de l'Europe occidentale. Bull. Soc. geol. Fr. 22, 623-626.

Terquem, O. 1858. Premiere memoire sur les Foraminiferes du Lias de Department de la Moselle. Mem. Acad. Imper. Metz. 39, 563-654.

_____ 1862. Recherches sur les Foraminiferes de l'Etage Moyen et de l'Etage inferieur du Lias, Memoire 2. Mem. Acad. Imper. Metz. 42 (ser 2,9), 415-466.

_____ 1863. Troisieme memoire sur les Foraminiferes du Lias des departements de la Moselle, de la Cote d'Or, du Rhone de la Vienne et du Calvados. Mem. Acad. Imper. Metz. 44 (2) (ser 2,11), 361-438.

_____ 1864. Quatrieme memoire sur les Foraminiferes du Lias comprenant les polymorphines des Departements de la Moselle, de la Cote d'Or et de l'Indre, 233-305. Metz.

_____ 1866a. Cinquieme memoire sur les Foraminiferes du Lias des Departements de la Moselle, de la Cote d'Or et de l'Indre, 313-454. Metz.

_____ 1866b. Sixieme memoire sur les Foraminiferes du Lias des Departements de l'Indre et de la Moselle, 459-532. Metz.

Wicher, C.A. 1938. Mikrofaunen aus Jura und Kreide, insbesondere Nordwestdeutschlands. I. Teil : Lias Alpha bis epsilon. Abh. Preuss. Geol. L.A. 193, 1-16.

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CORRELATION BETWEEN N-W EUROPEAN AMMONITE FAUNAS OF THE PLIENSBACHIAN STAGE (LOWER JURASSIC)

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The Pliensbachian faunas of Ammonitina are fundamentally different in the Eurocaucasian (including NW European country) and Mediterranean Provinces. Consequently, the biostratigraphical correlation between the two regions is very difficult. However, there are a few cases where rare examples of species from one province have infiltrated the marginal area on the other province.

Sufficient elements common to both provinces have been recognised to establish a reliable correlation for the upper part of the Middle Carixian the Upper Carixian and the lowermost Domerian (Luridum to Stokesi Subzones). Theses data and the resulting correlation of Mediterranean and NW European horizons are summarised.

For the earlier part of the Carixian it is not yet possible to present any unequivocal elements of correlation. The possibilities of correlation provided by the species of genera common to both provinces are examined (Tropidoceras spp., Metaderoceras spp., Oxynoticeratidae, Tetraspidoceras and Apoderoceras) and a tentative interpretation of stratigraphical relationships is outlined. This interpretation suggest that previous correlations based only on the generic ranges of "Polymorphitidae ", "Coeloceras", Tropidoceras and Metaderoceras are erroneous.

The profound differences in composition between the Carixian and early Domerian ammonite faunas of the Eurocaucasian Province (sensu SAPUNOV, 1971, i.e.mainly NW European country : Britain, France, Germany, N.Spain, and also Portugal, Bulgaria, N.TurKey and the Caucasus) and those of the Mediterranean Province (S.Spain, N.Africa, Italy, Austria and the Bakony Mountains of Hungary) have been outlined and analysed in several recent studies (DONOVAN 1967,HOWARTH 1973, ENAY 1980, DOMMERGUES 1982,1984 and DOMMERGUES,FERRETTI,GECZY and MOUTERDE 1983). It is not our intention to repeat here the analysis of this

provincialism, as we are primarily concerned with the details of correlation between the ammonite successions of the two provinces.

For the uppermost Middle Carixian, the Upper Carixian and the basal Domerian it is already possible to present a framework of reliable and precise correlations (right hand side of fig.1). These have recently been described in detail elsewhere (DOMMERGUES et al.1983), so it is only necessary to summaries them here. In contrast, for the Lower Carixian and the lower part of the Middle Carixian the data are not so reliable, but they nevertheless allow certain parallels to be established between the faunas of the two regions (left hand part of fig.1). These new data and their interpretations are critically examined below, illustrating the problems of inter-provincial correlation.

I. Upper Carixian and basal Domerian.

The reliable elements of correlation, for the Luridum Subzone, the Davoei Zone and the Stokesi Subzone, belong to two faunal groups.

The first comprises forma originating in NW Europe; which have penetrated the Mediterranean Province. These essentially belong to the phyletic lineage of capricorn Liparoceratidae (Androgynoceras sparsicosta (Trueman), A.maculatum (Young and Bird), A.capricornus (Schlotheim), A.crescens (Hyatt, Trueman)), and its descendant Amaltheus stokesi (J.Sowerby), and also the dactylioceratid species Prodactylioceras davoei (J.Sowerby).

The second comprises species of Mediterranean origin, observed in NW European successions (especially Portugal, Grands Causses, Bourgogne). This include "Gemmellaroceras aenigmaticum" (Gemmellaro), Reynesocoeloceras praeincertum Dommergues et Mouterde, Cetonoceras psiloceroides (Fucini), Protogrammoceras sp.1 (Dommergues et al. 1983, pl.3 fig.3-8), P.celebratum (Fucini) and Fieldingiceras fieldingii (Reynès) which represent several unrelated families (Dommerges et al. 1983, and see fig.1).

All these species have advantage of restricted stratigraphical ranges within their provinces of origin. Consequently, the first group have been used to define the biostratigraphical units which have become well-established in NW Europe (DEAN et al. 1961, DOMMERGUES 1979, PHELPS in press), or can al least be precisely placed within these zonal schemes (see left hand side of fig.1). The second group can be placed, with less precision, within the sequence of Mediterranean horizons which have recently been proposed by one of us (DOMMERGUES 1984, see right hand side of fig.1).

II Lower and Middel Carixian

For the Lower and Middel Carixian (apart from the Luridum Subzone), it is necessary to utilise other groups, whose stratigraphical ranges are still only poorly know and are perhaps appreciably longer.

a. Acanthopleuroceratidae

A typical example of the problems and potential results of correlation is provided by the Tropidoceras belonging to the T.flandrini (Dumortier)-T.obtusum (Futterer) group. These are fairly rare and localised in NW Europe where they have been reliably recorded from the base of the Ibex Zone (Arietiforme and Maugenesti Horizons) in Bourgogne (Nolay; unpublished data J.L.D.) and Swabia (SCHLATTER, 1980). However they have recently been equally well documented from the Lower Carixian, within the Jamesoni Subzone. In the thick Liassic sequence at Serre-Ponçon (Hautes Alpes, France) Tropidoceras of this group have been found (TURIN, MOUTERDE & DOMMERGUES, in press) 40 cm below the last Uptonia, in the middle of the range of U.lata (Quenstedt, sensu SCHLATTER 1980 = U.jamesoni sensu DONOVAN and FORSEY 1973) and about 2m below T.masseanum (d'Orbigny). T.gr.flandrini has also been observed in a similar stratigraphical position by MEISTER (1982 and thesis in preparation) in Aveyron (Grands Causses, S. France) and has been found in association with U.lata in a much thinner Carixian sequence at Môle (Haute-Savoie, France, DOMMERGUES 1984).

In the Mediterranean Province there is a horizon with abundant T.gr.flandrini at the beginning of the sequence of Tropidoceras species; e.g. in Morocco (Jbel Azrou, Middle Atlas, J.C.FAUGERES and R.MOUTERDE, collection) and in S.Spain (Subbetic Cordillera, Andalucia, GARCIA-HERNANDEZ et al.1981, RIVAS 1981 and personal communication P.RIVAS and J.C. BRAGA). A rigorous correlation with the NE European successions is still not possible but an early Carixian age for this Mediterranean horizon is suggested by its relative position and is further supported by the well-established Lower Carixian first appearance of the group in NW Europe (see fig.1).

Accepting the Jamesoni Subzone age of the first T.gr.flandrini, it appears that the subsequent Mediterranean species, T.mediterraneum (Gemmellaro) is about the same age as T.masseanum; which is well know in NW Europe at the extreme base of the subsequent Ibex Zone (sensu DEAN et al.1961). This inference is further corroborated by the presence of T.stahli (Oppel) in the beds immediatly after T.mediterraneum in the Mediterranean Province and T.masseanum in the NW European country. This reasoning is, of course, completly dependant upon the interpretation of the forms called T.stahli in both provinces as

the same species. In particular there is the possibility of confusion with the Mediterranean species T.catriense (Venturi), from Monte Catria (Central Apennines, Italy) which probably represents the middle part of the Ibex Zone. T.catriense can be distinguished from T.stahli by its slightly more curved ribs, which are always simple, even on the body chamber, whereas large examples of T.stahli show a more complex flandrini-like ornamentation on the outer whorls.

b. Metaderoceras and related genera

The use of species of Metaderoceras for correlation involves similar problems and demands equal caution. In NW Europe the genus has a markedly discontinuous stratigraphical distribution, with two marked acmes, one in the Brevispina Subzone comprising the M.muticum (d'Orbigny) group, and the other in the middle of the Valdani Subzone, comprising M.venarense (Oppel) and M.beirense Mouterde. This suggests that Metaderoceras had a long stratigraphical range in its regions of origin, which was probably in the Tethyan Realm. Paradoxically, Metaderoceras has not yet been proven in the basal Carixian of the Mediterranean Province, largely because of the scarcity of faunas of this age. The examples cited by DUBAR (1978, p.18, section 6,) from the Lower Carixian of Morocco are probably from the middle or upper part of the Jamesoni Zone, because of their association with Platypleuroceras. The great majority of Téthyan Metaderoceras, however, which belong to the M.gemmellaroi (Levi) - evolutum (Fucini) group (e.g. BRAGA et al.1982, pl.1,fig.10) come from the Middle Carixian where they are often associated with either T.gr.stahli or T.catriense (IMLAY 1968, FREBOLD 1970, FERRETTI 1975, GECZY 1976, FAUGERES 1978, DUBAR 1978, GARCIA-HERNANDEZ et al. 1981).

Errors have frequently been introduced into correlation by the confusion of Metaderoceras and related forms, with the strickly Eurocacasian family Polymorphitidae. For example "Uptonia" kondai Geczy, which is a senior synonym of M.atlanticum Dubar, belongs to the Middle Carixian M.gemmellaroi-evolutum group.Similar ambiguities have recently been removed by the recent erection of the genus Dubariceras (DOMMERGUES et al. 1984), for forms related to Metaderoceras with ribbing even more dense than M.kondai. Previously these have been variously attributed by different authors to Platypleuroceras (GECZY 1976), Polymorphites (DUBAR 1978), Uptonia venustula (Dumortier) (WIEDENMAYER 1977), Uptonia dayiceratoides Mouterde (FREBOLD 1970) and Dayiceras dayiceroides (SMITH 1983). Dubariceras apparently first occurs at the top of the Ibex Zone, where it accompagnies the first hildoceratid, Protogrammoceras dilectum (Fucini)(DOMMERGUES et al;1984).

Consequently, although the association of Tropidoceras and Metaderoceras in the Mediterranean Province (the Demonense Zone of RIVAS 1981) often represents the Middle Carixian, it probably also represents the upper part of the Lower Carixian.

c. Other ammonite families

The same care must be exercised in the use of Oxynoticeratidae, which continue into the Carixian or even later in the Tethys Realm, represented by forms with narrow umbilici (Radstockiceras,Metoxynoticeras and Fanninoceras). In the Pacific Province species of Fanninoceras are a major component of both Carixian and Domerian faunas and have been used to establish a local zonation (HILLEBRANDT 1973, 1981).

However, it appears that there is potential for more precise correlation at the base of the Carixian, using the genera Tetraspidoceras (NW and SW Germany, Bourgogne - Lyon, Internal Alps, Hungary etc..)Apoderoceras and its subgenus A.(Miltoceras) Wiedenmayer, created for "Aegoceras"sellae Gemmellaro and related species, wich include Coeloceras pettos (Quenstedt) sensu BRAGA et al.1982 (Andalucia, S.Spain GARCIA-HERNANDEZ et al. 1981 and unpublished data P.RIVAS and J;c; J.C.BRAGA; Jbel Azrou Morroco R.MOUTERDE and J.C.FAUGERES collection).

Conclusion.

Although detailed correlation between the Mediterranean and Eurocaucasian Provinces is already possible for the Upper Carixian and basal Domerian, only a few points of comparison are yet available for the Lower an Middle Carixian. This is partly due to the scarcity of detailed stratigraphical sequences representing the lower part of the Carixian in the Mediterranean Province and partly caused by taxonomic confusion which is exarcerbated by the frequent homeomorphy of NW European and Mediterranean groups.

It is anticipated that a reliable biostratigraphical correlation for the earlier part of the Carixian will result from further research in two main areas. First, the detailed analysis of the evolution of the Mediterranean sequences of Metaderoceras and Tropidoceras (e.g. RIVAS and BRAGA, in preparation) and also the poorly known smaller groups, such as Tetraspidoceras and Apoderoceras. This is especially necessary, as the correlation based solely on the generic ranges of Metaderoceras and Tropidoceras is proabably illusory. Secondly, the elucidation of the precise positions of the very rare examples of stratigraphically significant true Polymorphitidae within these Mediterranean sequences (e.g. in Morocco and Austria).

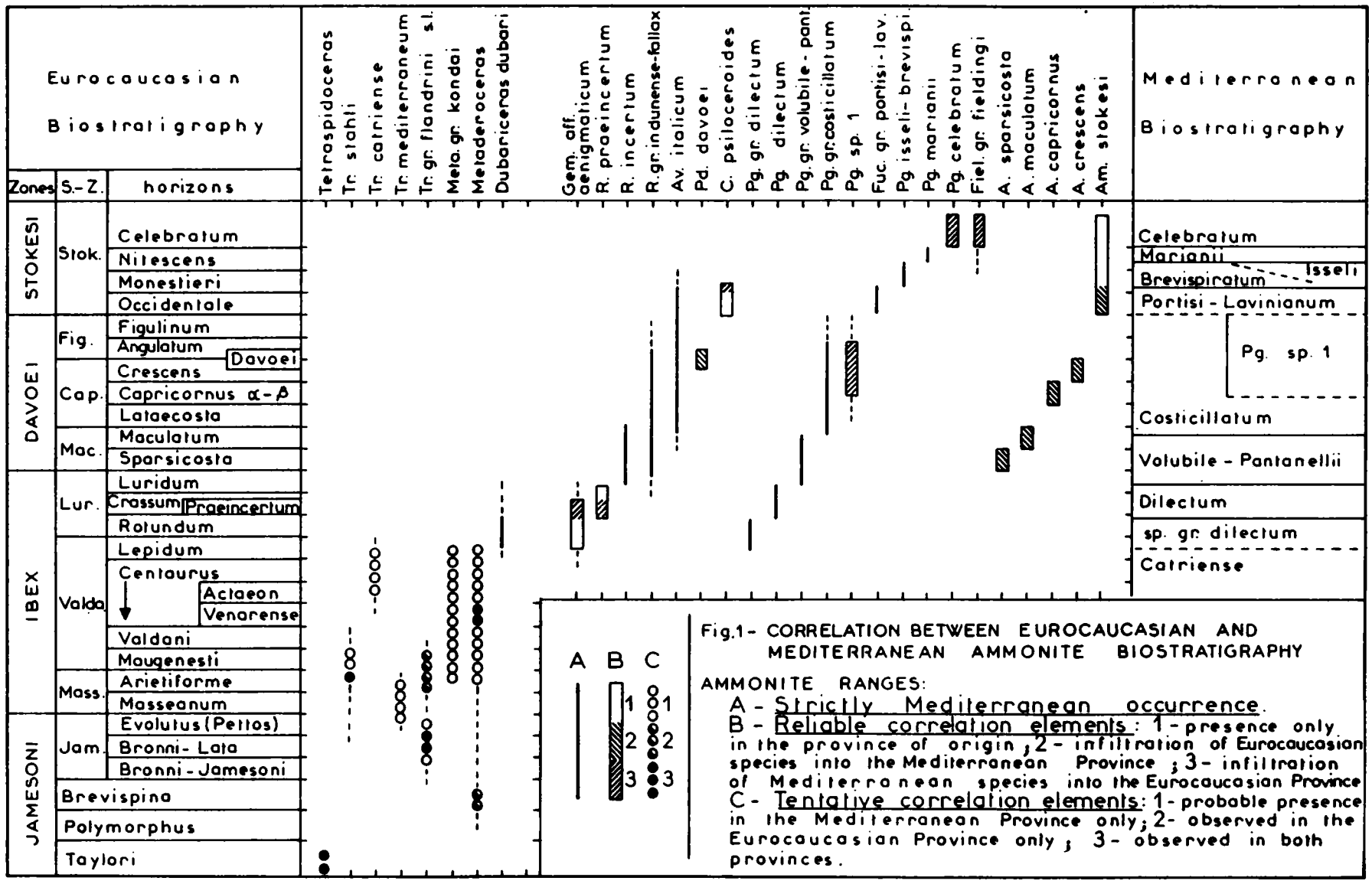

Fig.1- CORRELATION BETWEEN EUROCAUCASIAN AND MEDITERRANEAN AMMONITE BIOSTRATIGRAPHY

AMMONITE RANGES:

A - Strictly Mediterranean occurrence.

B - Reliable correlation elements: 1 - presence only in the province of origin; 2 - infiltration of Eurocaucasian species into the Mediterranean Province; 3 - infiltration of Mediterranean species into the Eurocaucasian Province

C - Tentative correlation elements: 1 - probable presence in the Mediterranean Province only; 2 - observed in the Eurocaucasian Province only; 3 - observed in both provinces.

BIBLIOGRAPHY

BRAGA J.C., COMAS-RENGIFO M.J., GOY A. y RIVAS P. (1982) - Comparaciones faunisticas y correlaciones en el Pliensbachiense de la zona Subbetica y Cordillera Iberica. Bol.R.Soc. Esp. Hist.Nat. -Geol, 80, 221-244, 3 fig., 3 pl.

DEAN W.T., DONOVAN D.T., HOWARTH M.K. (1961) - The Liassic Ammonite Zones and Subzones of the North-West European Province.Bull.Brit.Mus. (Nat.Hist.) London, 4,n°10, 435-505, 13pl.

DOMMERGUES J.L. (1979) - Le Carixien bourguignon. Biostratigraphie.Paléogéographie.Approches paléontologique et sédimentologique. Thèse 3e cycle, Univ.Dijon, 1 à 195, 52 fig., 52 tabl. 9 pl.

DOMMERGUES J.L. (1982) - Le provincialisme des ammonites boréales au Lias moyen; une crise faunique sous contrôle paléogéographique. Bull.Soc. Géol.France, Paris, 7, 24, 1047-1051, 2 fig.

DOMMERGUES J.L. (1984) - L'évolution des Ammonitina au Lias moyen (Carixien, Domérien basal) en Europe occidentale. Thèse Univ.Lyon. 1-303, 86 fig., 4 tabl. 12pl.

DOMMERGUES J.L., FERRETTI A., GECZY B. et MOUTERDE R. (1983) - Eléments de corrélation entre faunes d'ammonites mésogéennes (Hongrie, Italie) et subboréales (France, Portugal) au Carixien et au Domérien inférieur. Géobios, Lyon, 16, 471-499, 5 fig. 7 pl.

DOMMERGUES J.L , RIVAS P. et MOUTERDE R. (1984) - Un faux Polymorphitidae : Dubariceras nouveau genre d'Ammonitina du Carixien mésogéen. Geobios Lyon. in press.

DONOVAN D.T. (1967) - The geographical distribution of Lower Jurassic Ammonites in Europa and adjacent areas. in Adams C.G. & Ager D.V. red. Systematic Assoc.Publ.ed. London. 7. 111-134, 5 fig.

DONOVAN D.T. & FORSEY G.F. (1973) - Systematics of Lower Liassic Ammonitina. Univ.Kansas Paleont.Contrib. Lawrence. 64. 1-18, 4 pl.

DUBAR G. (et MOUTERDE R. coll.) (1978) - Les formations à Ammonites du Lias moyen dans le Haut Atlas de Midelt et du Tadla. Notes Mém.Serv.géol. Maroc. Rabat. 274. 1-119, 11 fig.,6 pl.

ENAY R. (1980)-Paléobiogéographie et Ammonites jurassiques : "Rythmes fauniques" et variations du niveau marin; voies d'échanges, migrations et domaines biogéographiques in Livre jubilaire S.G.F.1830-1980.Mém. hors.sér.Soc.géol.France. Paris. 10. 261-281, 6 fig.

FAUGERES J.C. (1978) - Les rides Sud-Rifaines, évolution sédimentaire et structurale d'un bassin Atlantico-Mésogéen de la Marge africaine. Thèse Univ.Bordeaux. 590. 1-480, 119 fig., 42 pl.

FERRETTI A. (1975) - Ricerche biostratigrafiche sul Sinemuriano-Pliensbachiano nella Gola del F.Bosso (Appennino marchigiano).Riv.ital.Paleont. Milano. 81. 161-194, 4 fig., 1 tabl.,4 pl.

FREBOLD H. (1970) - Pliensbachian Ammonoids from British Columbia and southern Yukon. Canad.Jour.Earth.Sci. Ottawa. 7. 435-456, 1 fig., 1 tabl. 1 pl.

GARCIA-HERNANDEZ M., RIVAS P., VERA J.A. (1979)1981) - El Carixiense en la Zona Subbetica. Cuad.Geol.Univ.Granada. 10. 275-283, 1 fig.

GECZY B. (1976) - Les Ammonites du Carixien de la montagne du Bakony. Akademiai Kiado éd. Budapest. 1-223, 138 fig., 34 pl.

HILLEBRANDT A.von (1973) - Neue Ergebnisse über den Jura in Chile und Argentinien. Münster Forsch.Géol.Paläont. Munster. 31/32. 167-199., 4 fig.,1 tab

HILLEBRANDT A.von (1981) - Faunas des Ammonites del Liasico inferior y medio (Hettangiano hasta Pliensbachiano) de America del Sur (Excluyendo Argentina) in Cunas sedimentarias del Jurassico y Cretacico de America del Sur. 2. 499-538, 10 pl.

HOWARTH M.K. (1973) - Lower Jurassic (Pliensbachian and Toarcian) Ammonites in Atlas of Paleobiogeography,A.Hallam red. Elsevier ed. Amsterdam. 275-282, 4 fig., 1 pl.

IMLAY R.W. (1968) - Lower Jurassic (Pliensbachian and Toarcian) Ammonites from Eastern Oregon and California. (U.S.) Geol.Surv. Prof.Paper Washington. 593 C. 1-51, 8 fig., 9 pl.

MEISTER Ch. (1982) - Distribution stratigraphique desAmmonites carixiennes des Causses (France) : remarques préliminaires. Bull.Geol.Lausanne. 262. 73-83.

PHELPS M.C. (1984?) - A refined Ammonite Biostratigraphy for the Middle and Upper Carixian (Pliensbachian stage) in North-West Europe. in press.

RIVAS P. (1979)1981) - Zonacion del Carixiense en la Zona Subbetica. Cuad.Geol. Univ.Granada. 10. 383-388, 1 fig.

SCHLATTER R. (1980) - Biostratigraphie und Ammonitenfauna des Unter-Pliensbachium im Typusgebiet (Pliensbach,Holzmaden und Nürtingen;Wurtemberg, S-W-Deutschland). Stuttgarter Beitr.Naturk. Stuttgart. B. 65. 1-261, 40 fig., 2 tabl., 23 pl.

SAPUNOV I.G. (1971)1974) - Notes on the geographical differenciation of the Lower Jurassic faunas. Colloque du Jurassique à Luxembourg. Mém. B.R.G.M. 75.,263-270, 2 fig.,1 tabl.

SMITH P.L. (1983) - The Pliensbachian ammonite Dayiceras dayiceroides and Early Jurassic paleogeography. Canad.Jour.Earth Sci. Ottawa. 20. 86-91. 4 fig.

TURIN G., MOUTERDE R. et DOMMERGUES J.L. (1984) - Précisions nouvelles sur le Lias MOyen de Serre-Ponçon (Hautes-Alpes, France).Cahiers Inst. Catholique de Lyon. in press.

WIEDENMAYER F. (1977) - Die Ammoniten des Besazio-Kalks (Pliensbachian, Sudtessin) Mém.suisses Paléont. Basel. 98. 1-169, 19 fig., 2 tabl., 19 pl.

TOARCIAN AMMONITE ZONES IN THE GERECSE MOUNTAINS, HUNGARY

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TOARCIAN AMMONITE ZONES IN THE GERECSE MOUNTAINS, HUNGARY

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In the Gerecse Mountains /Transdanubian Mid-Mountains/ Mediterranean ammonite faunas of Toarcian profiles yielded sporadic north-west European index genera. These make it possible to subdivide the monotonous Ammonitico Rosso sequences of reduced thickness into 7 standard zones, so the chronologic ranges of the Mediterranean genera could be determined. The sporadic occurrences of north-west European genera suggest a connection between the shallow sea covering the European craton and the ocean basin of the Tethys - at least at the northern margin of the "Apulian plate". According to previous studies, the "Tethyan filter" may have existed even in the Pliensbachian /and Sinemurian?/. From the Aalenian onwards the proportions of NW European species increase suddenly, i.e. the Tethyan filter became a Tethyan corridor. The closer connection of the faunal provinces can be due to the increasing proximity of the two areas, and to the termination of the filtering effect of a submarine elevation. This latter process can be explained most probably by subduction, which brought the Apulian plate closer to the European craton on the one hand, and destroyed the former, presumed mid-ocean ridge on the other.

INTRODUCTION

The Jurassic formations of the Gerecse Mountains, lying north-east to the Bakony Mountains, were reviewed by FÜLÖP /1971/. In 1976, J.KONDA, director of the Geological Survey of Hungary, initiated a systematic and detailed investigation in the area, and this resulted in collection

of rich ammonite faunas from the following localities:
Nagypisznice /1976-1978/,
Kisgerecse /1978-1979/,
Tölgyhát /1979-1980/,
Bányahegy /1981-1982/.

The fauna came from Ammonitico Rosso marls and limestones. The collection followed the methods introduced and proved useful for Bakony Mts. material: collecting bed by bed on extended surfaces. The average surface was 17.5 m², and the total volume of studied rock was 610 m². The resulted number of the studied ammonite specimens totalled as 15,690.

The whole fauna was prepared and determined by the author in the Paleontological Department of the Budapest University. Determinations were made to specific level, where it was possible. The evaluation of the data was completed in the Pierre et Marie Curie University, Paris, with the help of Professor J. DERCOURT. The author's personal thanks are due to J. KONDA and J. DERCOURT, for their valuable help.

In the quantitative, bed by bed evaluation of the faunal composition the splitting taxonomy was followed, but the summation was made according to the comprehensive classification of DONOVAN et al. /1981/. A single exception is genus Dumortieria, what includes the genus Catulloceras /GEMMELLARO, 1886/.

On the basis of the substantial collecting, the thin, lithologically monotonous sequences could be well subdivided, following the north-west European, especially the French zonal scheme. It was successful to record the vertical range of certain genera in the Mediterranean area, and to conclude to a paleobiogeographic change at the Toarcian/Aalenian boundary.

In subdivisioning the Toarcian, the NW European scheme of DEAN et al. /1961/ and the French /Thouars/ zonation given by GABILLY /1976/ was followed. The Harpoceras falcifer Zone of DEAN et al. seems justified to substitute with the Serpentinum zonal term, as emphasized by GABILLY and having priority /OPPEL, 1856/. The Thouarsense Zone was split into two zones /Thouarsense and Insigne/ — again after GABILLY. On the other hand, the Dumortieria levesquei Zone, which is subdivided by GABILLY into two zones /Pseudoradiosa and Aalense/, was maintained. The charac-

teristics ammonite faunal composition of the zones is discussed below.

ZONAL SCHEME

Dactylioceras tenuicostatum Zone

This zone was demonstrated only in the Kisgerecse profile. Here the total thickness of beds /Nos. 113 and 112/ belonging into this zone is 15 cm. Bed No. 113 yielded a specimen of Fontanelliceras cf. fontanellense /GEMMELLARO, 1885/. The zone is characterized by the sudden flourishing of Dactylioceratidae. The further precision of the Domerian/Toarcian boundary needs future collecting.

Hildaites serpentinus Zone

The recognition of this zone follows the concept of GABILLY /1976/, but the uppermost beds yielding Orthildaites were ranged into the Bifrons Zone, because this genus is a synonym of Hildoceras.

The average thickness of the zone is 123 cm, and the number of the collected ammonite specimens is 644. This is constituted by Phylloceratina and Lytoceratina in 77%, and Ammonitina in 23 %. Of the Ammonitina, 54 % is the Dactylioceratidae and 46 % is the Hildoceratidae family representation. From the latter group most common are the genera Hildaites, Harpoceras and Polyplectus.

Hildoceras bifrons Zone

The Bifrons Zone, so commonly recorded in the Mediterranean Jurassic, was represented in all four profiles. The zone can be characterized by the whole vertical range of the genus Hildoceras.

The average thickness of the zone is 263 cm. The fauna numbers 6,236 ammonites. Phylloceratina and Lytoceratina become less important /45 %/, because of the mass occurrence of Hildoceras. Within Ammonitina the proportion of Dactylioceratidae decreases /17 %/, Hildoceratidae are very common /75 %/, while Phymatoceratidae are still subordinate /8 %/. Genus Collina appears even in beds characterized by Hildoceras semipolitum. Harpoceras endures throughout the whole zone. The lowermost "Orthildaites beds" are lack of Mercaticeras. The appearance of Leukadiella within the lower part of the zone is significant from paleogeographical point

of view. Phymatoceras occurs sporadically throughout the zone, while the earliest Hammatoceras appears in the upper part. Into the group of persistent elements belong forms with rather varied morphology: e.g. the oxycone Polyplectus, the serpenticone Dactylioceras and the planulate Phymatoceras! In the Bifrons Zone the number of Ammonitina genera /19!/ is strikingly large.

Haugia variabilis Zone

This zone is characterized by the appearance and sporadic occurrence of Haugia, the lack of Hildoceras and the relative frequency of Brodieia. Beds lacking Haugia and yielding the jointly occurring Hildoceras semipolitum and Collina were ranged into the Bifrons Zone. The Variabilis Zone is more or less equivalent of the Collina gemma and Paroniceras sternale subzones recognized by GALLITELLI-WENDT /1969/ within the now classical Erbaense Zone of DONOVAN /1958/.

The zone was proved by fauna in the four studied profiles. The average thickness is 110 cm, and the total number of the yielded ammonites is 2,375. The fauna is dominated by Phylloceratina /58 %/ and Lytoceratina /20 %/. Within Ammonitina, most common is the family Phymatoceratidae /54 %/. Especially common are the Brodieia /=Pseudobrodieia, Merlaites/ and Pseudomercaticeras /=Crassiceras/. From the Phymatoceratidae, dominant are the Phymatoceratinae /82 %/, while Hammatoceratinae are completely subordinate /18 %/. 28 % of the Ammonitina is given by Hildoceratidae, with 80 % Grammoceratinae /Pseudogrammoceras/ and 20 % Harpoceratinae /mainly with "Osperlioceras" from the Pseudolioceras group, and with Polyplectus/. Dactylioceratidae /18 %/ are represented merely by three genera /Collina, Porpoceras, and Dactylioceras/. Harpoceras, Hildoceras and Mercaticeras are missing in the Variabilis Zone.

Grammoceras thouarsense Zone

The Thouarsense Zone can be identified from the appearance of Grammoceras.

The zone was identified in three profiles, with 120 cm average thickness. Within this zone ammonites become strikingly rarer. The specimen number is 439 altogether. While 1 m³ Ammonitico Rosso marl of the Bifrons Zone yielded 30 specimens in average, this value decreases to 23 in the Thouarsense Zone. 49 % of the fauna belongs to the Phylloceratina, 15 % to the Lytoceratina, and 36 % to the Ammonitina, respectively. Because of

the common occurrence of Pseudogrammoceras, 86 % of the Ammonitina is represented by the Hildoceratidae, with 99 % overabundance of Pseudogrammoceras. In the lack of Dactylioceratidae in the zone, other Ammonitina /14 %/ belong into the family Phymatoceratidae. Within this family some advance of the Hammatoceratinae /31 %/ can be recorded, against the Phymatoceratinae /69 %/. The Thouarsense Zone is rarely recorded in Mediterranean areas. This is probably caused by the small thickness, the impoverishment of the fauna and the rarity /0.06 %/ of the indexing Grammoceras. The zone can be described rather with negative than positive characters. This is shown by the decrease in the number of genera, as well. The Thouarsense Zone yielded 7 ammonite genera, as opposed to the 13 genera in the Variabilis Zone.

Hammatoceras insigne Zone

In the delimiting of this zone the appearance of Pseudolillia and Phlyseogrammoceras served as basis. This zone has a characteristic Hammatoceras fauna: H. aff. insigne /SCHUBLER in ZIETEN, 1830/, H. victorii BONARELLI, 1899, H. capuccinum BUCKMAN, 1921 and H. speciosum JANENSCH, 1902.

The Insigne Zone was identified in all the four profiles, with 98 cm average thickness. The number of the collected ammonites is 2,143, of which 51 % is Phylloceratina, 21 % is Lytoceratina and 28 % is Ammonitina. The faunal composition, as compared to that of the Thouarsense Zone, is changed considerably. With Pseudogrammoceras and Grammoceras becoming rare, Hildoceratidae fall into the background /27 %/, while Phymatoceratidae are advancing /73 %/. Within Phymatoceratidae family the ratio of Phymatoceratinae /6 %/ and Hammatoceratinae /94 %!/ is changed. Oxyparoniceras from the Hildoceratidae is restricted to the basal part of the zone. Large specimens of Polyplectus discoides /ZIETEN, 1831/ can be found throughout the zone. The number of ammonite genera is slightly larger /9/ than that in the Thouarsense Zone.

Dumortieria levesquei Zone

This zone is recorded by the appearance of Dumortieria.

The zone was identified in all studied profiles, with 149 cm average thickness and 2,142 ammonite specimens. 64 % of the fauna belongs to the Phylloceratina, 20 % to the Lytoceratina and only 16 % to the Ammo-

nitina. 53 % of the Ammonitina is given by subfamily Hammatoceratinae, and 47 % by the Grammoceratinae. The fauna is strikingly uniform, with Hammatoceras, Erycites and s.l. Dumortieria species. The Levesquei Zone yielded a single Polyplectus specimen, and Pleydellia species are missing in three profiles.

CONCLUSIONS

On the basis of the quantitative evaluation of the Toarcian ammonite faunas, further biostratigraphic and paleogeographic conclusions can be drawn.

The fauna unequivocally is of Mediterranean character, with the almost constant dominance of Phylloceratina and Lytoceratina. From the proportional increase of phylloceratids and lytoceratids in the Upper Toarcian one can conclude to the increasing subsidence of the sedimentary basin. It is noteworthy, that in the Aalenian Opalinum Zone the Ammonitina consist only 13 % of the fauna.

Regarding the relationship between zones and thickness of the sequences, it is remarkable, that the average thickness values in the pelagic Ammonitico Rosso facies show strikingly close correlation with the number of NW European ammonite horizons within the respective zones. In the Gerecse Mts. the thinnest zone is the Tenuicostatum Zone, which was subdivided by GABILLY /1976/ into two horizons. On the other hand the thickest Bifrons Zone correspods to 6 horizons. 6 horizons were designated also in the similarly thick Levesquei Zone. In spite of local differences, there is a correlation between the number of horizons and the oceanic sedimentation rate. The Bifrons "chron" represents a longer time interval than the Tenuicostatum "chron".

The Bifrons Zone has special significance both from paleontological and biostratigraphical points of view. The number of the ammonite genera is largest in this zone, and similarly highest is the specimen-number/m^3 value. However, these maxima become smoothed out when one regards this zone as of exceptionally long endurance. Hildoceras and Dumortieria are index forms of easy identification. This latter fact - together with the longer endurance - caused probably that the stratigraphic literature cites the Bifrons and Levesquei /=Meneghinii/ Zones very commonly from Mediterranean areas.

It is remarkable, especially from the point of view of paleogeography, that the north-west European zonal index forms are exceptionally rare in Mediterranean regions. This was probably the cause for range the Bifrons to Levesquei time interval usually into a single unit /Erbaense Zone, DONOVAN, 1958/. Large-scale collecting was needed to show, that the "Erbaense Zone" - at least in the Gerecse Mts. - corresponds to three NW European zones. The zonal indices are represented within the faunas with the following proportional values: Haugia with 0.008 %, Grammoceras with 0.06 %, and Phlyseogrammoceras with 0.007 %! These are markedly low values, however sufficient toplace the faciologically monotonous sequences into the NW European standard zonal scheme.

The question arises: how can be explained this striking rarity of NW European index forms in the Mediterranean region? The question can be answered from paleogeographic approach.

The differentiation of the Moditerranean and NW European faunal provinces can be due probably to geographical isolation /GÉCZY, 1973/. This isolation can be related equally to the significant distance between the two provinces, and to an intervening submarin elevation, both factors having effects on the restriction of exchange between the two epiplagic Ammonitina faunas /=Tethyan filter, GÉCZY, 1984/. This filter may have existed as early as Pliensbachian, even Sinemurian times. This is suggested by quantitative data from the Bakony Mts. From the studied 11,615 ammonites of the Pliensbachian Davoei Zone /GÉCZY, 1982/, only 5 belonged to the NW European index form /Prodactylioceras davoei SOWERBY, 1822/ and 47 to the subzonal index Liparoceratidae. These specimens, while forming an insignificant proportion of the whole fauna, matched the NW European forms at species level /DOMMERGUES et al., 1983/. It is clear, that in the Pliensbachian and Toarcian barrier between the two provinces did not exist.

The situation changed at the Toarcian/Aalenian boundary.

According to the revision of the fauna of the Tüzköves-ravine at Bakonycsernye /GÉCZY, 1967/, the Aalenian Ammonitina comprise 11 exclusively Mediterranean, 6 mainly Mediterranean, 7 cosmopolitan, 15 mainly and 36 exclusively NW European species, respectively. This locality yielded 10 species, which were recorded previously only from southern England! These

results were supported recently by the studies of GALÁCZ /1980/ on Bajocian-Bathonian faunas of Gyenespuszta /Bakony Mts./. He described 4 Mediterranean, 20 cosmopolitan and 10 north-west European species from the Bajocian, and 4 Mediterranean, 14 cosmopolitan and 6 NW European species from the Bathonian. Thus the independence of the provinces diminished from the Middle Jurassic onwards, with the increase of number of cosmopolitan forms. The Tethyan filter became a "Tethyan corridor"!

The disappearance of the Lower Jurassic filter can be probably due partly to the increasing proximity of the two faunal provinces, and partly to the destruction of the supposed submarine elevation. This might facilitate the faunal exchange of the epipelagic Ammonitina. The twofold paleogeographic phenomenon can be fitted into plate-tectonic framework. The faunistic change at the Toarcian/Aalenian boundary can be explained by subduction within the East-Mediterranean basin suggested by BIJU-DUVAL et al. /1977/. Accordingly the north-eastern margin of the Apulian plate, with the Bakony and Gerecse Mountains as parts, came closer to the European craton, and the intervening submarine ridge, with its destruction, lost its role as a filter.

References

BIJU-DUVAL,B., DERCOURT,J., LE PICHON,X. /1977/: From the Tethys Ocean to Mediterranean seas: A plate tectonic model of evolution of the Western Alpine System. Int.Sym.Struct.Hist.Medit., pp.143-167.

DEAN,W.T., DONOVAN,D.T., HOWARTH,M.K. /1961/: The Liassic ammonite zones and subzones of the North-West European province. Bull.British Mus./Nat.Hist./, 6, No.10, pp.435-505.

DOMMERGUES,J.L., FERRETTI,A., GÉCZY,B., MOUTERDE,R. /1983/: Élements de corrélation entre faunas d'ammonites mésogéennes /Hongrie, Italie/ et subboréales /France, Portugal/ au Carixien et au Domérien inférieur. Geobios, 16, No.4, pp.471-499.

DONOVAN,D.T. /1958/: The ammonite zones of the Toarcian /Ammonitico Rosso facies/ of southern Switzerland and Italy. Eclogae Geol.Helv., 51, No.1, pp.33-60.

DONOVAN,D.T., CALLOMON,J.H., HOWARTH,M.K. /1981/: Classification of the Jurassic Ammonitina. In: House,M.R. and Senior,J.R. /eds./: The Ammonoidea. System. Ass. Spec. Vol.18, Academic Press, London. pp.101-155.

FÜLÖP,J. /1971/: Les formations jurassiques de la Hongrie. Ann.Inst.Geol. Publ.Hung., 54, No.2, pp.31-45.

GABILLY,J. /1976/: Le Toarcien à Thouars et dans le Centre-Ouest de la France. Les Stratotypes Francais, Vol.3, CNRS., pp.1-217.

GALÁCZ,A. /1980/: Bajocian and Bathonian ammonites of Gyenespuszta, Bakony Mountains, Hungary. Geol.Hung., Ser.Palaeont., 39, pp.1-227.

GALLITELLI-WENDT,M.F. /1969/: Ammoniti e stratigrafia del Toarciano Umbro-Marchigiano /Appennini Centrale/. Boll.Soc.Paleont.Ital., 8, pp.11-62.

GÉCZY,B. /1967/: Ammonoides Jurassiques de Csernye, Montagne Bakony, Hongrie. Part.2. Geol.Hung., Ser. Palaeont., 35, pp.1-413.

GÉCZY,B. /1973/: The origin of the Jurassic faunal provinces and the Mediterranean plate tectonics. Ann.Univ.Sci.Budapest., Sect.Geol., 16, pp.99-114.

GÉCZY,B. /1982/: The Davoei Zone in the Bakony Mountains, Hungary. Ann. Univ.Sci.Budapest., Sect.Geol., 21, pp.1-11.

GÉCZY,B. /1984/: Provincialism of Jurassic ammonites: Examples from Hungarian faunas. Acta Geol.Hung., /in press/

THE LIASSIC BRACHIOPODS OF THE IBERIAN RANGE (SPAIN): STRATIGRAPHIC DISTRIBUTION AND BIOZONATION

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THE LIASSIC BRACHIOPODS OF THE IBERIAN RANGE (SPAIN): STRATIGRAPHIC DISTRIBUTION AND BIOZONATION

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A Brachiopod Zonal Scale is proposed on the base of the detailed stratigraphic distribution of the more important species in the Iberian Range, in relation to the Ammonite Zones and Subzones. The proposed scheme appears also valid to the rest of Spanish Brachiopod Province during Upper Domerian and Toarcian. A whole of 6 zones, as well as 10 subzones, are defined from Upper Lotharingian to Lower Aalenian; i.e., Dunrobinensis, Numismalis, Resupinata, Jauberti, Infraoolithica and Cynocephala Zones.

The studied fauna shows clear affinities with that of European Province during Lotharingian and Carixian, becoming progressively endemic from Lower Domerian upwards.

RESUMEN

A partir de la distribución estratigráfica detallada, en relación con las Zonas y Subzonas de Ammonites, de las más importantes especies de braquiópodos del Lías de la Cordillera Ibérica, se propone una escala zonal basada en estos fósiles, aplicable en el Domeriense Superior y el Toarciense al resto de la Provincia Española de braquiópodos. Se han definido 6 zonas y 10 subzonas, desde el Lotharingiense Superior al Aaleniense Inferior: Zonas Dunrobinensis, Numismalis, Resupinata, Jauberti, Infraoolithica y Cynocephala.

La fauna estudiada muestra afinidades claras con la Provincia Europea en el Lotharingiense y el Carixiense, haciéndose progresivamente endémica a partir del Domeriense.

INTRODUCTION

In the Lias of Iberian Range, Brachiopods constitute an abundant and long time known group of Fossils, several species having been already figured by TORRUBIA (1754). Subsequently, several species described by DES-

LONGCHAMPS (1863), DUBAR (1931) and BATALLER (1931) were based on type specimens coming from the Iberian Range. Recent descriptions of new forms as well as some remarks on the precise distribution of identified species are due, in these recent years, to GOY & ROBLES (1971), DELANCE (1974), GOY (1974), COMAS-RENGIFO & GOY (1975, 1978), COMAS-RENGIFO (1982), GARCIA-JORAL (1983) y GARCIA-JORAL & GOY (1984).

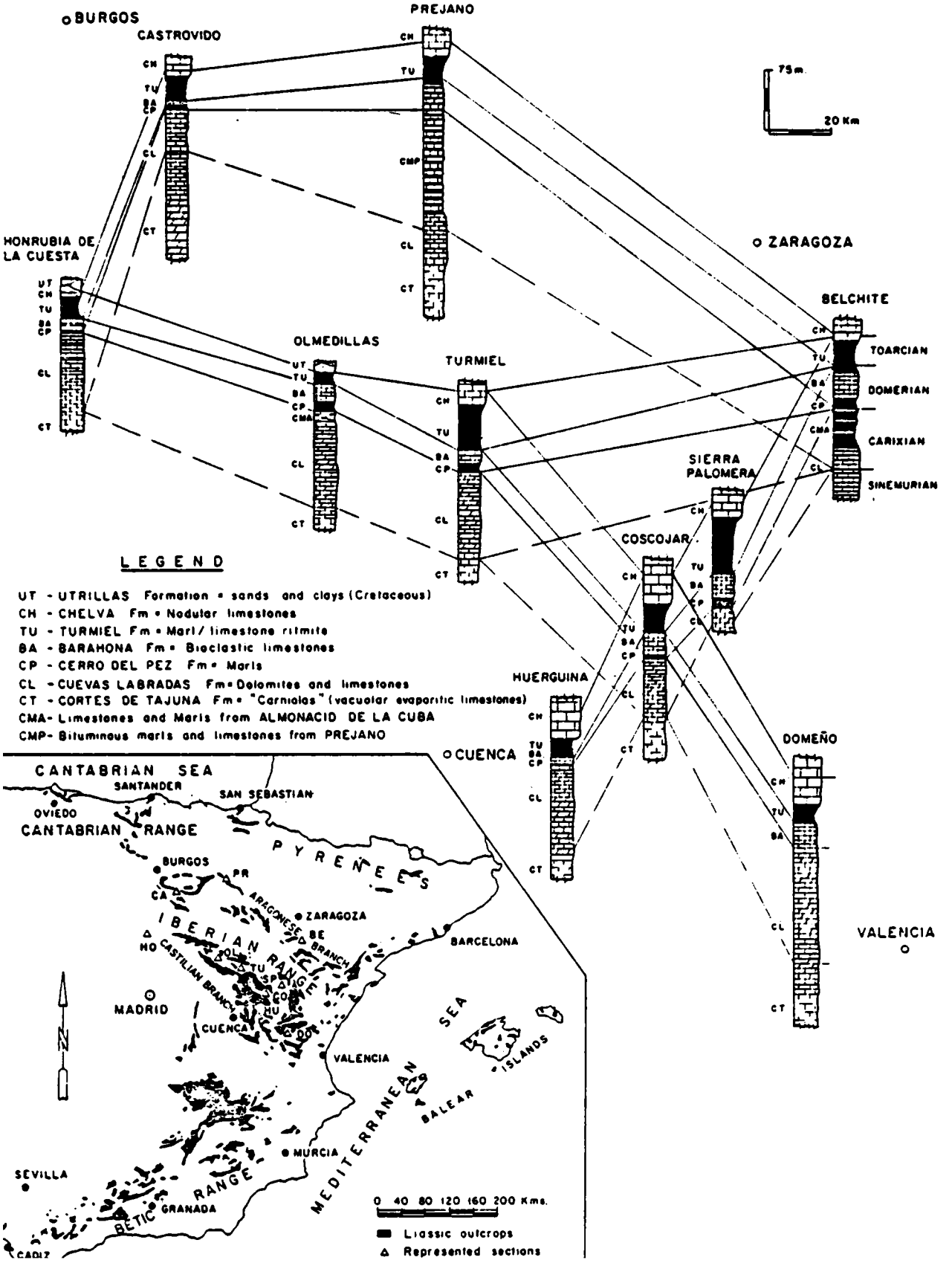
It is important to note that Brachiopods have always been collected bed by bed, together with Ammonites, in order to have a good reference on their precise stratigraphic position. The bulk of the studied assemblage comprises a large collection of over 18.000 specimens from more than 60 sections throughout the whole Iberian Range. Lithostratigraphic units of every type-section in all different parts of Iberian Range are syntethized in Fig. 1.

The resulting data allowed the authors to elaborate a table in order to illustrate the stratigraphic distribution of the more important species in relation to the Zonal Scheme currently proposed for the Iberian Range (Fig. 2).

DISTRIBUTION OF LIAS BRACHIOPODS IN IBERIAN RANGE

The first Brachiopods identified from the Lias of Iberian Range are of Lotharingian, Upper Sinemurian, age. The major part of them come from Raricostatum Zone of Préjano section (Northern Iberian Range), where open sea conditions are detected earlier. The central and southern parts of Iberian Range are characterized at that time by a stromatolitic and dolomitic sedimentation, of more restricted conditions. Among the Spiriferinacea, *Liospiriferina rostrata* and *Callospiriferina tumida* are common; Zeilleriacea are represented by *Zeilleria* (*Cincta*) *cor* and *Z.* (*Zeilleria*) *quiaiosensis* and Terebratulacea and Rhynchonellacea, mainly by *Cuersithyris gijonensis* and *Tetrarhynchia dunrobibensis*. With the exception of *C. gijonensis*, all that species are known from the "Celtic-Swabian Kingdom" of DELANCE (1972), or the "European Province" of AGER (1967) and VOROS (1980).

During Lower and Middle Carixian, the open platform conditions characterize the northern area, extending partly, towards the central part (Pré


BURGOS
CASTROVIDO
PREJANO
75 m.
20 Km
HONRUBIA DE LA CUESTA
ZARAGOZA
BELCHITE
TOARCIAN
DOMERIAN
CARIXIAN
SINEMURIAN
OLMEDILLAS
TURMIEL
SIERRA PALOMERA
COSCOJAR
HUERGUINA
DOMEÑO
VALENCIA
CUENCA
LEGEND
UT - UTRILLAS Formation = sands and clays (Cretaceous)
CH - CHELVA Fm = Nodular limestones
TU - TURMIEL Fm = Marl / limestone ritmite
BA - BARAHONA Fm = Bioclastic limestones
CP - CERRO DEL PEZ Fm = Marls
CL - CUEVAS LABRADAS Fm = Dolomites and limestones
CT - CORTES DE TAJUNA Fm = "Carniolas" (vacuolar evaporitic limestones)
CMA - Limestones and Marls from ALMONACID DE LA CUBA
CMP - Bituminous marls and limestones from PREJANO
CANTABRIAN SEA
SANTANDER
SAN SEBASTIAN
OVIEDO
CANTABRIAN RANGE
PYRENEES
BURGOS
ZARAGOZA
ARAGONESE BRANCH
IBERIAN RANGE
CASTILIAN BRANCH
BARCELONA
MADRID
CUENCA
VALENCIA
MEDITERRANEAN SEA
BALEAR ISLANDS
MURCIA
SEVILLA
GRANADA
BETIC RANGE
CADIZ
N
0 40 80 120 160 200 Kms.
Liassic outcrops
Represented sections

jano, Belchite), and Brachiopods representatives are more abundant. It is detected the persistance of many of the already mentioned species together with some new ones Cuersithyris ? davidsoni and Gibbirhynchia curviceps. On the other hand, among the Zeilleriidae it is remarkable the sustitution of Lotharingian species by Z. (C.) numismalis, Z. (Z.) waterhousii and Z. (Z.) cf. roemeri. At the same time, at the Eastern edge of Iberian Meseta it takes place the deposition of chanelized facies (of presumably shallow water) with transported Brachiopods. Besides Spiriferina walcotti, G. curviceps, T. dunrobinensis and L. punctata, also already found in near areas, several species, such as Squamirhynchia squamiplex, Piarorhynchia ? sp. and Plectothyris fimbrioides, are typically found in these facies. The last species, described from Pliensbachian of Sarthe (W. France), has been now identified for the first time in Spain. These costate Terebratulids are regarded as a relevant group by AGER & WALLEY (1977) in their study on migration ways of Jurassic Brachiopods. According to ELMI et al. (1982), and ALMERAS & ELMI (1984) it could be originated from "Terebratula" riberoi CHOFFAT, from the Lotharingian of Portugal.

As a whole, the referred associations belong,as the former ones, to the European Province; some species, such as Z. (C.) numismalis and G. curviceps display a large distribution, having been referred as well from North Africa, Sicily, Bulgaria, Hungary, etc.

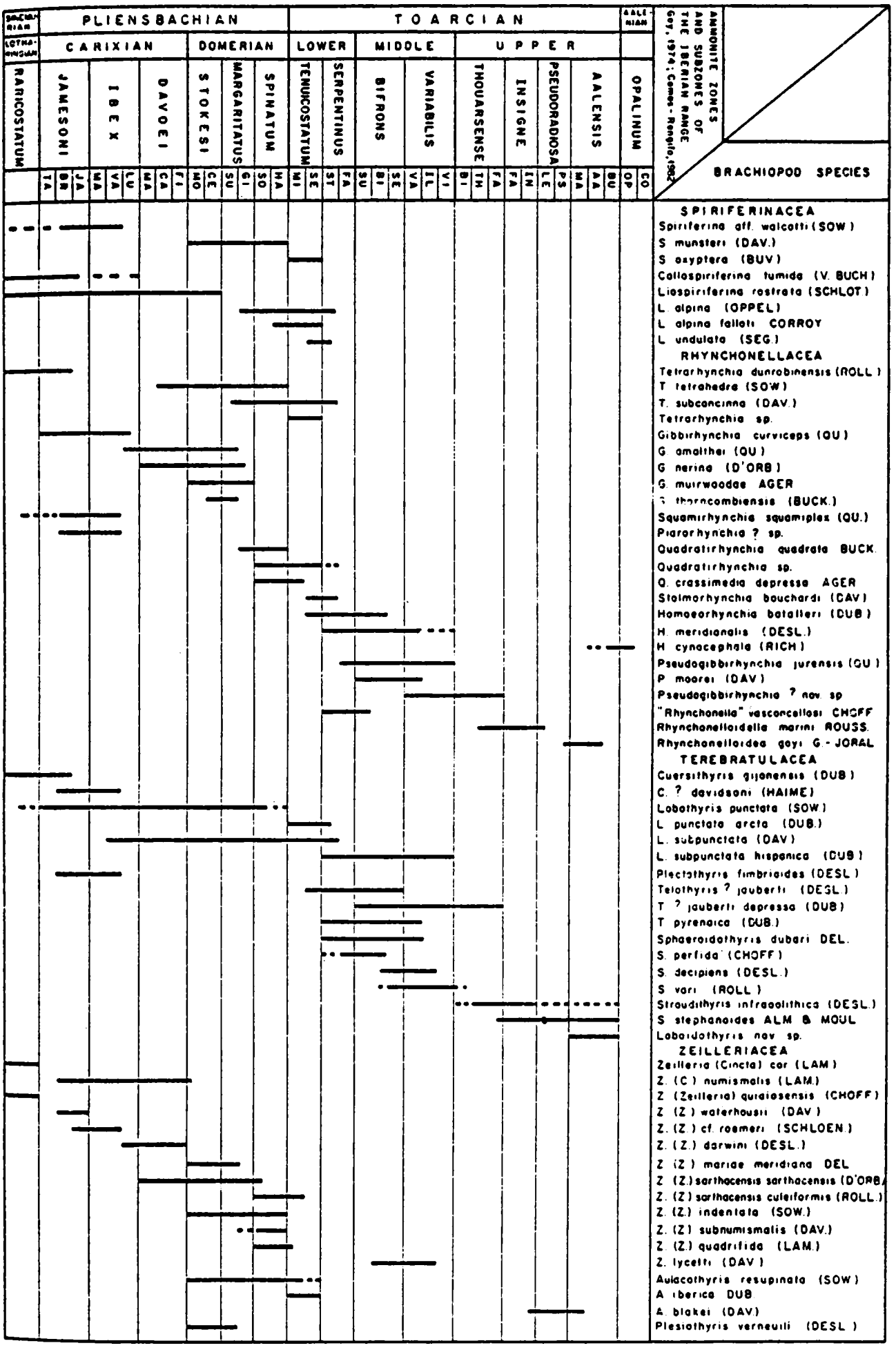
During the Upper Carixian, the Spiriferinacea are practically absent throughout the whole Iberian Range, the remaining other Superfamilies being similarly scarce in the central (Castilian Branch) and southern parts of it. In the northern region, and in the northern Aragonese Branch, there have been detected the first representatives of Aulacothyris, with Z. (Z.) sarthacensis sarthacensis and Z. (Z.) mariae meridiana. Among the Terebratulacea, Lobothyris punctata and L. subpunctata (highly abundant during Domerian) are common. Among the Rhynchonellacea, there have been found several species of Gibbirhynchia and the first Tetrarhynchia tetrahedra.

Open platform conditions become generalized during Domerian, allowing the development of a large number of Brachiopod species, with numerous common taxa with England and Central Europe. In the northern part of Iberian

Range (Préjano), such conditions are quite homogeneous during the whole Domerian, whilst in the more western part of this region (Castrovido), and in the Central area (Honrubia de la Cuesta, Olmedillas, Turmiel, Belchite, Sierra Palomera, Coscojar), an increase of depth (bathimetric maximum) seems to take place during Lower Domerian, with a slight retreat (shallowing) process during Middle-Upper Domerian. In the southern part of Iberian Range, the Ammonite-bearing marly sediments dissappear, being substituted by bioclastic limestones similar to that of Middle-Upper Domerian elsewhere. It is worth to note the presence of L. rostrata, L. alpina, Spiriferina munsteri, Z. (Z.) sarthacensis sarthacensis, Z. (Z.) quadrifida, Aulacothyris resupinata, L. punctata, L. subpunctata, T. tetrahedra and T. subconcinna, as well as some several forms of the genera Gibbirhynchia and Quadratirhynchia. On the other hand, there have also been found some taxa typical of more southerly areas, such as Plesiothyris verneuili, Z. (Z.) mariae meridiana, L. subpunctata (morphotype: thomarensis), and L. alpina falloti, which reaches its acme during Lower Toarcian.

During Lower and Middle Toarcian, the open platform marls reach their maximum extent (Fig. 1). However, the share of common taxa with neighbouring basins is slightly lower, the presence of numerous species typical of the Iberian basin having been detected (L. punctata arcta, L. subpunctata hispanica, Telothyris ? jauberti, T. pyrenaica, Sphaeroidothyris perfida, Homoeorhynchia batalleri, H. meridionalis, etc.), as well as many forms know from other areas besides the Iberian Range, such as Zeilleria lycetti, Stolmorhynchia bouchardi, Pseudogibbirhynchia jurensis, P. moorei, Sphaeroidothyris vari, etc., their populations sometimes displaying some striking peculiarities with respect to that described from other regions.

This set of taxa, typical from that basin, conforms the so-called "Faciès espagnol" of CHOFFAT (1880) and DUBAR (1931). The boundaries of that "Spanish faunistic realm" were delimited by DELANCE (1972), and coincide remarkably with that so-called Spanish Bioprovince of GARCIA-JORAL & GOY (1984) in an intermediate position between European and Mediterranean faunal assemblages, both of them less diversifies. The individualization of this faunal realm is explain by DELANCE (op. cit.) as a consequence of palaeogeographic events at the end of Domerian. According to HALLAM (1972), an important sedi


PLIENSBACHIAN
TOARCIAN
CARIXIAN
DOMERIAN
LOWER
MIDDLE
UPPER
RARICOSTATUM
JAMESONI
IBEX
DAVOEI
STOKESI
MARGARITATUS
SPINATUM
TENUICOSTATUM
SERPENTINUS
BIFRONS
VARIABILIS
THOUARSENSE
INSIGNE
PSEUDORADIOSA
AALENSIS
OPALINUM
AMMONITE ZONES AND SUBZONES OF THE IBERIAN RANGE Goy, 1974; Comas - Rengifo, 1982
BRACHIOPOD SPECIES
SPIRIFERINACEA
Spiriferina aff. walcotti (SOW)
S. munsteri (DAV.)
S. oxyptera (BUV)
Callospiriferina tumida (V. BUCH)
Liospiriferina rostrata (SCHLOT)
L. alpina (OPPEL)
L. alpina falloti CORROY
L. undulata (SEG.)
RHYNCHONELLACEA
Tetrarhynchia dunrobinensis (ROLL)
T. tetrahedra (SOW)
T. subconcinna (DAV.)
Tetrarhynchia sp.
Gibbirhynchia curviceps (QU)
G. amalthei (QU)
G. nerina (D'ORB)
G. muirwoodae AGER
G. thorncombiensis (BUCK.)
Squamirhynchia squamiplex (QU.)
Piarorhynchia ? sp.
Quadratirhynchia quadrata BUCK.
Quadratirhynchia sp.
Q. crassimedia depressa AGER
Stolmorhynchia bouchardi (DAV)
Homoeorhynchia batalleri (DUB)
H. meridionalis (DESL.)
H. cynocephala (RICH)
Pseudogibbirhynchia jurensis (QU)
P. moorei (DAV)
Pseudogibbirhynchia ? nov. sp
"Rhynchonella" vasconcellosi CHOFF
Rhynchonelloidella marini ROUSS.
Rhynchonelloidea goyi G.-JORAL
TEREBRATULACEA
Cuersithyris gijonensis (DUB)
C. ? davidsoni (HAIME)
Lobothyris punctata (SOW)
L. punctata arcta (DUB.)
L. subpunctata (DAV)
L. subpunctata hispanica (DUB)
Plectothyris fimbrioides (DESL)
Telothyris ? jouberti (DESL.)
T. ? jouberti depressa (DUB)
T. pyrenaica (DUB.)
Sphaeroidothyris dubari DEL.
S. perfida (CHOFF)
S. decipiens (DESL.)
S. vari (ROLL)
Stroudithyris infraoolithica (DESL.)
S. stephanoides ALM & MOUL
Loboidothyris nov. sp.
ZEILLERIACEA
Zeilleria (Cincta) cor (LAM)
Z. (C.) numismalis (LAM.)
Z. (Zeilleria) quadrosensis (CHOFF)
Z. (Z.) waterhousii (DAV)
Z. (Z.) cf. roemeri (SCHLOEN.)
Z. (Z.) darwini (DESL.)
Z. (Z.) maride meridiana DEL
Z. (Z.) sarthacensis sarthacensis (D'ORB)
Z. (Z.) sarthacensis culeiformis (ROLL.)
Z. (Z.) indentata (SOW.)
Z. (Z.) subnumismalis (DAV.)
Z. (Z.) quadrifida (LAM.)
Z. lycetti (DAV)
Aulacothyris resupinata (SOW)
A. iberica DUB
A. blakei (DAV)
Plesiothyris verneuili (DESL)

mentary change takes place in N. Europe, towards a deeper sedimentary conditions, involving a faunistic turnover. Such change seems to be less noticeable in SW. Europe, so that, several forms such as Spiriferina, or T. tetrahedra, not known to cross the Pliensbachian/Toarcian boundary in N. Europe, are found in Lower Toarcian from Spain and Portugal. This is one of the differencial points which allowing to separate biogeographically both fauna

Specific diversity probably decreases in Upper Toarcian, as the trend to appearance of taxa typical of that basin is still observed (Rhynchonelloidella marini, Rhynchonelloidea goyi, Loboidothyris n. sp., ...), a well as some other markedly scarce in the neighbouring areas, such as A. blkei. This relative minimum in the number of species also appears quite general in Europe, and has been recently related by VOROS (1980) with the Centr Atlantic aperture. In the Iberian Range, some sedimentary changes, presumab related with the final phase of an intense crustal extension (ALVARO et al 1979), can be observed at the upper part of Insigne Zone.

This would mean a moment of tectonic instability dominated by the fragmentation of the carbonate platform during Lower Dogger, and marked by volcanic activity, intraformational tectonics, etc, (GAUTIER & MOUTERDE, 1964; GOMEZ, 1979; CAPOTE et al., 1982), which would imply the renewal of the Brachiopod Fauna. However, there have also been found several taxa commonly found in more northerly areas (Homoeorhynchia cynocephala, Stroudithyris infraoolithica...).

BRACHIOPOD ZONES AND SUBZONES (Fig. 3)

Brachiopod biozonation can be tentatively proposed in base of the detailed stratigraphical range of the main Brachiopod species for the Iberi basin and extended for the whole Spanish Province during Upper Domerian - Lower Toarcian (Fig. 2).

Zonal and subzonal boundaries are marked at the first occurrence the corresponding index species in the basin. The main characteristic associations are also described.

The here discussed zonation is found on the fact that the majo

rity of the studied species across the Iberian Range show a similar stratigraphic range, their first occurrence appearing widely isochronous. Nevertheless, there have been also used some species whose stratigraphic range appears in some way sedimentologically dependent. This is specially the case of P. verneuili and R. marini. The first occurrence of the first one seems to coincide with the sudden setting of open marine platform conditions across large areas, whereas occurrence of R. marini appears related to an slight increase in fine detritic sediments known to be heterochronous for the different parts of Iberian basin.

Correlation with neighbour european areas is favored by the co-occurrence of typically wide spread taxa together with others of marked endemic character. In that sense, zonal index have been chosen, as far as possible, among well-characterized species of wide geographic distribution. For subzonal index, however, there have been used, in some cases, species geographically limited to the Iberian Range, or to the Spanish Province.

- DUNROBINENSIS ZONE

Index-species: Tetrarhynchia dunrobinensis (ROLLIER, 1917)

Associated taxa: S. aff. walcotti (SOW.), C. tumida (v. BUCH), L. rostrata (SCHLOT.), G. curviceps (QU.), S. squamiplex (QU.), C. gijonensis (DUB.), L. punctata (SOW.), Z. (C.) cor (LAM.), Z. (Z.) quiaiosensis (CHOFF.)

The index species is quite common in the Iberian Range. It has been first used as zonal index by TCHOUMATCHENCO (1967, 1972) for Lower Jurassic of Central and Western Balkans. The stratigraphic interval of this zone, (sensu TCHOUMATCHENCO) would range from base of Obtusum Zone to the top of Ibex Zone. The scarcity of Ammonites in the major part of Lotharingian in the Iberian Range makes the characterization of Obtusum and Oxynotum Zones uncertain. Similarly, as far as Brachiopods is concerned, T. dunrobinensis has still not been recorded undoubtedly below Raricostatum Zone. On the other hand, its stratigraphic distribution in the Carixian in the Iberian Range is somewhat more reduced than in the Balkans, its record having not been confirmed in the Ibex Zone, similarly as T. "tetrahedra", as referred by REVERT (1971) in the Causses Region (S. France). This would be a specimen morfolo-

gically closer to T. dunrobinensis than to T. tetrahedra according to TCHOUMATCHENCO (in REVERT & TCHOUMATCHENCO, 1973).

In Spain, besides the Iberian Range, the index species has been also recorded in the Cantabrics (N. Spain), by SUAREZ-VEGA (1974). The species has also been recorded from Upper Sinemurian of England (AGER, 1956).

- NUMISMALIS ZONE

Index-species: Zeilleria (Cincta) numismalis (LAMARCK, 1819)

Associated taxa: S. aff. walcotti (SOW.), C. tumida (v. BUCH), L. rostrata (SCHLOT.), T. dunrobinensis (ROLL.), G. curviceps (QU.), G. amalthei (QU.), G. nerina (D'ORB.), S. squamiplex (QU.), Piarorhynchia ? sp., C. gijonensis (DUB.), C. ? davidsoni (HAIME), L. punctata (DAV.), L. subpunctata (SOW.), P. fimbroides (DESL.), Z. (Z.) waterhousii (DAV.), Z. (Z.) cf. roemeri (SCHLOEN.), Z. (Z.) darwini (DESL.), Z. (Z.) sarthacensis sarthacensis (D'ORB.).

The designation of the index species Z. (C.) numismalis is well justified on account of its wide geographic distribution throughout Europe and North Africa, having been reported even from several points in the Mediterranean Province. In the Iberian Range, the index species is generally scarce. It ranges from the base of Brevispina Subzone to the extreme base of Domerian. Some representatives of it have been reported as well from the Cantabric Range (DAHM, 1965) and from Pyrenees (DUBAR, 1925).

- Davidsoni Subzone

Index-species: Cuersithyris ? davidsoni (HAIME, 1855)

The subzone is characterized by the record, in almost its whole extension, of the index species. This corresponds to a peculiar taxa with a distinct morphology within Terebratulids (type locality: Paraje de la Muleta, Sóller Area, Majorca). The species is commonly found throughout the northern and central parts of Iberian Range, being specially abundant in the Jamesoni Subzone.

The index species appears normally associated to G. curviceps, a fairly common in the Lower and Middle Carixian of Spain, previously used as

zonal index by REVERT (1971) for the Causses area, and of distribution equivalent to Ibex Zone.

"T." gr. davidsoni was also used as zonal index for the Castilian Branch of Iberian Range by GOY (1974), who assignes the species a distribution equivalent to the whole Carixian, i.e., a much larger stratigraphic range than here assumed.

Besides Majorca and the Iberian Range, this form has also been recorded in Portugal (CHOFFAT, 1947) in the jurassic outcrops from North of Tagus River. Some other records come from Cantabrics (SUAREZ-VEGA, 1974), Pyrenees (DUBAR, 1925), and the Costero-Catalan Range (BATALLER, 1926; DUBAR, 1931). Outside the Iberian Peninsula, it has been reported from the Causses (REVERT & TCHOUMATCHENCO, 1973), and Provence (ALMERAS & MOULAN, 1979).

- Darwini Subzone

Index-species: Zeilleria (Zeilleria) darwini (DESLONGCHAMPS, 1863)

The stratigraphic range of this subzone extends from Upper Ibex Zone to the top of Davoei Zone. The marked scarcity of Brachiopods during this stratigraphic interval makes the lower boundary of this subzone often uncertain. The index species, which appears normally associated to G. amalthei and G. nerina, ranges through this precise interval. Its acceptance, however, as a subzonal index species is made here with reservation, on account of its scarcity and still poorly known stratigraphic range.

Z. (Z.) darwini would be, according to DELANCE (1974), a relatively scarce carixian taxa, recorded in England, Paris Basin, NW. Germany, Swabian Alb, and most probably, Carpathian area.

- RESUPINATA ZONE

Index-species: Aulacothyris resupinata (SOWERBY, 1816)

Associated taxa: S. munsteri (DAV.), S. oxyptera (BUV.), L. rostrata (SCHLOT.), L. alpina (OPP.), L. alpina falloti (CORR.), T. tetrahedra (SOW.), T. subconcinna (DAV.), Tetrarhynchia sp., G. amalthei (QU.), G. nerina (D'ORB.), G. muirwoodae AGER, G. thorncombiensis (BUCK.), Q. quadrata BUCK.,

Quadratirhynchia sp., Q. crassimedia depressa AGER, L. punctata (SOW.), L. punctata arcta DUB., L. subpunctata (DAV.), Z. (Z.) mariae meridiana DEL., Z. (Z.) sarthacensis sarthacensis (D'ORB.), Z. (Z.) sarthacensis culeiformis (ROLL.), Z. (Z.) indentata (SOW.), Z. (Z.) subnumismalis (DAV.), Z. (Z.) quadrifida (LAM.), A. iberica DUB., Plesiothyris verneuili (DESL.).

The Resupinata Zone corresponds to a stratigraphic interval highly enriched in Brachiopods, with a high number of taxa, many of which are commonly found as well in more northerly areas. Associations typical of its lower part (G. muirwoodae, G. thorncombiensis, Z. (Z.) mariae meridiana, P. verneuili..)and of its upper part (S. oxyptera, S. alpina falloti, L. punctata arcta, Z. (Z.) sarthacensis culeiformis, Z. (Z.) quadrifida, A. iberica, ...) can be recognised, each of them comprising both wide spread and endemic taxa which permits a good correlation between Iberian and neighbouring european basins.

A. resupinata appears widely extended throughout Europe and N. Africa, having also been reported from Turkey (AGER, 1959), and from Carpathian Mountains (SIBLIK, 1966). REVERT (1971) reports it from Margaritatus Zone (Gibbosus Subzone) of Causses, and DELANCE (1974) regards it as an Upper Domerian taxa, well extended throughout Western Europe, and absent in more septentrional areas. In the "spanish" realm it ranges to the base of Toarcian. In North Africa the species has been reported by ELMI et al. (1982), from Domerian of Tlemcenian and Atlassic realms.

In Spain, it is commonly found in the Iberian Range, from Lowermost Domerian (Stokesi Zone) to Lower Toarcian (Tenuicostatum Zone),its presence having being also detected in upper Davoei Zone, with A. capricornus (SCHLOT.) and P. davoei (SOW.), by COMAS-RENGIFO (1982). A further reference to A. cf. resupinata, in association with Lower and Middle Domerian Ammonites, in the Costero-Catalan Range, is due to CADILLAC et al. (1982).

- Verneuili Subzone

Index-species: Pleisothyris verneuili (DESLONGCHAMPS, 1863)

The range of this Subzone corresponds practically to the vertical extension of the index species: P. verneuili (Type locality: Josa, near the

classical locality of Obón, Teruel, Iberian Range). The species appears suddenly at the base of Domerian (Stokesi Subzone). Its occurrence in the studied area appears strikingly related to the extended development of marly and marly-limestones facies throughout wide areas of central and northern part of Iberian Range. It disappears in different moments along Stokesi or Margaritatus Zones, showing a similar association with facial changes detected in the basin.

Throughout the whole (or the major part of) its vertical range, P. verneuili is recorded with S. munsteri, T. tetrahedra, G. amalthei, G. nerina, G. muirwoodae, G. thorncombiensis, L. punctata, L. subpunctata, Z. (Z.) mariae meridiana, Z. (Z.) sarthacensis sarthacensis, and Z.(Z.) indentata, occuring as well with L. rostrata in the Stokesi Zone, and with T. subconcinna in the Margaritatus Zone.

The species has already been proposed as zonal index by GOY (1974) for the Castilian Branch of the Iberian Range, with a similar vertical range as here assumed.

Some other references to this species, outside the Iberian Range, include the classical outcrops of Thomar region (DELANCE, 1974), Pyrenees (DUBAR, 1925), Provence (CHARLES, 1948) and Sicily (DI STEFANO, 1891). In North Africa, it has been reported from the Tlemcenian Realm and from High Atlas, by ELMI et al. (1982) and ALMERAS & ELMI (1984).

- Quadrifida Subzone

Index-species: Zeilleria (Zeilleria) quadrifida (LAMARCK, 1819)

The Subzone corresponds to the vertical extension of the index species, up to the present still not found in cooccurrence with the index species of the former one, P. verneuili. It is a common taxa in the Upper Domerian - Lowermost Toarcian interval, showing a high morphological variability, which has been accurately precised by DELANCE (1974). In the Iberian Range, its extreme morphotypes (bicornea and quadricornea) are usually found separately, their cooccurrence together having been however recorded in certain levels along the central and northern outcrops of the studied area.

The distribution of both morphotypes shows a marked facies control, the morphotype "bicornea" appearing connected with the development of bioclastic limestones during Upper Domerian - Lower Toarcian, whereas the morphotype "quadricornea" seems rather related to marly sediments. Therefore, in the Castilian Branch, where bioclastic formations range up to Lower Toarcian (Tenuicostatum Zone), representatives of the "quadricornea" morphotype are markedly scarce. On the contrary, along the central part of the Aragonese Branch and East of the Demanda Mts., the marly sedimentation begins as early as Spinatum Zone (Hawskerense Subzone), the "quadricornea" morphotype becoming much more common.

Z. (Z.) quadrifida appears throughout the whole, or the major part of its distribution, associated to L. alpina, L. alpina falloti, T. subconcinna, Q. crassimedia depressa, L. subpunctata and Z. (Z.) sarthacensis sarthacensis. Moreover, it is recorded in cooccurrence with S. munsteri, T. tetrahedra, Q. quadrata, L. punctata, Z. (Z.) sarthacensis sarthacensis, Z. (Z.) indentata, and Z. (Z.) subnumismalis in the Spinatum Zone, and with S. oxyptera, L. punctata arcta, and A. iberica in the Tenuicostatum Zone (Mirabile Subzone).

Z. cornuta has been used as Zonal Index by TCHOUMATCHENCO (1967, 1972) in Central and Western Balkans. The faunistic associations described by the author are, generally, similar to that found in the Iberian Range. However, the stratigraphic range admitted for them "from the Davoei Zone to the Stokesi Subzone of the Margaritatus Zone inclusive"; and from Davoei to Stokesi in REVERT & TCHOUMATCHENCO (1973), is markedly lower than that recorded in the Iberian Range. The same zonal index has been used by GOY (1974) for the Castilian Branch of the Iberian Range, its stratigraphic range comprising Spinatum and, partly, Tenuicostatum Zones.

Z. (Z.) quadrifida appears widely extended in Europa (England, Germany, France, Iberia, Bulgaria) and in North Africa (Algeria, Morocco).

- JAUBERTI ZONE

Index-species: Telothyris ? jauberti (DESLONGCHAMPS, 1863)

Associated taxa: S. oxyptera (BUV.), L. alpina (OPP.), L. alpina fa-

lloti (CORR.), L. undulata (SEG.), Tetrarhynchia sp., S. bouchardi (DAV.), H. batalleri (DUB.), H. meridionalis (DESL.), P. jurensis (QU.), P. moorei (DAV.), Pseudogibbirhynchia ? nov. sp., "R." vasconcellosi CHOFF., L. punctata arcta (DUB.), L. subpunctata (DAV.), L. subpunctata hispanica (DUB.), T. ? jauberti depressa (DUB.), T. pyrenaica (DUB.), S. dubari DEL., S. perfida (CHOFF.), S. decipiens (DESL.), S. vari (ROLL.), Z. lycetti (DAV.), A. iberica DUB.

In the Iberian Range the Jauberti Zone is characterized by a high specific diversity with numerous taxa typical of the Spanish Province. Its charactheristical elements are: T. ? jauberti (Type form) from Tenuicostatum to Bifrons Zone, followed by T. ? jauberti depressa from Bifrons to Thouarsense Zone. The type specimen of the species comes from Anchuela del Campo (Guadalajara), most probably from Serpentinus Zone, where the type form reaches its maximum development. A specimen from the Bifrons Zone (Sublevisoni Subzone) from the locality of Cuers (Provence), has recently been designed as neotype for that species by ALMERAS & MOULAN (1982).

The type species, quite abundant in the studied area, has been recorded in numerous localities besides the Iberian Range. Records from Portugal (N. Tagus River outcrops) are reported by CHOFFAT (1880, 1947), as well as in the Algarve (S. Portugal). It has been also recorded in the Costero-Catalán Range (BATALLER, 1926; DUBAR, 1931; CADILLAC et al., 1982; CALZADA, 1983), Pyrenees (DUBAR, 1931; DELANCE, 1969; CLUTSON, 1979; CALZADA, 1981), Provence (CHARLES, 1948; ALMERAS & MOULAN, 1982) and, in North Africa, in Algeria and Morocco (DUBAR, 1940, 1943; GOURION, 1960; ELMI et al., 1982). Finally, some other records are reported from Madagascar (THEVENIN, 1908) and from Argentine (JAWORSKI, 1926).

- Bouchardi Subzone

Index-species: Stolmorhynchia bouchardi (DAVIDSON, 1852).

The Subzone extends through the almost whole vertical range of the index species as recorded in the Iberian Range, appearing suddenly at the Tenuicostatum Zone (Semicelatum Subzone), and being common up to Serpentinus Zone (Strangewaysi Subzone) associated to L. alpina, L. undulata, H. batalle-

ri, L. punctata arcta, T. ? jauberti, etc.

The group has recently revised by ROUSSELLE (1974), on the basis of North Africa material. The species is one of the scarce Lower Toarcian taxa reported both from European and Spanish Provinces, which makes it a strong correlation element between both provinces.

The index species has been reported from S. England, Germany and France, where its presence in Provence has been proved by ALMERAS & MOULAN (1982), though it has not, up to the present, been found in the Causses Region (REVERT, 1971). In the Iberian Peninsula it has been reported from Portugal, in the basins around the Iberian Meseta (Betics excluded) and from Pyrenees (DUBAR, 1931; DELANCE, 1969; CLUTSON, 1979; CALZADA, 1981). Some specimens also referable to that species from Algeria have been figured by GOURION (1960) and ALMERAS & ELMI (1984).

- Perfida Subzone

Index-species: Sphaeroidothyris perfida (CHOFFAT, 1947)

Its extension comprises from the moment the mass occurrence of S. perfida is detected, in Serpentinus Zone (Falcifer Subzone), up to the first occurrence of S. vari in Bifrons Zone (Bifrons Subzone). The index species appears mainly associated to other Brachiopod taxa, such as H. batalleri, H. meridionalis, T. pyrenaica, T. ? jauberti, etc.., all of them typical of the Spanish Province, reaching their maximal abundance at this Subzone.

The type specimen of the index species comes from Portugal (lectotype designated by ALMERAS & MOULAN, 1982; CHOFFAT, op. cit. L. 5, f. 19), its geographical distribution being largely the Spanish Province. Except for the Betic Range, the index species is know throughout the whole Iberian Peninsula, Pyrenees, Provence and North Africa in the Oudja Region (DARESTE DE LA CHAVANNE, 1930)

- Vari Subzone

Index-species: Sphaeroidothyris vari (ROLLIER, 1918)

This Subzone is characterized by a marked decrease in specific va-

riability of Brachiopods in the Iberian Range, the groups being generally scarce and irregularly represented. It ranges from Bifrons Zone (Bifrons Subzone) to upper part of Variabilis Zone, and possibly up to Thouarsense Zone (Bingmanni Subzone). S. vari appears associated to S. decipiens, T. ? jauberti depressa, Z. lycetti as well as to scarce Rhynchonellidae. It is frecuently found in the Spanish Province, having also been reported from Provence (CHARLES, 1948; ALMERAS & MOULAN, 1982), Portugal (CHOFFAT, 1947), Pyrenees (DUBAR, 1925, 1931), Costero-Catalan Range (CADILLAC et al., 1982) and North Africa, in Morocco and Algeria (GARDET & GERARD, 1946; ALMERAS & ELMI, 1984).

INFRAOOLITHICA ZONE

Index-species: Stroudithyris infraoolithica (DESLONGCHAMPS, 1871)

Associated taxa: R. marini ROUSS., R. goyi GARCIA-JORAL, T. ? jauberti depressa (DUB.), S. stephanoides ALM. & MOUL., Loboidothyris nov. sp., A. blakei (DAV.).

The Infraoolithica Zone is characterized by the presence of some few taxa in association with the index species, all of them represented by a remarkable high amount of specimens. It ranges from Thouarsense Zone (Thouarsense Subzone) to Aalensis Zone (Aalensis Subzone).

S. stephanoides (including "T." submaxillata DAV. sensu CHOFFAT, 1947) shows a similar stratigraphic range and is usually highly abundant in the studied area, which would make a good contender for zonal index species. However, the species S. infraoolithica is here erected on account of its wider geographic distribution, allowing correlation with European Province. S. infraoolithica is commonly found in some parts of France (Deux-Sevres, Provence), Lorraine and Luxemburg (BENECKE, 1905; QUENSTEDT, 1871), Southern Germany (ROTHPLETZ, 1886), Spain (Iberian and Costero-Catalan Ranges), and Morocco (GARDET & GERARD, 1946).

- Marini Subzone

Index - species: Rhynchonelloidella marini ROUSSELLE, 1975

Its lower boundary is defined by the mass occurrence of the index species, in the Thouarsense Zone (Thouarsense or Fascigerum Subzone), ranging

up to Insigne Zone (Insigne Subzone). Its upper boundary is delimited by the first occurrence of A. blakei, the index species however still persisting in the basin up to Pseudoradiosa Zone (Levesquei Subzone).

According to ROUSSELLE (1975) the holotype of the index species comes from Obón (Teruel, Iberian Range), Bifrons Zone. In turn, for the present authors its stratigraphic position would be slightly higher, the species having never been found below Thouarsense Zone. It usually appears associated to S. infraoolithica and S. stephanoides.

R. marini shows a remarkable facies dependency, being almost exclusively found in marly-limestone sediments. Outside the Iberian Range, it has been only reported from Lérida Pyrenees (CLUTSON, 1979), where Upper Toarcian sediments appear strikingly similar to that of central part of Iberian Range. On the other hand, it is not excluded that many specimens cited as H. cynocephala by various authors should be better accomodated within this species.

- Blakei Subzone

Index-species: Aulacothyris blakei (DAVIDSON, 1878)

The lower boundary of this subzone is delimited by the first occurrence of the index species, approximately at the uppermost part of Insigne Zone. Its stratigraphic range comprises the whole Pseudoradiosa Zone, some few specimens having eventually been found within Aalensis Zone.

The species, originally described in England, appears remarkably scarce in the European Province (DELANCE, 1974), its record being, however, much more abundant in the central part of Iberian Range, where its stratigraphic range (according to GOY, 1974; COMAS-RENGIFO & GOY, 1978; GARCIA-JORAL & GOY, 1984) appears slightly narrower than first assumed by previous authors. In the first levels of the Subzone it is still customarily recorded together with R. marini, and, as in the former Subzone, the main associated taxa are usually S. infraoolithica and S. stephanoides. The record of the species is, up to the present, limited to England and Iberian Range only.

		AMMONITES		BRACHIOPODS	
		ZONES	SUBZONES	ZONES	SUBZONES
AAL.	LOW.	OPALINUM	Comptum	CYNOCEPHALA	
			Opalinum		
TOARCIAN	UPPER	AALENSIS	Buckmani	INFRAOOLITHICA	
			Aalensis		Goyi
			Mactra		
		PSEUDORADIOSA	Pseudoradiosa		
			Levesquei		Blakei
		INSIGNE	Insigne		
			Fallaciosum		Marini
		THOUARSENSE	Fascigerum		
			Thouarsense		
			Bingmanni	JAUBERTI	
	MIDDLE	VARIABILIS	Vitiosa		
			Illustris		Vari
			Variabilis		
		BIFRONS	Semipolitum		
			Bifrons		
			Sublevisoni		Perfida
	LOWER	SERPENTINUS	Falcifer		
			Strangewaysi		Bouchardi
		TENUICOSTATUM	Semicelatum		
			Mirabile		
PLIENSBACHIAN	DOMERIAN	SPINATUM	Hawskerense	RESUPINATA	Quadrifida
			Solare		
		MARGARITATUS	Gibbosus		
			Subnodosus		Verneuili
		STOKESI	Celebratum		
			Monestieri		
	CARIXIAN	DAVOEI	Figulinum	NUMISMALIS	
			Capricornus		Darwini
			Maculatum		
		IBEX	Luridum		
			Valdani		
			Masseanum		Davidsoni
		JAMESONI	Jamesoni		
			Brevispina		
			Taylori		
SIN.	LOTH.	RARICOSTATUM		DUNROBINENSIS	

Fig. 3.- Proposed Brachiopod Zonal Scale for the Lias of the Iberian Range.

- Goyi Subzone

Index-species: Rhynchonelloidea goyi GARCIA-JORAL, 1983

This subzone comprises the uppermost part of Pseudoradiosa Zone and the major part of Aalensis Zone, where the index species is highly common. It is a typically Iberian taxa, the holotype coming from Villar de Cobeta (Guadalajara, Castilian Branch), and usually found together with S. infraoolithica, S. stephanoides and Loboidothyris nov. sp. Its record is, up to the present, limited to the Iberian Range. However, its presence both in Pyrenees and in Provence appears probable.

- CYNOCEPHALA ZONE

Index-species: Homoeorhynchia cynocephala (RICHARD, 1840)

Associated taxa: S. infraoolithica (DESL.), S. stephanoides ALM. & MOUL. and Loboidothyris nov. sp.

The species was elected as zonal index by TCHOUMATCHENCO (1967), assuming a stratigraphic range slightly wider than observed by the present authors in the Iberian Range, where it is rarely recorded below Aalensis Zone. It is specially abundant during Aalensis Zone (Buckmani Subzone) and Opalinum Zone.

Know from many different european areas, H. cynocephala appears broadly extended, from England and France, as far as Bulgaria.

CONCLUSIONS

From Sinemurian to Toarcian, a growing endemism can be detected within the Lias Brachiopods of Iberian Range.

The most important affinities with European Province are observed from Lotharingian to Carixian. During this interval, however, some several taxa of more meridional affinities are also found, the species C. ? davidsoni being of relevant stratigraphic interest for the Iberian Range and Majorca.

Meridional influences appear more important during Domerian, with the appearance of some "southern" species, such as P. verneuili, Z. (Z.) mariae meridiana, L. subpunctata (thomarensis morphotype), etc., providing a first shape of the so-called Spanish Province. Such province reaches its maximum extension during Lower and Middle Toarcian, with numerous characteristic taxa (A. iberica, L. punctata arcta, T. ? jauberti, T. pyrenaica, S. perfida, H. batalleri, H. meridionalis...). On the other hand, it should be also noted the presence of some taxa known from European Province (S. bouchardi, T. subconcinna...) displaying striking morphological particular features.

The specific diversity shows a remarkable decrease in Upper Toarcian, with the presence of many taxa geographically restricted, either to the Iberian Range (R. marini, R. goyi...) or to the Iberian Peninsula and Provence (S. stephanoides).

REFERENCES

AGER, D.V. (1956): A Monograph of the British liassic Rhynchonellidae. Part 1 Palaeont. Soc., 110: I-XXVI + 1-50.

AGER, D.V. (1959): Lower Jurassic brachiopods from Turkey. Journ. Paleont., 33: 1018-1028.

AGER, D.V. (1967): Some Mesozoic brachiopods in the Tethys region. In: "Aspects of Tethyan Biogeography". ADAMS, C.G. & AGER, D.V. (Eds.). Systematics Assoc. Publ., 7: 135-151.

AGER, D.V. & WALLEY, C.D. (1977): Mesozoic brachiopod migrations and the opening of the North Atlantic. Palaeogeog., Palaeoclim., Palaeoecol., 21: 85-99.

ALMERAS, Y. & ELMI, S. (1984): Fluctuations des peuplements d'Ammonites et de Brachiopodes en liaison avec les variations bathymétriques pendant le Jurassique inférieur et moyen en Mediterranée occidentale. Boll. Soc. Paleont. Ital., 21 (2,3): 169-188.

ALMERAS, Y. & MOULAN, G. (1979): Biostratigraphie des Terebratulidae et des Zeilleriidae du Lias et du Dogger de la Region Toulounnaisse (Var, France). Geobios, 12 (6): 893-897.

ALMERAS, Y. & MOULAN, G. (1982): Les Terebratulides liasiques de Provence (Paléontologie - Biostratigraphie - Paléoécologie - Phylogénie). Docum. Lab. Géol. Lyon, 86: 365 p.

ALVARO, M., CAPOTE, R. & VEGAS, R. (1979): Un modelo de evolución geotectónica para la Cadena Celtibérica. Ac. Geol. Hisp., Homenatge a Lluis Solé i Sabarís, 14: 172-177. (Publ. 1981).

BATALLER, J.R. (1926): Sur le Jurassique de la partie méridionale de la Catalogne (Puertos de Tortosa). Bull. Soc. géol. Fr., (4), 26: 101-116.

BATALLER, J.R. (1931): Las Spiriferina de las colecciones paleontológicas del IGME. Bull. Inst. Geol. Min. Esp., 52: 3-26.

BENECKE, E.W. (1905): Die Versteinerungen der Eisenerzformation von Deutsh-Lothringen und Luxemburg. Abh. Geol. Spezialkarte Elsass-Lothr. (n.f.) VI: 598 p.

CADILLAC, H., CANEROT, J. & FAURE, Ph. (1982): Le Jurassique inférieur aux confins del Iberides et des Catalanides (Espagne). Estudios Geol., 37: 187-198.

CALZADA, S. (1981): Niveles de Braquiópodos del Lías de Camarasa (Lérida). Cuad. Geol., 10: 197-211.

CALZADA, S. (1983): Sobre 3 variedades de Sphaeroidothyris jauberti (DESLONGCHAMPS). (Braquiópodo del Lías español). Trab. Mus. Geol. Semin. Barcelona, 206: 15 p.

CAPOTE, R., DIAZ MOLINA, M., GABALDON, V., GOMEZ, J.J., ROSSELL, J., RUIZ, P., SANCHEZ DE LA TORRE, L., SOPEÑA, A. & YEBENES, A. (1982): Evolución

sedimentológica y tectónica del Ciclo Alpino en el tercio Noroccidental de la Rama Castellana de la Cordillera Ibérica. Temas Geológico Mineros I.G.M.E., 5: 390 p.

CHARLES, R.P. (1948): Le Lias de la Basse Provence Occidentale. Etude paléontologique et paléobiologique. Thèse Doct. Univ. Aix-Marseille, 207 p.

CHOFFAT, P. (1880): Etude stratigraphique et paléontologique des terrains jurassiques du Portugal. 1ère livraison: Le Lias et le Dogger au Nord du Tage. Mém. Serv. Trav. Géol. Portugal, XII + 72 p.

CHOFFAT, P. (1947): Description de la faune jurassique du Portugal.- Brachiopodes. Serv. Geol. Portugal, 46 p.

CLUTSON, M.J. (1979): A study of some Early Jurassic Brachiopoda from the Central Spanish Pyrenees. Dpt. Geology Swansea (unpubl.)

COMAS-RENGIFO, M.J. (1982): El Pliensbachiense de la Cordillera Ibérica. Tesis Doctoral Univ. Complutense de Madrid, 594 p. (in litt.)

COMAS-RENGIFO, M.J. & GOY, A. (1975): Estratigrafía y Paleontología del Jurásico de Ribarredonda (Guadalajara). Estudios Geol., 31: 297-339.

COMAS-RENGIFO, M.J. & GOY, A. (1978): El Pliensbachiense y Toarciense en la Rambla del Salto (Sierra Palomera, Teruel). Grupo Esp. Mesozoico; Jur. Cord. Ibér., IV: 11 p.

DAHM, H. (1965): Stratigraphie und Paläogeographie im Kantabrischen Jura (Spanien). Beih. Geol. Jb., 44: 13-54.

DARESTE DE LA CHAVANNE, J. (1930): La region d'Oudjda. Monographie paléontologique des faunes liasiques et jurassiques du Maroc Nord-Oriental (Brachiopodes, Echinodermes, Lamellibranches et Gastropodes). Notes et Mem. Serv. Min. et Carte géol. Maroc, 16: 31-100.

DELANCE, J.H. (1969): Etude de quelques Brachiopodes liasiques du nord-est de l'Espagne. Ann. Paleontologie, 55 (1): 1-44.

DELANCE, J.H. (1972): Problèmes posés par la variation géographique des espèces, leurs implications stratigraphiques - exemples pris chez les Brachiopodes jurassiques. Mém. B.R.G.M., 77: 69-76.

DELANCE, J.H. (1974): Zeilleridés du Lias d'Europe occidentale (Brachiopodes) Mém. Géol. Univ. Dijon, 2: 406 p.

DESLONGCHAMPS, E.E. (1863): Etudes critiques sur des Brachiopodes nouveaux ou peu connus. VII. Brachiopodes recueillis par M. de Verneuil dans le Lias d'Espagne. Bull. Soc. linn. Normandie, 8: 64-76.

DI STEFANO, G. (1891): Il Lias medio del M. San Giuliano (Erice) presso trapani. Atti Accad. Gioenia Sci. Nat. Catania, (4), 3: 121-270.

DUBAR, G. (1925): Etudes sur le Lias des Pyrénées françaises. Mem. Soc. Geol. Nord., 9 (1): 332 p.

DUBAR, G. (1931): Brachiopodes liasiques de Catalogne et des régions voisines. Bull. Inst. Catal. Hist. Nat., 31: 103-180.

DUBAR, G. In TERMIER, H. & DUBAR, G. (1940): Notice explicative de la Carte géologique provisoire du Moyen Atlas Septentrional. Notes & Mem. Serv.

géol. Maroc, 24 bis: 74 p.

DUBAR, G. (1943): Notice explicative de la Carte géologique provisoire du Haut-Atlas de Midelt. Notes & Mem. Serv. géol. Maroc, 59: 58 p.

ELMI, S., ALMERAS, Y., AMEUR, M., ATROPS, F., BENHAMOU, M. & MOULAN, G. (1982): La dislocation des plates-formes carbonatées liasiques en Mediterranée Occidentale et ses implications sur les échanges fauniques. Bull. Soc. géol. France, (7), 24 (5-6): 1007-1016.

GARCIA-JORAL, F. (1983): Caracterización de Rhynchonelloidea goyi n. sp. (Brachiopoda, Rhynchonellidae) del Toarciense superior en la Cordillera Ibérica (NE. de España). Bol. R. Soc. Esp. Hist. Nat. (Geol.), 80: 89-103.

GARCIA-JORAL, F. & GOY, A. (1984): Características de la fauna de Braquiópodos del Toarciense Superior en el Sector Central de la Cordillera Ibérica (NE. de España). Estudios Geol., 38. (in litt.).

GARDET, G. & GERARD, Ch. (1946): Contribution à l'étude paléontologique du Moyen-Atlas septentrional. Not. & Mém. Serv. Geol. Maroc, 64: 85 p.

GAUTIER, F. & MOUTERDE, R. (1964): Lacunes et irrégularités des depôts à la limite du Jurassique inférieur et du Jurassique moyen de la bordure nord des Chaînes Ibériques (Espagne). C.R. Acad. Sc. Paris, 258 (11): 3064-3067.

GOMEZ, J.J. (1979): El Jurásico en facies carbonatadas del Sector Levantino de la Cordillera Ibérica. Seminarios de Estratigrafía, Ser. Mon., 4: 683 p.

GOURION, A. (1960): Revision de certains Brachiopodes liasiques de l'Ouest de l'Algèrie. Publ. Serv. Carte geol. Algérie, 28: 68-148.

GOY, A. (1974): El Lías de la mitad Norte de la Rama Castellana de la Cordillera Ibérica. Tesis Doct. Fac. Geología, Univ. Complutense, XV + 940 p. (unpubl.). Abstract: Publ. Dpto. Paleont. Univ. Compl. Madrid, 14: 35 p.

GOY, A. & ROBLES, F. (1971): Resultado de un estudio sobre braquiópodos liásicos del NE de Guadalajara. Vol. Extr. I Cent. R. Soc. Esp. Hist. Nat. 1: 243-254.

HALLAM, A. (1972): Diversity and density characteristics of Pliensbachian-Toarcian molluscan and brachiopod faunas of the North Atlantic margins. Lethaia, 5: 389-412.

JAWORSKI, E. (1926): La fauna del Lías y Dogger de la Cordillera Argentina en la parte meridional de la provincia de Mendoza. Act. acad. Nac. Ciencias Córdoba, 9: 135-317.

QUENSTEDT, F.A. (1871): Petrefactenkunde Deutschlands. Die Brachiopoden. Fuess édit., 748 p.

REVERT, J. (1971): Les Brachiopodes du Lias moyen du bassin des Causses. Etude biostratigraphique. Géobios, 4 (3): 199-222.

REVERT, J. & TCHOUMATCHENCO, P.V. (1973): Les zones de brachiopodes du Lias en Bulgarie et dans le sud de la France (bassin des Causses): Essai de corrélation. Doc. Lab. Geol. Fac. Sci. Lyon, 56: 181-191.

ROTHPLETZ, A. (1886): Geologisch-Paleontologische Monographie der Vilser Alpen mit besonder Berücksichtigung der Brachiopoden Systematik. Palaeontographica, 33: 180 p.

ROUSSELLE, L. (1974): Le genre Stolmorhynchia (Rhynchonellacea) dans le Lias supérieur du Haut Atlas central et oriental (Maroc). Not. Serv. Géol. Maroc, 36 (264): 141-151.

ROUSSELLE, L. (1975): Présence du genre Rhynchonelloidella (Brachiopodes, Rhynchonellacea) dans le Toarcien moyen d'Espagne (Chaîne Celtiberique orientale). Description de Rhynchonelloidella marini nov. sp. Géobios, 8 (2): 139-142.

SIBLIK, M. (1966): The brachiopods of the Kostelec-Klippe. Géol. práce, 38: 137-157.

SUAREZ-VEGA, L.C. (1974): Estratigrafía del Jurásico en Asturias. Cuad. Geol. Ibér., 3 (1-2): 304 p.

TCHOUMATCHENCO, P.V. (1967): Notes sur la répartition stratigraphique des Brachiopodes du Jurassique inférieur dans les Balkanides centrales et occidentales (Bulgarie). Coll. Jurassique Luxembourg, 1967. Mém. B.R. G.M., 75 (1971): 183-187.

TCHOUMATCHENCO, P.V. (1972): Repartition stratigraphique des Brachiopodes du Jurassique inférieur du Balcan Central et Occidental et du Kraiste (Bulgarie). Bull. Geol. Inst., Ser. Strat. and Lithol., 21: 63-84.

THEVENIN, A. (1908): Paleontologie de Madagascar. Pt. V: Fossiles liasiques. Ann. Paléont., 3: 105-143.

TORRUBIA, P.J. (1754): Aparato para la historia natural española.

VÖRÖS, A. (1980): Lower and Middle Jurassic brachiopod provinces in the Western Tethys. Földtani Közlöny, Bull. Hung. Geol. Soc., 110 (3-4): 395-416.

OSTRACOD BIOSTRATIGRAPHY OF THE UPPER TOARCIAN IN SOUTHERN GERMANY

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OSTRACOD BIOSTRATIGRAPHY OF THE UPPER TOARCIAN IN SOUTHERN GERMANY

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Abstract: The upper Toarcian of Southern Germany can be devided into ten zones by means of ostracods. The boundary between the lower and the upper Toarcian can be drawn by ostracod stratigraphy and can be correlated with that between the **crassum**-and the **variabilis**-subzone. The boundary between the Toarcian and the Aalenian can also be drawn by means of ostracods, but it does not coincide exactly with the ammonite subdivision.

Introduction

The first complete ostracod stratigraphy of the upper Toarcian in Southern Germany has been established by KNITTER (1983). Meanwhile some new profiles have been examined for ostracods as well as for ammonites, which show almost complete sections of the highest parts of lower Toarcian to lower Aalenian strata (KNITTER and OHMERT, 1983; KNITTER and RIEGRAF, 1984). These profiles have shown that some of the ranges of stratigraphical distribution of upper Toarcian ostracods differ slightly from the data given by KNITTER (1983). A further result of the two profiles mentioned above is the possibility to draw a boundary between lower and upper Toarcian strata, i. e. between the **crassum**- and the **variabilis**-subzone, by means of ostracods also.

Ostracod Stratigraphy

The Toarcian in general shows a change in ostracod distribution, which does not coincide with the stratigraphic division in its lower and upper part. At the beginning of the **falciferum**-zone of the lower Toarcian a dramatic change in faunal composition of ostracods occurs

(RIEGRAF, 1985) which can be correlated to the same event in foraminiferal associations (BARTENSTEIN and BRAND, 1937). At this point the ostracod genera of the family Healdiidae, which have been so characteristic for the Pliensbachian and the lower parts of the lower Toarcian, vanish completely. During the, in micropalaeontological sense, almost unfossiliferous **falciferum**-zone of the lower Toarcian a new faunal composition is established, giving a ground stock for the faunas of the upper parts of the lower Toarcian, the upper Toarcian and the higher parts of the Jurassic system.

The ranges of ostracod species in the upper Toarcian are listed in fig. 1. The dashed lines are for those species, which do not have any stratigraphic value for the subdivision of this substage. The thin complete lines characterize those species, which have a minor stratigraphic value because of their merely episodic stratigraphic and local occurrence. They can be used to support the stratigraphic subdivision, but should not be used to establish a stratigraphy by means of themselves. The ranges of species used here for stratigraphic separation of the lower from the upper Toarcian or for further subdivision of the upper Toarcian are marked by a thick line.

The boundary between the lower and upper Toarcian is not characterized by a dramatic change in ostracod associations. Only some new species occur, giving a chance to draw a boundary between the two substages also by means of ostracods. These species are **Supratoarcina supratoarcensis** KNITTER, 1984 and **Ektyphocythere bucki** (BIZON, 1960). They are index fossils of the first ostracod-zone of the Upper Toarcian, which ranges from the lowest to the higher **variabilis**--subzone.

The end of the first zone is characterized by lack of **Ektyphocythere bucki** (BIZON, 1960), which has been proven to be very constant in its stratigraphical level. Since no new species occur, this is the only possibility for drawing a boundary. This zone comprises a rather long section of the upper Toarcian, reaching as high as the lower **fallaciosum**-subzone. Charcteristic ostracod species, but not index fossils, are the species **Cytherelloidea praecadomensis** KNITTER, 1984, **Kinkelinella costata** KNITTER, 1983, **Kinkelinella sermoisensis** (BIZON, 1960), and **Praeschuleridea aspera** KNITTER, 1983, which occur in almost

every sample from this strigraphic level. All three species have been recorded even from the lower Toarcian (BATE and COLEMAN, 1975; KNITTER and RIEGRAF, 1984, RIEGRAF, 1985).

The third zone begins with the first occurrence of **Cytheropterina cribra** (FISCHER, 1962) and **Infracytheropteron groissi** KNITTER, 1984 reaching up to the higher **fallaciosum**-subzone.

At this stratigraphic level **Otocythere callosa** TRIEBEL and KLINGLER, 1959 appears. Also **Kinkelinella fischeri** MALZ, 1966 can be recorded for the first time (see also below). From this time on the diversities of ostracod faunal composition increases, while in the lower parts of the upper Toarcian the number of ostracod species in almost every sample is small.

The next ostracod zone begins in the higher **insigne**-subzone with the first occurrence of the species **Ektyphocythere furcata** (Wienholz, 1967) and ends in the **dispansum**-subzone, where **Cytherelloidea cadomensis** BIZON, 1960 appears reaching up to the lower **levesquei**-subzone.

The top of the former zone is marked by the first appearance of **Praeschuleridea gallemannica** MALZ, 1966 and **Praeschuleridea punctulata** (PLUMHOFF, 1963). This zone ends in the lower **moorei**-subzone.

With the first occurrence of **Praeschuleridea ventriosa** (PLUMHOFF, 1963) the next ostracod zone begins. Within this zone the species **Ektyphocythere furcata** (WIEN-HOLZ, 1967) and **Praeschuleridea gallemannica** MALZ, 1966 die out. The end of the range of these two species as well as the extinction of **Praeschuleridea aspera** KNITTER, 1983 in the zone below should not be used for stratigraphic purpose anymore, because the stratigraphic level where this happens varies in different localities.

In the middle of the **aalensis**-subzone the ostracod species **Aphelocythere ramosa** FISCHER, 1961 appears, beginning the next zone. Sometimes this species is very rare, whereas in other profiles it is a abundant and very useful tool for the stratigraphic subdivision of the **aalensis**-subzone.

The highest stratigraphic marker in the upper Toarcian is the occurrence of **Aphelocythere kuhni** TRIEBEL and KLINGLER, 1959 which always occurs in the highest **aalensis**-subzone just below the Liassic/Dogger boundary, defined by ammonite stratigraphy

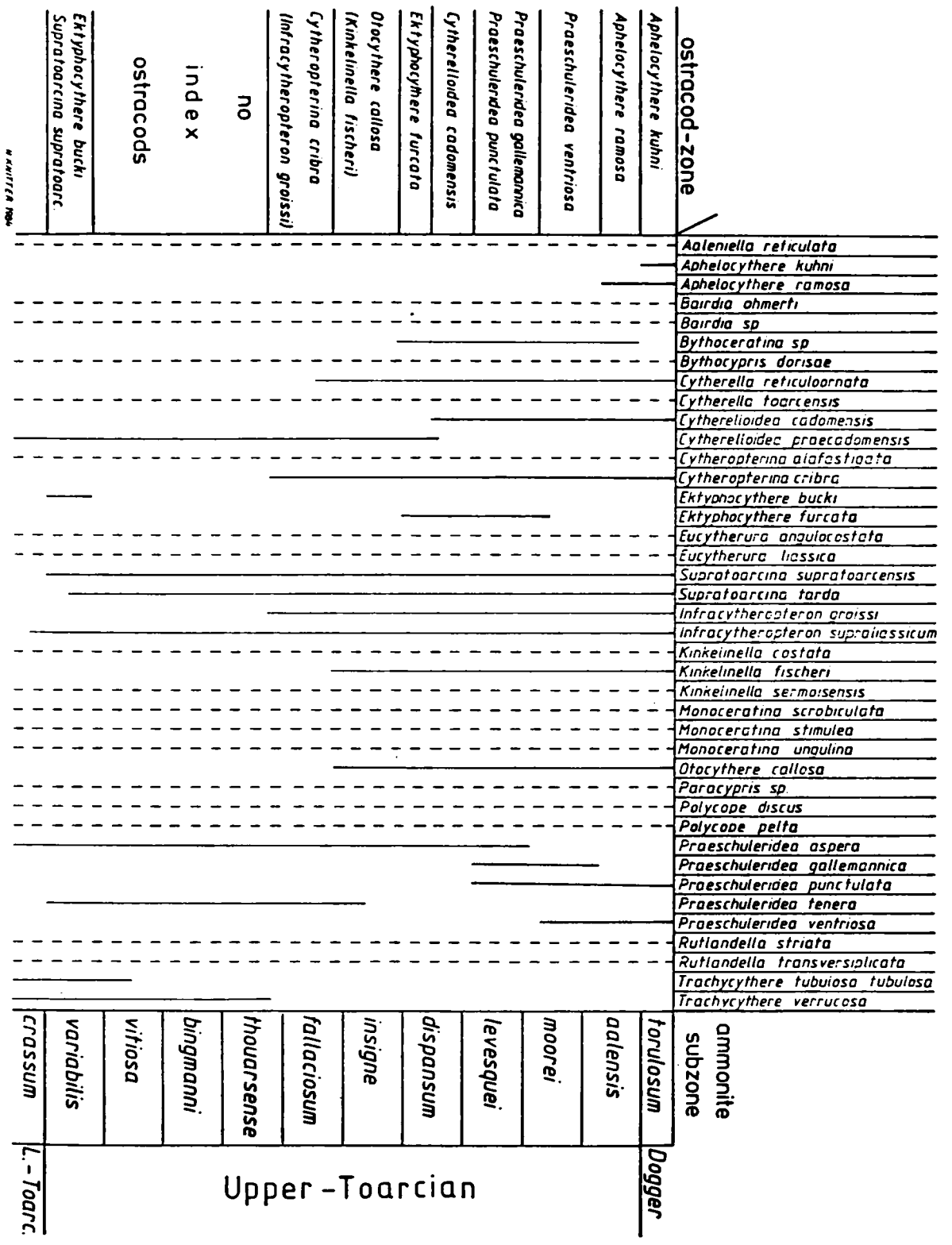

Fig. 1: Upper Toarcian Ostracod zonation and stratigraphical distribution of Ostracod species.

Discussion

Some data from KNITTER (1983) had to be revised. The species **Ektyphocythere bucki** (BIZON, 1960) is described in that paper as **Ektyphocythere debilis** BATE and COLEMAN, 1975. However, the latter has been proven to occur only in lower Toarcian strata (RIEGRAF, personal communication), whereas **Ektyphocythere bucki** seems to be a good stratigraphic index fossil for the lower and middle **variabilis**-subzone. The other species used here as stratigraphic index fossils are less precise, because their first occurrence seems to be influenced ecologically and cannot always be recorded. As mentioned above the species **Kinkelinella costata** KNITTER, 1983 and **Praeschuleridea aspera** KNITTER, 1983 already appear in the **crassum**-subzone of the lower Toarcian (KNITTER and RIEGRAF, 1984; RIEGRAF, 1985) and therefore cannot be used for the separation of lower and upper Toarcian strata.

The complete lower part of the upper Toarcian shows some problems in ostracod stratigraphy. Until the lower **fallaciosum**-subzone ostracod diversity differs very greatly and often is very low. The only possibility of zonation is the use of the extinction of **Ektyphocythere bucki** in the higher **variabilis**-zone, a date that has been proven to be very precise in all sections examined. No other new species occurs until the lower **fallaciosum**-subzone. In Franconia the upper Toarcian until the **dispansum**-subzone does not contain ostracods at all, therefore no stratigraphical statements nor those about ostracod distribution in this area can be made (KNITTER, 1983).

The higher ostracod zones are well defined by characteristic species. One problem is the first occurrence of **Kinkelinella fischeri** MALZ, 1966, which derives from **Kinkelinella sermoisensis** (BIZON, 1960). The transition between these two species is very gradual and the limit can only be drawn subjectively. **Kinkelinella sermoisensis** has a characteristic irregular polygonal ornamentation on the surface of the valves, while **Kinkelinella fischeri** shows a roofshaped arrangement of these polygonal fields. The phylogenetic older specimens of **Kinkelinella fischeri** often are not to be distinguished from **Kinkelinella sermoisensis**. The problem is where to draw the line between these closely related species. Fortunately another well distinguishable species, **Otocythere callosa** TRIEBEL and KLINGLER, 1959 appears during the time where the transition between these two species happens. Finding out the proper criteria for separating the two species exactly, I leave to other ostracod workers. Nevertheless, this phenomenon is

very interesting in comparison with another transition between two, respectively three, species occuring in upper Toarcian strata. The species **Praeschuleridea gallemannica** MALZ, 1966 has its ancestor in **Praeschuleridea aspera** KNITTER, 1983, and **Praeschuleridea ventriosa** (PLUMHOFF, 1963) can be derived from **Praeschuleridea gallemannica**. These transitions are very sharp and no continuous change of features can be recorded. The reason of the differences may be the way that the change in ornamentation is made. In the transitional line **Kinkelinella sermoisensis-Kinkelinella fischeri** a complete new arrangement of the polygonal pits can be recorded. In the transitional line **Praeschuleridea aspera-P. gallemannica-P. ventriosa** the number of pits of the ornamentation is changed by doubling some rows of pits respectively reducing them. The ornamentation of the valves is a result of the arrangement of the cells of the cuticula inside the valves. Therefore, a complete rearrangement of cells needs more time to be established than the simple doubling or reducing of cells. The stratigraphic result of this mechanism is the sudden appearance of **Praeschuleridea gallemannica** respectively **Praeschuleridea ventriosa**, which therefore can be used as better index fossils than **Kinkelinella fischeri**.

As already mentioned the zones where species of the genus **Praeschuleridea** are index fossils have well defined boundaries. The co-occurrence of **Praeschuleridea aspera** and **Praeschuleridea ventriosa** could only be recorded in some profiles (e. g. KNITTER and OHMERT, 1983), where the thickness of the **aalensis**-subzone exceeds ten meters. This fact offered the possilbility for a detailed sampling, which may be the reason of clearer determination of the ranges of these two species. Perhaps also the extinction of **Praeschuleridea aspera** happens at different times in different localities. Therefore, the upper end of the range of **Praeschuleridea aspera** should not be used for stratigraphic subdivision any longer. The same facts can be recorded for the species **Ektyphocythere furcata** and **Praeschuleridea gallemannica**, whose extinction can not be determined as precisely as in the case of **Ektyphocythere bucki** in the higher **variabilis**-subzone.

The Liassic/Dogger boundary can not be determined as exactly as that between the lower and upper Toarcian. The only ostracod species appearing close below this level is **Aphelocythere kuhni** TRIEBEL and KLINGLER, 1959. Its occurrence always just below this boundary is very constant all over Southern Germany. This ostracod species ought to be used

to define the micropaleontological Lias/Dogger boundary with respect to the fact that this boundary does not coincide exactly with the ammonite zonation.

Acknowlegdement

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Literature

BARTENSTEIN, H. & BRAND, E. (1937): Mikro-paläontologische Untersuchungen zur Stratigraphie des nordwest-deutschen Lias und Dogger. -Abh. senckenb. naturf. Ges., 439, 1-224, 20 pl., 20 figs., 5 tabs., Frankfurt a. M.

BATE, R. H. & COLEMAN, B. E. (1975): Upper Lias Ostracoda from Rutland and Huntingdonshire. - Bull. Geol. Surv. (G. B.), 55, 1-42, 27 pl., 42 figs., 2 tabs., London.

KNITTER, H. (1983): Biostratigraphische Untersuchungen mit Ostracoden in Toarcien Süddeutschlands. - Facies, 8, 213-262, pl. 34-40, 4 figs., Erlangen.

-- (1984): Nomenklatorische Bemerkungen zu einigen Ostracodenarten aus dem oberen Lias Süddeutschlands. - Jh. geol. Landesamt Baden-Württemberg, 26, 1 pl., Freiburg i. Br. (in press).

KNITTER, H. & OHMERT, W. (1983): Das Toarcium an der Schwärze bei Badenweiler (Oberrheingebiet S Freiburg). - Jh. geol. Landesamt Baden-Württemberg, 25, 233-281, 5 pl., 6 figs., Freiburg i. Br.

KNITTER, H. & RIEGRAF, W. (1984): Biostratigraphie (Cephalopoden, Ostracoden) des Oberen Toarcium von Blumberg-Achdorf (Wutach) und Weilheim/Teck (Baden-Württemberg). -Jh. geol. Landesamt Baden-Württemberg, 26, Freiburg i. Br. (in press).

Riegraf, W. (1985): Mikrofauna, Biostratigraphie und Fazies im Unteren Toarcium Südwestdeutschlands und Vergleiche mit benachbarten Gebieten. - Thesis Univ. Tübingen (manuscript, in preparation).

PROBLEMS AT THE TOARCIAN/AALENIAN BOUNDARY

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PROBLEMS AT THE TOARCIAN/AALENIAN BOUNDARY

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In noncondensed sections of Southwestern Germany as well as of Western France Pachylytoceras torulosum obviously proves to precede Leioceras opalinum. Its range coincides with the modern 'buckmani subzone' placed in the uppermost Liassic in contradiction to the original intention of OPPEL (1856-58) and MAYER (1864).

Introduction

There are no problems at the Toarcian/Aalenian boundary in many regions, as for instance in the Aalen-area or in Northwestern Germany. There are no problems wherever those beds are condensed or even reworked. In such sections Leioceras opalinum (REINECKE) appears together with Pachylytoceras torulosum (ZIETEN) and some reworked late Pleydellia, sometimes even together with Pleydellia aalensis (ZIETEN).

But problems rise in less condensed sections and especially where these beds reach considerable thicknesses, as for instance in the Rhinegraben area. I think just those sections should be of superior interest for the studies of such a boundary. The only handicap in the Rhinegraben is the poor outcrops in the clays and marls of these stratigraphical units, called 'Jurensismergel' and 'Opalinuston'. Therefore in 1982/83 a new artifical exposure near Badenweiler was welcome. The results are published by KNITTER & OHMERT (1983).

For this purpose also the material of KLÖCKER (1966/67) was studied once again. Further material could be gained from KLÖCKER's section, an old clay pit south of Freiburg, still accessible.

	general	Rhinegraben	Rhinegraben	general	Rhinegraben	Toarcian Type Loc.	Aalenian Type Loc.	Rhinegraben	
	OPPEL 1856-58 MAYER 1864	THÉOBALD & MAUBEUGE 1949	SCHIRARDIN 1961	Colloque Jurassique Luxembourg 1962	KLÖCKER 1967	GABILLY 1976	DIETL & ETZOLD 1977	KNITTER & OHMERT 1983	
Aalenian	Zone der Trigonia navis	opalinum	Cotteswoldia costulata + Cotteswoldia crinita	Leioceras opalinum	Leioceras opalinum	opalinum	(with Pl.fluitans) Leioceras opalinum + Pachylytoceras torulosum	Leioceras opalinum	Middle Jurassic
						subglabrum			
	Zone des Amm. torulosus	Lytoceras torulosum		Pleydellia aalensis	L.opalinum* +L.costosum**	buckmani (with torulosum)		(with Pleydellia lotharingica) Pachylytoceras torulosum (with Pl.-fluitans)	
					L.opalinum*+ Pleyd.fluitans				
					L.opalinum,* +Pleyd.fluitans+Pachylytoceras torulosum				
Toarcian	Zone des Ammonites jurensis	Pl.aalensis	Pleydellia aalensis		Pleydellia aalensis + Pleydellia subcompta	aalensis	Pleydellia aalensis + Dumortieria moorei	Pleydellia aalensis	Lower Jurassic
		D.radiosa	Dumortieria radiosa			mactra		Dumortieria moorei	
						pseudo-radiosa			
			Dumortieria levesquei			levesquei		Dumortieria levesquei	
			dispansum					Phlyseogrammoceras dispansum	

* = Pleydellia ex.gr.buckmani
** = Pl.lotharingica

tab. 1 zonal/subzonal division and position of the Toarcian/Aalenian boundary (===) in the Upper Rhinegraben.

The problem

I will not resume the numerous efforts here again, made to solve the problems with this boundary. They are composed for instance by SAPUNOV (1964) or by RIEBER (1977). For the Rhinegraben area the different suggestions are listed in table 1. I only want to refer to the general attempt of the first Colloque du Jurassique at Luxembourg (1964, p. 84), where the opalinum zone has been recommended as the basal zone of the Aalenium. This recommendation has been believed to correspond with the original intention of MAYER when he established the Aalenian in 1864 (see DUBAR, ELMI, MOUTERDE & RUGET-PERROT 1971, p. 397). But GABILLY & RIOULT (1971, p. 391) already have shown that Pachylytoceras torulosum (ZIETEN), used as the index fossil for the basal Aalenian by MAYER (and before him by OPPEL 1856-58 for the Lower-/Middle Jurassic boundary), precedes Leioceras opalinum (REINECKE) in the Toarcian type area of Central Western France. These torulosum beds were put into the subzone of Pleydellia buckmani MAUBEUGE and into the uppermost Toarcian by GABILLY, ELMI, MATTEI, MOUTERDE & RIOULT (1971, p. 626), without refering to OPPEL's torulosum zone, which should have the priority.

New investigations in Southwestern Germany

A similar distribution of torulosum has been observed by KLÖCKER (1966/67) in the Rhinegraben south of Freiburg. But due to some misleading determinations of Pleydellia species (corrected by CONTINI 1970, p. 55 and by KNITTER & OHMERT 1983, p. 257 ff.) opalinum seemed to share its range partly with torulosum. Therefore only little attention has been payed to these results up to now. Meanwhile new samples of the Badenweiler section have confirmed and completed these observations (KNITTER & OHMERT 1983). The sheme of distribution patterns in the Rhinegraben area is given in fig.1. Therein cross-sections mark the levels with uncompressed specimens, thick vertical lines mean compressed material. Dashed lines are assumed relations. This sheme corresponds with the main distribution patterns from the Toarcian type area as recorded by GABILLY (1976). Moreover it could be verified in condensed sections of the Swabian Alb by KNITTER & OHMERT (1983).

In the Rhinegraben sections the genus Pleydellia can be seen to appear for the first time in the uppermost levesquei zone (moorei subzone) and

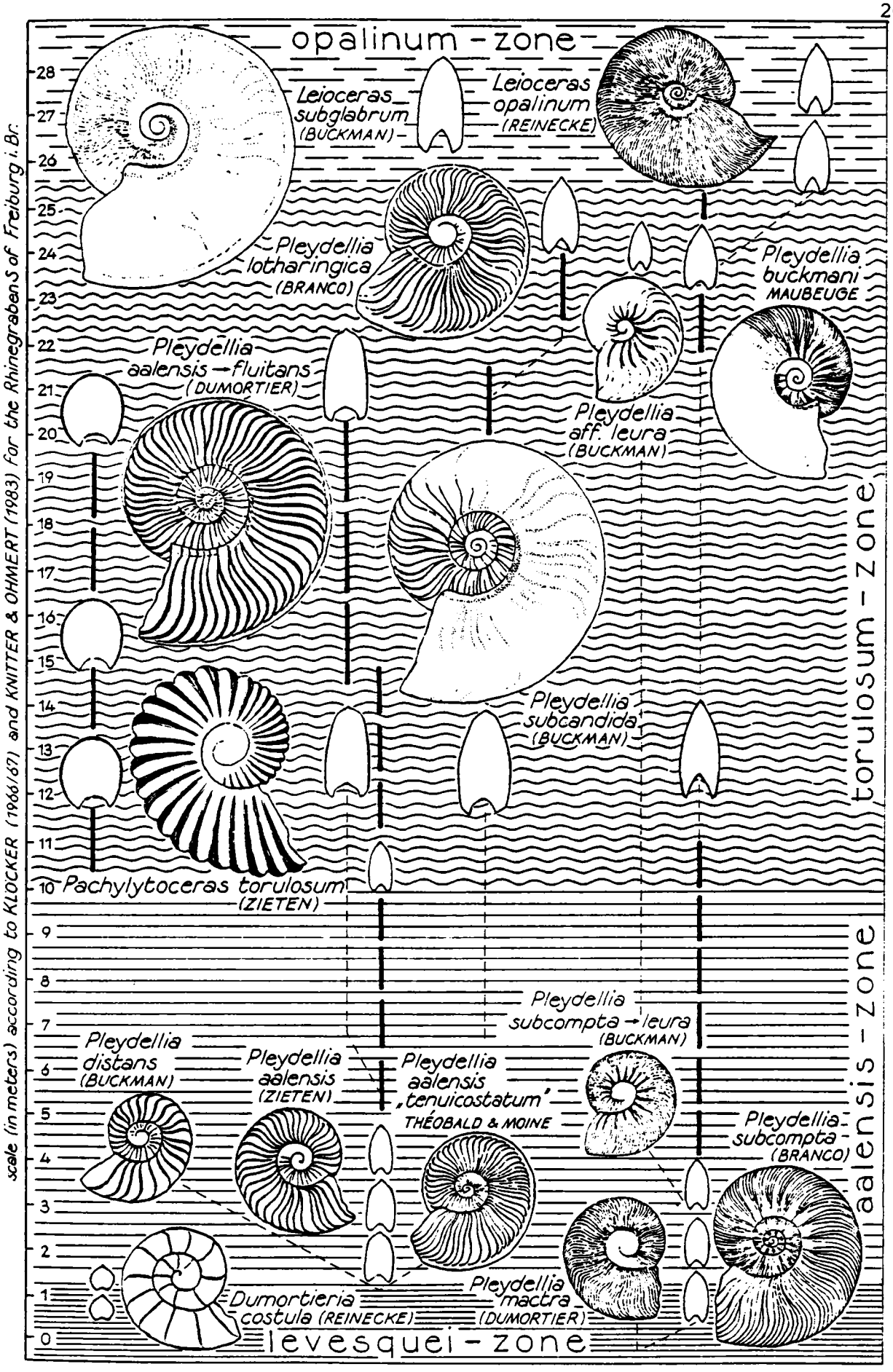

fig. 1: distribution of the main species at the Toarcian/ Aalenian boundary in the Rhinegraben area.

then to spread in the lowermost aalensis zone with numerous forms of different ribbing patterns. Those reach from wide-ribbed species as Pl. distans (BUCKMAN) to narrow-ribbed forms as the 'tenuicostatum' type of THEOBALD & MOINE and the extremely fine-ribbed Pl. mactra (DUMORTIER). All of them have a broadly rounded venter which sharpens soon within the aalensis zone. So Pl. buckmani MAUBEUGE can be traced to descend already early in the aalensis zone from Pl. subcompta (BRANCO) with its fasciated fine ribbs, as mentioned by GABILLY (1976, p. 18).

Coarse-ribbed forms with stout venter lead to the group of Pl. fluitans (DUMORTIER) in the beds with Pachylytoceras torulosum (ZIETEN); those with fading ribbs on the body chamber lead to Pl. subcandida (BUCKMAN) (= Pleydellia fluitans of KLÖCKER 1967 partly; fig. 16b, not fig. 16a and fig. 15; the characteristic cross-section of KLÖCKER's specimen is shown in fig. 1 of this paper) and to related forms, which all have a marked umbilical slope.

On the top of the torulosum beds there follow some meters of sediment wherein neither torulosum nor Leioceras opalinum are proved. This level is characterised by Pleydellia lotharingica (BRANCO) (= Leioceras costosum of KLÖCKER 1967) showing similar differentiated ribbing patterns like the older aalensis group which is extinct now. In fig. 1 a rather fine-ribbed specimen is shown, corresponding to Pl. 'misera' (BUCKMAN). In these very fossiliferous layers all transitions to coarser ribbed forms like the type of lotharingica, even to speciemens with single prominent umbilical ribbs, given here as Pl. aff. leura (BUCKMAN) can be found.

Leioceras opalinum (REINECKE) does not appear but above the 'lotharingica- beds'. So the range of torulosum obviously precedes the opalinum zone.

The torulosum zone

This zone, introduced by OPPEL (1856-58), approximately corresponds with the buckmani subzone in the sense of GABILLY, ELMI, MATTEI, MOUTERDE & RIOULT (1971) (introduced by THEOBALD & MAUBEUGE 1949, p. 282 for the first time) and therefore should have the priority, apart from its stratigraphic position whether in the Toarcian or in the Aalenian.

There have been repeated objections against torulosum as index fossil refering to its scarcity, its restricted occurence or its assumed persistent range. But a lot of index fossils only occur scarcely and in restricted faunal provinces. The range of torulosum proves to be distinct enough and also other Lytoceras species seem to be reliable time markers (for instance in the Upper Toarcian L. sublineatum in the lower variabilis zone, L. jurense in the thouarsense zone and Holcolytoceras coarctatum and H. germaini in the insigne zone). In the lowermost meters of the torulosum range of the Rhinegraben sections, torulosum is accompanied by Pl. aalensis, which passes upwards into Pl. fluitans. Also Pl. subcandida and Pl. buckmani belong to this assemblage, as mentioned above.

Of course the exact range of torulosum should be examined in as many scections as possible. In the Rhinegraben sections it is not found any more in the 'lotharingica-beds' despite of their rich fauna. Nevertheless here these beds are placed into the torulosum zone as they do not contain opalinum yet. Pleydellia buckmani, still present herein, was observed to originate already in the early aalensis zone (see above). Therefore it seems to be less suitable as index fossil for these beds.

Following the recommendations of the Colloque du Jurassique at Luxembourg (1964) the position of the torulosum zone consequently would be the uppermost Toarcian. But we have to realize that this is in contradiction to the original intention of MAYER an OPPEL.

References

Colloque du Jurassique, Luxembourg, 1962 (1964): Recommendations, pp. 84-86.- Vol. C.R. et Mem.Inst. Grand-Ducal, Sect. Sc. nat., phys., math.; Luxembourg.

CONTINI, D. (1970): L'Aalenien et le Bajocien du Jura franc-comptois. Etude stratigraphique.- Annales Sc. Univ. Besancon, 3. Ser., Geologie, 11, 204 pp., 56 figs., 24 pls.; Besancon.

DIETL, G. & ETZOLD, A. (1977): The Aalenian at the Type Locality.- Stuttgarter Beitr. Naturk., B 30, 13 pp., 3 figs., 2 pls.; Stuttgart.

DUBAR, G., ELMI, S., MOUTERDE, R. & RUGET-PERROT, CH. (1971): Divisions et limites de l'Aalenien (Sud-Est de la France et quelques regions meridionales).- Colloque du Jurassique, Luxembourg, 1967, Mem. B.R.G.M., Fr., 75, pp. 397-410; Paris.

GABILLY, J. (1976): Le Toarcien a Thours et dans le Centre-Ouest de la France. Biostratigraphie - Evolution de la faune (Harpoceratinae, Hildoceratinae).- Les stratotypes francais, 3, 217 pp., 52 figs., 18 tabs., 29 pls.; Paris (CNRS).

GABILLY, J., ELMI, S., MATTEI, J., MOUTERDE, R. & RIOULT, M. (1971): L'etage Toarcien, zones et sous-zones d'Ammonites.- Colloque du Jurassique, Luxembourg, 1967; Mem. B.R.G.M., Fr., 75, pp. 605-634, 1 tab.; Paris.

GABILLY, J. & RIOULT, M. (1971): Le Bajocien Inferieur et le Toarcien Superieur sur les bordures du Massif Armoricain, Limite entre le Jurassique Inferieur et le Jurassique Moyen, Probleme de l'Aalenien.- Colloque du Jurassique, Luxembourg, 1967; Mem. B.R.G.M., Fr. pp. 385-396, Paris.

KLÖCKER, P. (1966): Faunistische und feinstratigraphische Untersuchungen an der Lias-Dogger-Grenze am Schönberg bei Freiburg i.Br. 1. Teil: Profil und Fauna (Lamellibranchiata und Gastropoda).- Ber. naturf. Ges. Freiburg i.Br., 56, pp. 209-248, 10 figs., 5 tabs., 1 section; Freiburg i. Br.

- (1967): 2. Teil: Fauna (Ammonoidea) und Stratigraphie.- Ibidem, 57, pp. 69-118, 18 figs., 8 tabs.; Freiburg i. Br.

KNITTER, H. & OHMERT, W. (1983): Das Toarcium an der Schwärze bei Badenweiler (Oberrheingebiet S Freiburg).- Jh. geol. Landesamt Baden-Württ., 25, pp. 233-281, 6 figs., 5 pls.; Freiburg i. Br.

MAYER, CH. (1864): Tableau synchronistique des terrains jurassiques; Zürich.

OPPEL, A. (1856-1858): Die Juraformation Englands, Frankreichs und des südwestlichen Deutschlands.- Jh. Ver. vaterl. Naturk. Württ., 12-14, 857 pp., 1 tab., 1 geol. map; Stuttgart.

RIEBER, H. (1977): Remarks to the Aalenian of the Swabian Alb.- Stuttgarter Beitr. Naturk., B. 29, 5 pp., 2 tab.; Stuttgart.

SAPUNOV, I.G. (1964): Notes on the boundary between the Lower and Middle Jurassic and on the stage term Aalenian.- Colloque du Jurassique, Luxemburg, 1962, Vol. C.R. et Mem. Inst. Grand-Ducal, Sect. Sc. nat., phys., math.; pp. 221-228, 2 tabs.; Luxembourg.

THEOBALD, N. & MAUBEUGE, P.L. (1949): Paleographie du Jurassique inferieur et moyen dans le Nord-Est de la France et le Sud-Ouest de l'Allemagne.- Ber. naturf. Ges. Freiburg i. Br., 39, pp. 249-320, 1 fig., 2 tabs., 5 maps., 3 pls.; Freiburg i. Br.

FACIAL AND EVENT CORRELATIONS IN THE POLISH LOWER JURASSIC - SOME CONTRIBUTIONS TO THE STRATIGRAPHY OF MARINE - MARGIN AND NON - MARINE DEPOSITS

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FACIAL AND EVENT CORRELATIONS IN THE POLISH LOWER JURASSIC - SOME CONTRIBUTIONS TO THE STRATIGRAPHY OF MARINE - MARGIN AND NON - MARINE DEPOSITS

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Liassic deposits occuring in the Northern Slope of the Holy Cross Mountains /Fig.1, in the frame/ represent the most eastern margin of the Liassic Basin in Europe. They constitute an extension of the liassic sedimentary cover along the Danish - Polish Through. In Western Poland the liassic formations do not occur on the surface - they have become accessible owing to the drilling of many boreholes /Dadlez 1969/. The Holy Cross Lower Liassic appears on the surface and additionally 27 shallow boreholes have been examined. Obtained results allowed to choose Holy Cross Lower Liassic as a model for sedimentological, facial and correlational considerations /Pieńkowski 1983, 1984/. It is well known that biostratigraphy based on megaspores /Marcinkiewicz 1971 - comp. Fig. 2 in this paper/ can not give detailed divisions, which were based on lithostratigraphical and facial correlations /Karaszewski 1962, Dadlez 1978/. According to the sedimentological investigations, previous facial interpretations of the Holy Cross Lower Liassic have been changed and new lithostratigraphy and correlation with the West European Basin is proposed here /Fig.2/

Sedimentary evolution of the Lower Liassic of the Holy Cross Mountains should be consider as an interaction between "cyclic" and "event" stratification /Einsele and Seilacher 1982/. Transgressions are considered here as "great events" which influenced sedimentary evolution either in continental or marine margin areas for a long time. The character of the cyclic sedimentation underwent big changes and beginning of transgression is always well visible, giving an excellent correlative horizon. Those nor

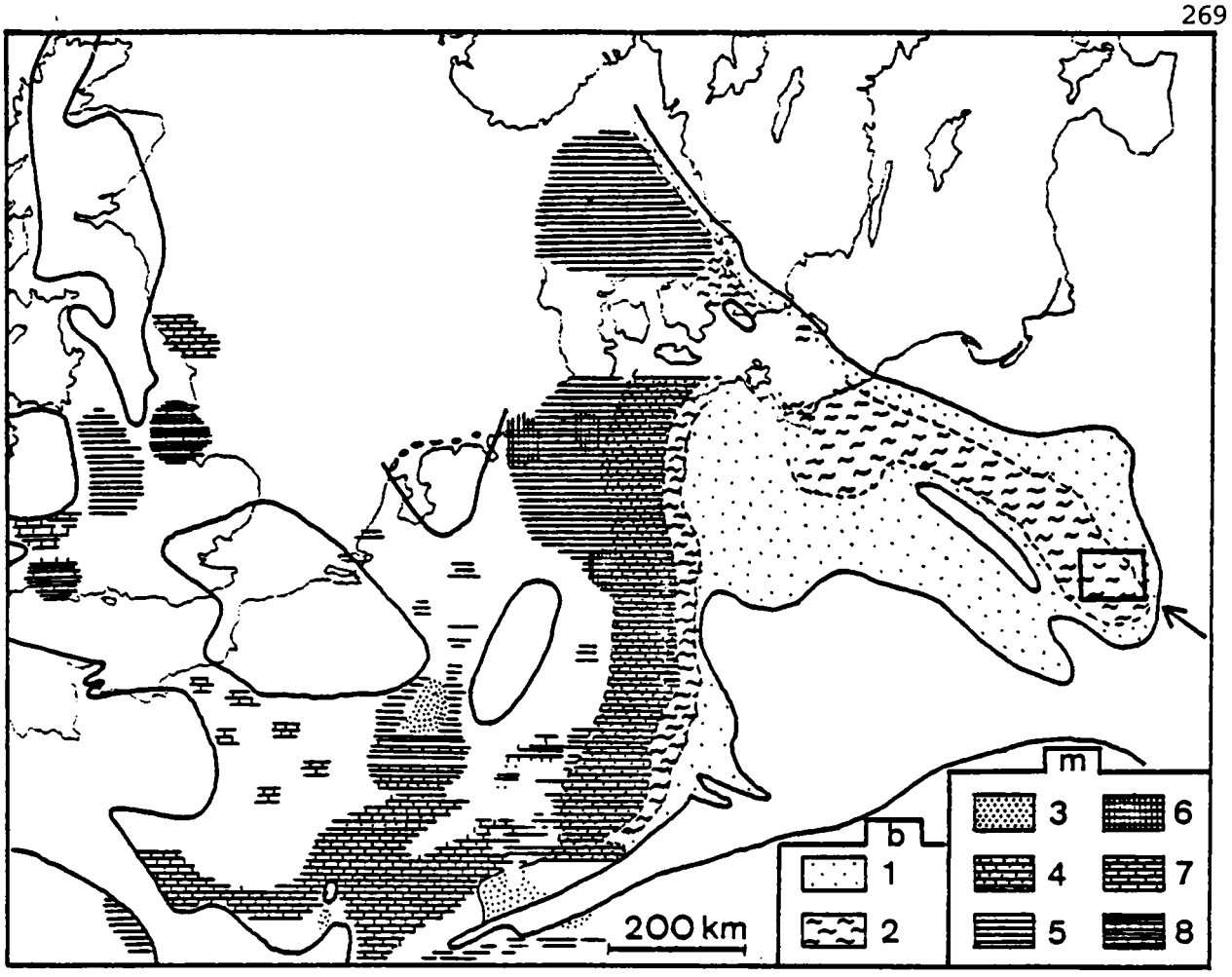

Fig.1. Paleogeographical sketch of the Hettangian Basin in Europe. 1- Estuarine, deltaic, coastal and fluvial facies, 2 - Nearshore shally facies /mainly heteroliths/ - in West Germany according to Bloos 1982, in Poland and Skane based on literature and present author's observations ; b - brackish conditions, 3 - Marine sandstones, 4 - Marine shales and sandstones, 5 - Shales with carbonate layers, 6 - Bituminous shales /"Blue Lias"/ ; m - marine conditions. Based on compilation of Bloos 1976, somewhat simplified in the western part and changed in the Polish part according to Dadlez 1969.

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zons are comparable to the main eustatic changes /Fig.2/. Among other events, storm effects may be visible in the profiles, but they play here subordinate role. Also tsunamis were in this epicontinental basin too rare to have any bigger importance. Without

rapid tectonical movements, but with stable sedimentation and stable, not rapid subsidence, the cyclicity of sedimentation is the most impressive feature of the Holy Cross Lower Liassic. On this background the changes of sea level controlled transgressions and sedimentary trends. Other events gave only "intercalations" without bigger changes in cycles - products of facial shifting. The thickness of an individual cycle ranges between one and several meters, very rare exceeding ten meters. Autocyclical processes were prominent here - in continental conditions mainly migration of river channels, in marine margin environments mainly differentiation in sediment supply due to the shore morphology, current directions, amount of sediment from rivers etc. Individual cycles may be grouped into "series" reflecting more general trends in the basin. Generally those "series" may be identified with formations /Fig.2/, but sometimes they constitute minor assemblages /identified with members/. Sedimentary evolution of the Holy Cross Lower Liassic may be presented as follows :

The lowermost Zagaje formation, lying with a sharp erosional contact on the different Triassic deposits, contains exclusively continental deposits showing gradual decreasing of energy of depositional processes and giving the following sequence : alluvial fans and braided river deposits /on the marginal parts of the basin/ - meandering river deposits /developed on the whole area/ - lacustrine and swamp deposits /in the central part of the basin/. Fining upward, river cycles dominate and reversed levee - prograding or symmetrical lacustrine cycles occur. Lacustrine cycles are grouped mainly in the upper part of the formation, but on the SE and SW margins of the basin river sedimentation was dominating till the upper boundary of the Zagaje formation. Rootlets, coal seams, plant remains are very abundant.

The beginning of the next formation - Ruszkowice formation[1] - is connected with rapid and widespread brackish - water transgression. Lowered salinity of the transgreding sea is proved by the character of scanty pelecypods - Cardinia follini Lundgren, Cardinia cf. expansa Lundgren, Modiolus hillanus Sow., Liostrea hissingeri Nilsson, Taeniodon ? nathorsti Lundgren. Identical forms were found in Skane /Troedsson 1951/ and this is most probably a contemporaneous migration of the same forms in the same basin. The character of transgressive surface depends very much on the type of underlying sediment. In majority of cases the sea transgreded on the muddy sediments and the lithological contrast is weak. That is why a considerable parts of grey muds and heteroliths were included to the Zagaje formation and this transgression was not noted before. The transgression level may be observed on the whole area, in the marginal parts where the underlying sediments were more coarse, the basal conglomerate may be observed. This level constitutes the correlational horizon of a first importance /Fig.2/. Above the transgressive surface the character of cyclic sedimentation is completely different in comparison to the Zagaje formation. Reversed, coarsening - upward cycles dominate and they represent shifting of facies in the basin, caused mostly by the autocyclic mechanisms. Some storm intercalations may be noted. They show erosional bases, hummocky stratification and evidences of rapid sedimentation like escape structures of bivalves /Pieńkowski 1984 in press/. Graded bedding and specyfic spill - over ripples on tops are further evidences. An average thickness of individual storm - generated bed ranges from several centimeters to 30 cm.

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[1] Previously /Karaszewski 1962, Pieńkowski 1983,1984 ,in press/ it was called Skłoby series /formation/.

In the profile of Ruszkowice formation some minor transgressive - regressive trends may be distinguished /Fig.2/. At the peripheries of sedimentary basin barrier - lagoon and deltaic cycles prevail. Lagoonal deposits have been found either in transgressive or regressive sequences, but the former case is more prominent. It seems to be in a good accordance with Kraft's /1978/ opinion, that there is no reason for regressive barriers to be more likely preserved in the geologic record than transgressive barriers. Ruszkowice formation represents quartz - arenite assemblage and there are many evidences of permanent and intense wave action in the relatively wide and open brackish reservoir.

Some regressive trends may be observed in the uppermost part of the Ruszkowice formation, but those trends are much more prominent in the next Przysucha Ore - Bearing formation. This formation was known for a long time for its siderite ore resources. Those siderites are grouped in three main muddy horizons called "ore - bearing levels". It was proved /Wyrwicki 1966/ that majority of those siderites were syngenetic or very early diagenetic. Indeed, they were formed in extensive, though closed and shallow basins. Plant roots may be observed in many parts of the "ore - bearing horizons". The source of iron were extensive swampy areas around "ore basins" with deltas and rivers. The "ore basins" may be treated as large lagoons separated from the open reservoir by barriers. They were three times filled by more coarse deltaic and river deposits /"inter - ore levels"/. The last of those periods was most widespread and intense ; continental conditions returned over the whole area. Lithologically those deposits are sandy and they were included to the next Ostrowiec formation /Karaszewski 1962, Pieńkowski 1983, 1984/, but due to the sedimentological character they should belong to the Przysucha Ore - bearing formation. In comparison to the Ruszkowice formation, barrier - lagoon,

deltaic and river cycles are much more frequent, shore prograding cycles are rare and grouped mainly in the NW part of the area studied. Because of its muddy character and faunal finds /in a fact faunal occurences are much more numerous in the Ruszkowice and Ostrowiec formations/, the Przysucha Ore - bearing formation was previously regarded as the formation of strongest marine influences /Karaszewski 1962, Dadlez 1969/. This view must be postponed and reinterpretation of paleogeographical character of the Przysucha fm. makes correlational problems more clear /Fig.2/.

The uppermost Ostrowiec formation /Sinemurian/ shows sedimentary development simillar to that of the Ruszkowice formation. The transgressive level covers continental deposits of the uppermost part of the Przysucha formation. In the upper part of the Ostrowiec formation regressive trends may be observed. Above the Ostrowiec formation Gielniów formation occurs. The later formation /Lower Pliensbachian/ comprises fully marine fauna /Karaszewski and Kopik 1970/.

After all, the correlational and stratigraphical suggestions should be presented. Two main transgressions have been observed in the area studied : first in the Lower/Middle Hettangian, second in the Lower Sinemurian. Hallam /1978/ has shown that: "The shallow marine Jurassic sequences in northwest Europe reveals a number of widespread, synchronous cycles of deepening and shallowing water, independent of local tectonics and facies development. The most favoured by the evidence eustatic model involves a rapid rise of sea level followed by a longer phase of stillstand and then rapid fall. These changes are tentatively related to episodes of uplift and subsidence of oceanic ridges." Those "great events" obviously influenced the sedimentation on the adjacent marine - margin and even continental areas. Sometimes those influences seem to be better visible on those marginal areas than in the open epeiric seas.

Knowing the age of those eustatic events in the marine basins of Western Europe, it seems to be possible to correlate their age with the marginal and continental basins /Fig.2/. In the result, it is possible to correlate unfossiliferous marginal formations with the formal stratigraphical division based on ammonites. Initial assumption for such a correlation are : weak regional tectonics /confirmed for Hettangian and less for Sinemurian by Hallam and Sellwood 1976/, relatively flat paleorelief /actual for Lower Liassic/ and relatively stable subsidence and sedimentation. On such a background strong global changes of sea level coming from distant oceanic regions influenced in the same time epeiric seas and marginal reservoirs. Upwelling of the erosional base could strongly influenced the character of the river sedimentation, which is visible in the profile of continental deposits /Fig.2, Zagaje formation/. It is visible, that the first influence of brackish - marine water did not come to the Holy Cross Mountains in the Lowermost Hettangian. The first influence of Planorbis transgression in W Europe is probably connected here with the start of sedimentation after a long period of strong erosion and denudation /uppermost Rhaetian - Subplanorbis Zone/. Development of the Planorbis transgression led to the flattening of the landscape caused by an extensive sedimentation of muds and clays of lacustrine origin /uppermost part of the Zagaje formation/. It seems to be possible, that the small transgressive impulse in the Liassicus time /Hallam 1978, ? Bloos 1976/ was enough strong to have this flat and low area cover by the shallow brackish sea /transgression in the base of the Ruszkowice formation/. On the other hand, the Upper Hettangian /and may be the lowermost Bucklandi Zone/ show regressive tendencies in West Europe /Bloos 1976, Hallam 1978/ and in Skane /Troedsson 1951/ as well as in Norwegian - Danish Basin /Bertelsen 1978/. Those regressive tendencies are reflected in the Przysucha formation /Fig.2/

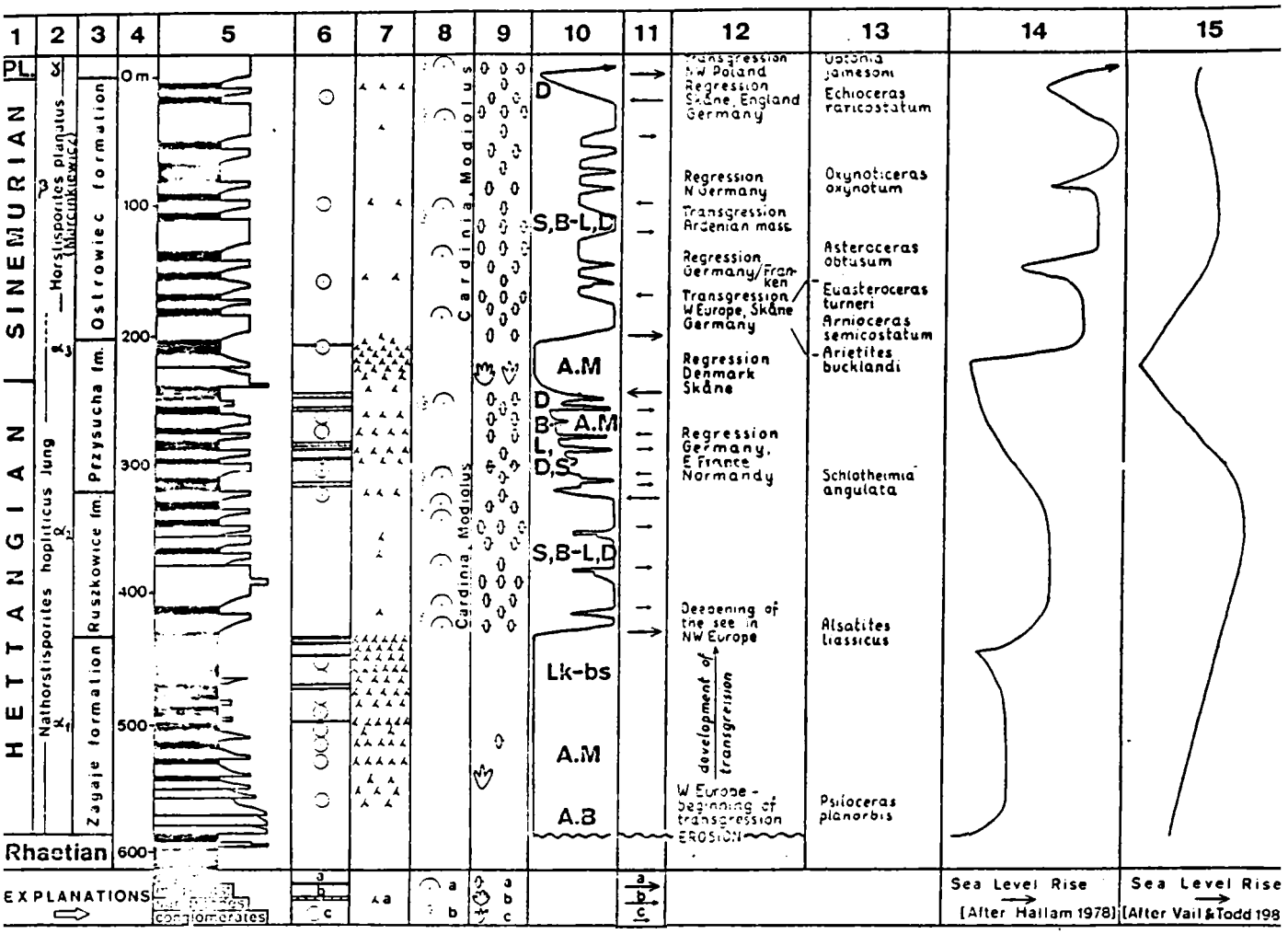

Fig.2. Correletion of the Lower Liassic of the Holy Cross Mountains /Poland/ with the West Europe, based on great transgressive - regressive events. Column 6 : a - coal seams, b - siderite bands, c - siderite concretions ; 7 : a - plant roots, 8 : a - brackish bivalves b - foraminifera, 9 : a - invertebrate trace fossils, b - pentadactyl dinosaurian footprints, c - tridactyl dinosaurian footprints, 10 : A.B - braided rivers, A.M. - meandering rivers, Lk - lakes, bs - backswamps, D - deltas, B-L - barrier - lagoon, S - open brackish reservoir and shore prograding cycles, 11 : transgressive /arrow to the right/ or regressive /arrow to the left/ trends in the Holy Cross Mountains - a - main, b- intermediate, c - small scale, 14, 15 - horizontal range of the curves not to scale.

Lower Sinemurian is the time of a big transgression in the West Europe /Hallam 1978/, Skane /Troedsson 1951/, Norwegian - Danish

Basin /Bertelsen 1973/ and Bornholm /Gravesen et al. 1982/. This transgression is obviously connected with the transgression in the lower part of the Ostrowiec formation. While the Lower Sinemurian shows transgressive character, the Middle and Upper Sinemurian are characterized by more or less visible regressive trends, especially in the Obtusum /W Europe, Hallam 1973/ and Oxynotum /France, Germany/ Zones. Regressive trends occur also in Raricostatum Zone in Yorkshire /Hallam 1978/, in Skane /Troedsson 1951/ and in Norwegian - Danish Basin /Michelsen 1978/. Sinemurian correlations based on transgressive - regressive trends seem to be not so clear as the Hettangian ones, perhaps owing to the local tectonic movements.

Mentioned above correlations should be important for future works in adjacent areas, like Skane, East Germany and Norwegian - Danish Basin. My scheme /Fig.2/ is in a quite good accordance with that presented by Bertelsen /1978/ for Norwegian - Danish Basin. It should be also noted, that marine Fjerritslev formation /Michelsen 1978/ has its brackish counterparts in the Polish Middle Hettangian and Lower - Middle Sinemurian.

References :

Bertelsen,F./1978/: The Upper Triassic - Lower Jurassic Vinding and Gassum Formations of the Norwegian - Danish Basin - Danmarks Geologiske Undersøgelse, Serie B, Nr.3, København.

Bloos,G./1976/: Untersuchungen über Bau und Entstehung der feinkörnigen Sandsteine des Schwarzen Jura /Hettangium und tiefstes Sinemurium/ im schwäbischen Sedimentationsbereich - Arb. Inst. Geol. Paläont. Univ. Stuttgart, N.F. 71 : 1 - 269.

Dadlez,R./1969/: Stratigraphy of the Lias in Western Poland, Prace Instytutu Geologicznego, LVII, 1 - 92, in Polish, English summary.

Dadlez,R./1978/: Stan litostratygrafii epikontynentalnej dolnej jury w Polsce i propozycje jej usystematyzowania - Kwartalnik Geologiczny 22, 773 - 790, in Polish, English summary.

Einsele,G.,Seilacher,A./1982,eds/: Cyclic and Event Stratification,

Springer - Verlag, Berlin, Heidelberg, New York.

Gravesen,P.,Rolle,F.,Surlyk,F.,/1982/: Lithostratigraphy and sedimentary evolution of the Triassic, Jurassic and Lower Cretaceous of Bornholm, Denmark - Danmarks Geologiske Undersøgelse, Serie B, Nr.7, København.

Hallam,A./1978/: Eustatic cycles in the Jurassic - Palaeogeogr., Palaeoclimatol., Palaeoecol., 23 : 1 - 32.

Hallam,A., Sellwood,B.W., /1976/: Middle Mesosoic sedimentation in relation to tectonics in the British Area - Journal of Geology, Vol. 84, 301 - 321.

Karaszewski,W./1962/: Stratygrafia liasu w północnym obrzeżeniu Gór Świętokrzyskich - Prace Instytutu Geologicznego, XXX, III, 333 - 416, in Polish, English summary.

Karaszewski,W.,Kopik,J./1970/: Jura dolna, Prace Instytutu Geologicznego, LVI, 65 - 98, in Polish, English summary.

Kraft,J.C.,/1978/: Coastal Stratigraphic Sequences - in : Davis R.A.Jr.,ed. "Coastal Sedimentary Environments", Chapter 7, 361 - 383, Springer - Verlag.

Marcinkiewicz,T.,/1971/: The Stratigraphy of the Rhaetian and Lias in Poland based on Megaspore Investigations - Prace Instytutu Geologicznego, LXV, 1 - 57.

Michelsen,O.,/1978/: Stratigraphy and distribution of Jurassic deposits of the Norwegian - Danian Basin - Danmarks Geologiske Undersøgelse, Serie B, Nr.2, København.

Pieńkowski,G.,/1983/: Early Lias sedimentary environments at northern margin of the Holy Cross Mts. - Przegląd Geologiczny, 4, 223 - 231, in Polish, English summary.

Pieńkowski,G.,/1984, in press/: Early Liassic Trace Fossils from the Holy Cross Mountains, Poland : Their Distribution in Different Depositional Environments - in : Curran H.A. /ed./, "Biogenic Structures", S.E.P.M. Special Publications.

Troedsson,G.,/1951/: On the Höganäs Series of Sweden - Lunds Universitets Arsskrift. N.F. Adv.2. Bd 47 Nr.1.

Vail and Todd,/1981/: Eustatic curve of Jurassic - from paper in : Westermann /ed./, Juras. - Cret. Biochron. and Paleogeog. of N. America. Geol. Ass. Canada Spec. Pap. for 1984.

Wyrwicki,R.,/1966/: Osady żelaziste liasu świętokrzyskiego - Biul. Inst. Geolog., 195, 71 - 158.

PRESENTATION OF THE AMMONITE FAUNA IN THE TRANSITION LOTHARINGIAN/ CARIXIAN OF SOUTHWESTERN GERMANY AND NORTHERN SWITZERLAND

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PRESENTATION OF THE AMMONITE FAUNA IN THE TRANSITION LOTHARINGIAN/CARIXIAN OF SOUTHWESTERN GERMANY AND NORTHERN SWITZERLAND

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INTRODUCTION

In this preliminary note about the ammonite fauna in the transition Lotharingian/Carixian of SW-Germany and Northern Switzerland it should be documented the biostratigraphic and biogeographic significance of an investigation area, situated near the southern margin of the northwest European liassic ammonite province (sensu DEAN et al. 1961).

THE INVESTIGATION AREA

One of the most significant change in lithofacies of the liassic deposits can be observed in the transition Lotharingian/Carixian from SW-Germany (Middle Swabian Alb) in direction to Northern Switzerland.

In the Middle Swabian Alb (eastern of Stuttgart) the upper Lotharingian (from the oxynotum- to the raricostatum-Zone) is developed as dark clays ("Obere Betatone" sensu SÖLL 1956) interrupted by three characteristic marlstone beds (Mergellagen II-IV, see fig. 1), whereas in direction to Northern Switzerland (Wutach, Klettgau) there is a considerable change in lithofacies. The so-called "obliqua-Schichten" are developed (see figs. 2-4). The oyster Gryphaea obliqua (GOLDFUSS) is characteristic for this calcareous marlstone beds with phosphatic nodules. The lithology of this layers (thickness about 1 meter) shows great similarity to the "Calcaire ocreux" of Lorraine. The obliqua-Schichten represent equivalents from the oxynotum-Zone to the base of the Pliensbachian, defined by the first appearance of Apoderoceras nodogigas (QUENST.).

The obliqua-Schichten have been studied by several authors. A summarized account with bibliographic notes is given by HOFFMANN (1964) and SCHLATTER (1983, 1984).

Since 1979 the present author is employed on a documentation about the ammonite fauna and biostratigraphy in the transition Lotharingian/ Carixian. Especially in this transition part the ammonites are rare and of the most part of bad preservation. This study [in preparation for press] was supported by the Swiss National Science Foundation (grant 2.146-0.78).

In this short report some interesting biogeographic aspects to the ammonite assemblage in the obliqua-Schichten should be treated.

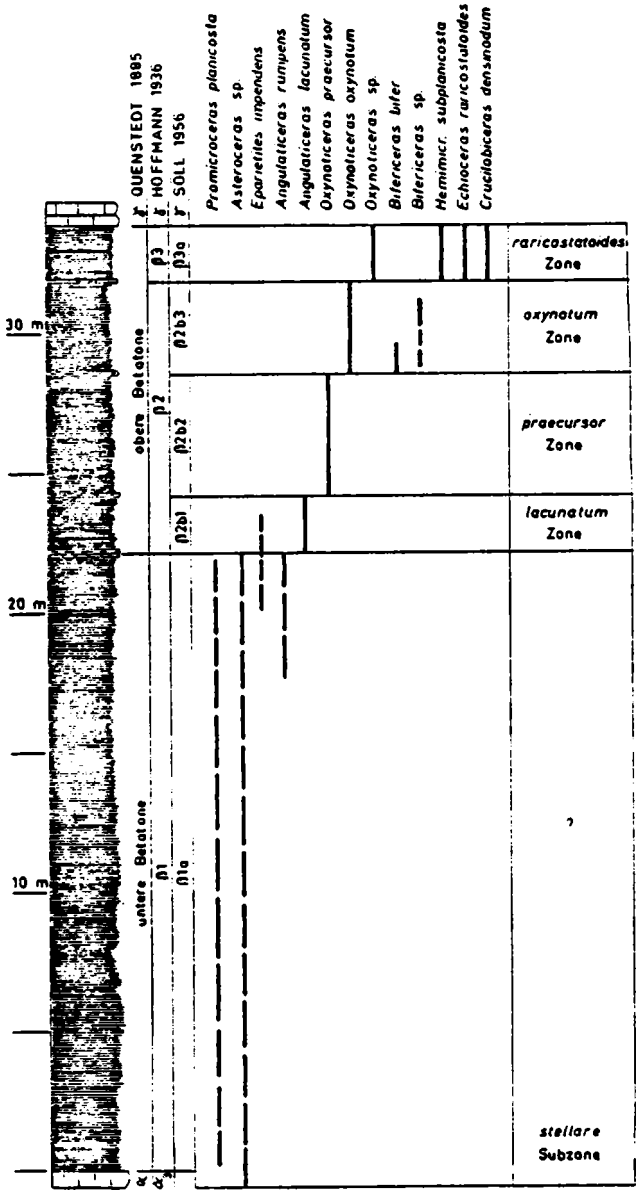

Fig. 1. - Lithology, ammonites and zonal subdivison of the "Schwarzer Jura β" (Lotharingian s.l.) in the Middle Swabian Alb [adapted from URLICHS 1977].

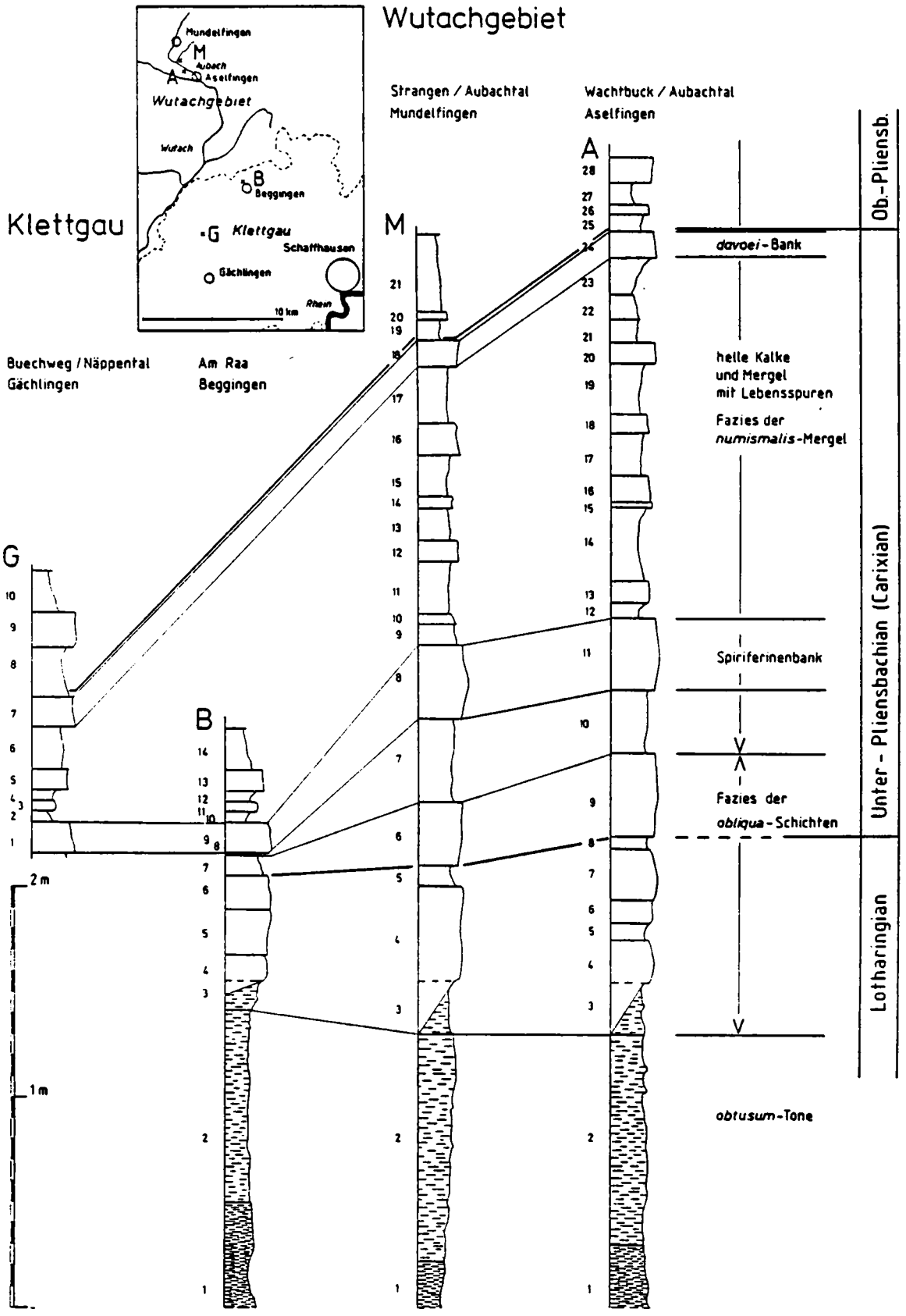

Fig. 2.- Sections representing the lithology of the upper Lotharingian and Carixian in the Klettgau and Wutach region. The limit Lotharingian/ Carixian is situated in the beds of the obliqua-Schichten.

THE AFFINITIES OF THE FAUNA

The ammonite fauna is a mixed one and includes elements characteristic of the Eastern Alps, Median Prealps / Langeneckgrat (see DONOVAN 1958), on the one hand, and Britain, Baden-Württemberg and the Rhône basin on the other (see figs. 3-4).

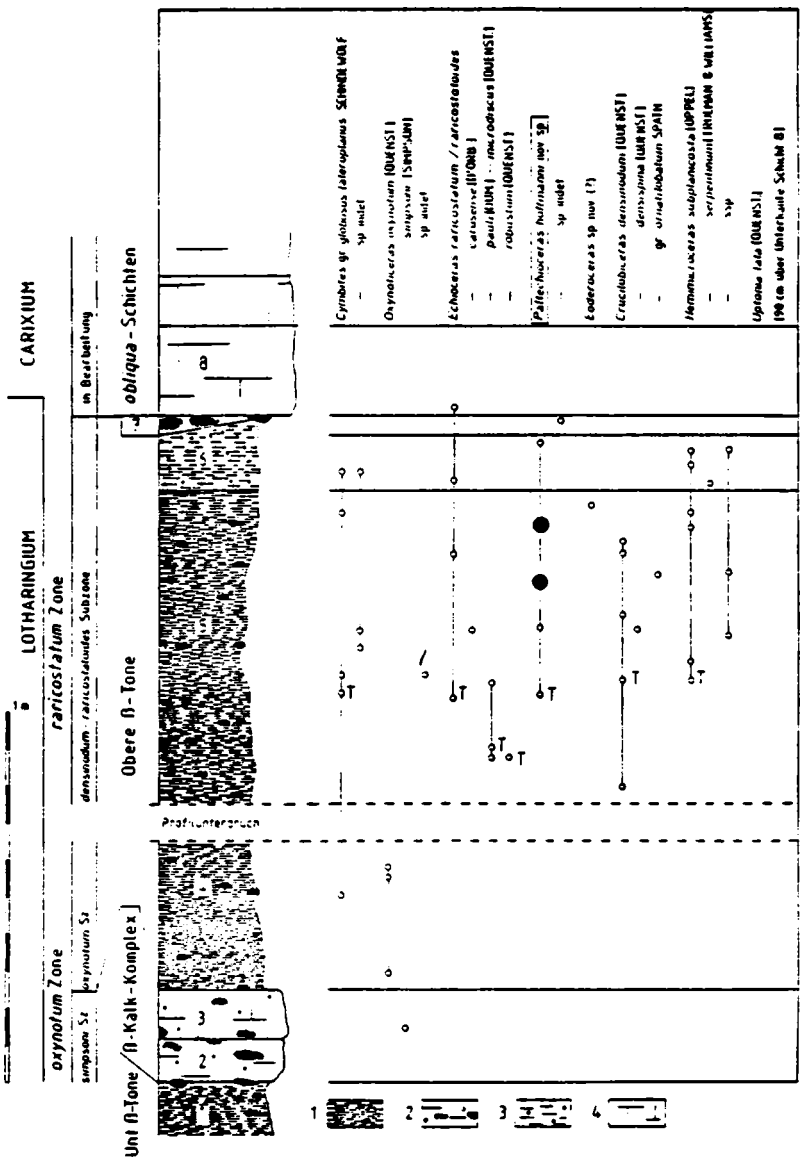

Fig. 3.- Characteristic section representing the situation in the upper Lotharingian where the facies has partly changed from the clayey "Obere ß-Tone sensu SÖLL (1956) into the more condensed calcareous facies of the obliqua-Schichten. Locality: Sunthausen (near Donaueschingen, Württemberg) [according to SCHLATTER 1984].

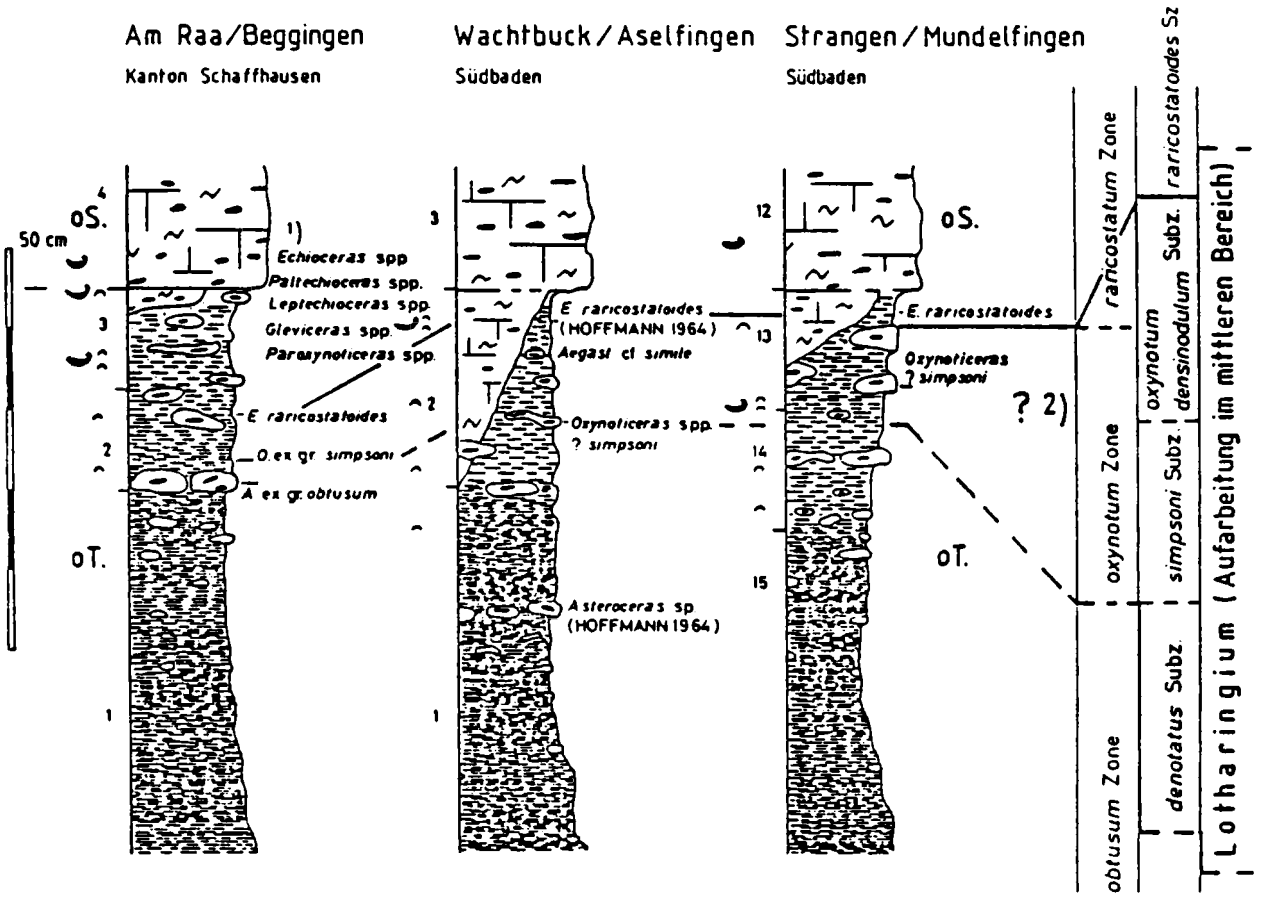

Fig. 4.- Sections representing the ammonite succession in the transition obtusum-Tone (o.T.) and the obliqua-Schichten (o.S.) in the Klettgau and Wutach region. For the localities see fig. 2 [according to SCHLATTER 1983].

The following ammonite genera have been recorded (Wutach area, Klettgau) in the obliqua-Schichten.

C = Carixian part of the obliqua-Schichten

L = Lotharingian part of the obliqua-Schichten

Asteroceras (L), Aegasteroceras (L), Echioceras (L), * Leptechioceras (L), Paltechioceras (L), * Plesechioceras (L), * Orthechioceras (L), * "Echioceratoides" (L), Oxynoticeras (L), Gleviceras (L), * Paroxynoticeras (L), Eoderoceras (L,C), * Ophideroceras (L), * Metaderoceras (L), Apoderoceras (C), Epideroceras (*L,C), Hemimicroceras (L).

This genera [*] are restricted as far as known to the Wutach region and the Klettgau (south of the Danube).

In the Middle Swabian Alb the following genera are restricted according to the present state of investigations.

Crucilobiceras (L), Bifericeras (L), Angulaticeras (L), Leptonotoceras (L), Phricodoceras (C).

On the maps (figs. 5-11) the biogeographic distribution of some important ammonite genera and species of special palaeogeographic interest is represented.

Explanatory note to the figs. 5-11:

Geographical distribution of certain ammonite genera and species in the Lotharingian of Central Europe. The mixed fauna in the investigation area [marked by an asterisk] shows affinities to the Tethyan and the NW-European province (sensu DEAN et al. 1961).
Of special interest is the abundance of the genus Epideroceras, which is a good palaeogeographic index of northern margin of the Tethys (see DOMMERGUES 1982). The palaeogeographic indications outside the investigation area have been adapted mainly from DONOVAN (1958, 1967), GETTY (1972, 1973), HÖLDER (1964), HOFFMANN (1964) and MOUTERDE (1953).

The heavy broken line marks the southern and the eastern boundary of the North-West European province (sensu DEAN et al. 1961, pl. 75).

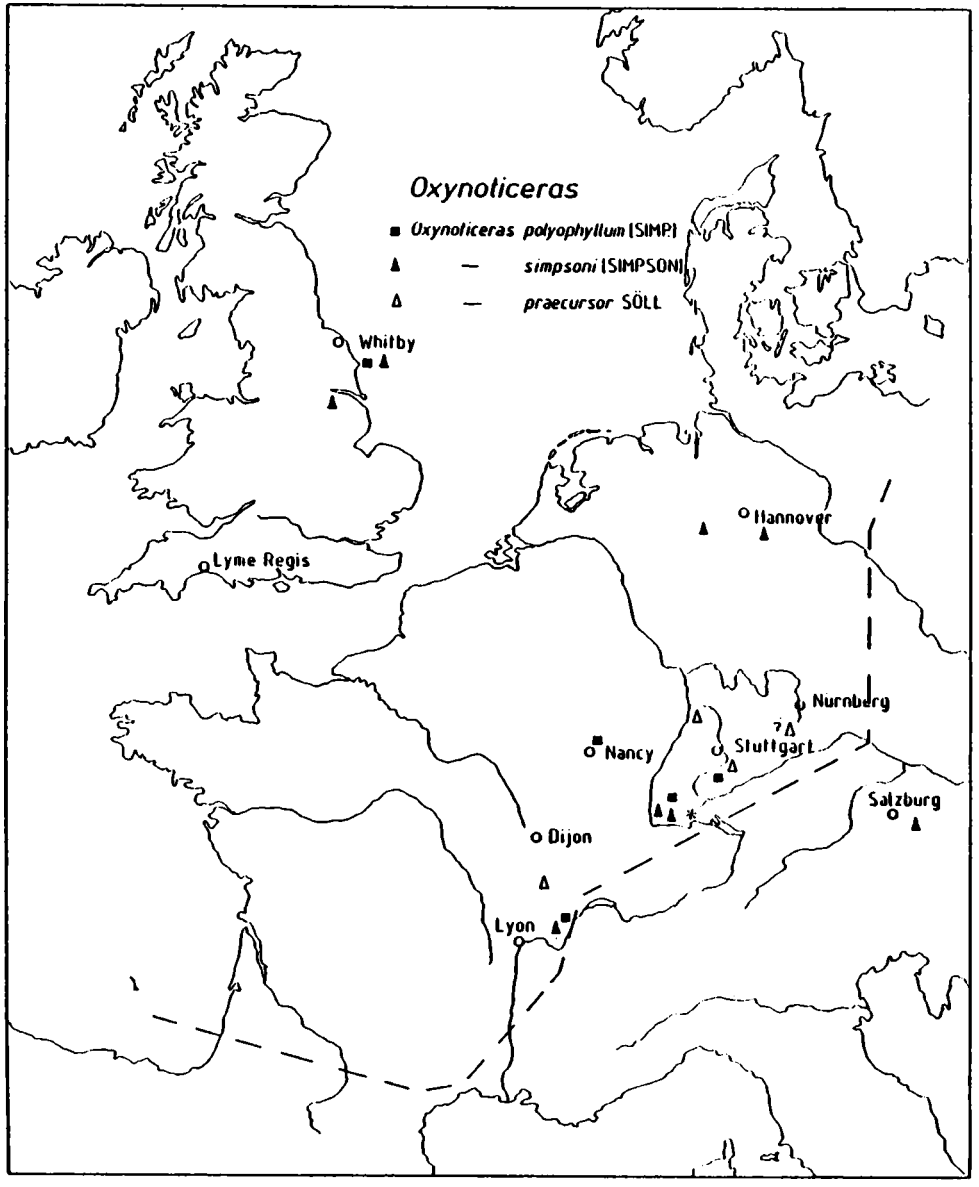

Fig. 5. Oxynoticeras

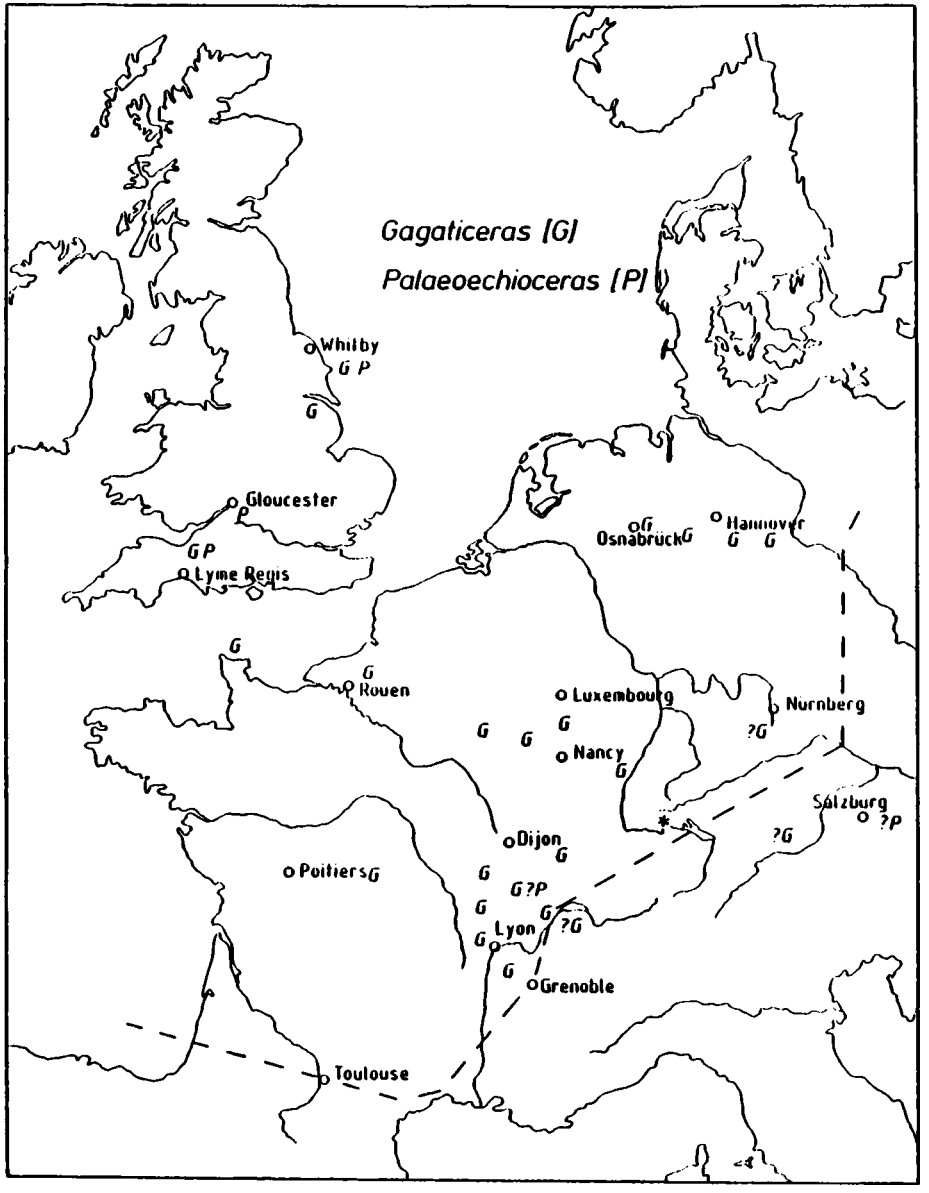

Fig. 6. Gagaticeras, Palaeoechioceras

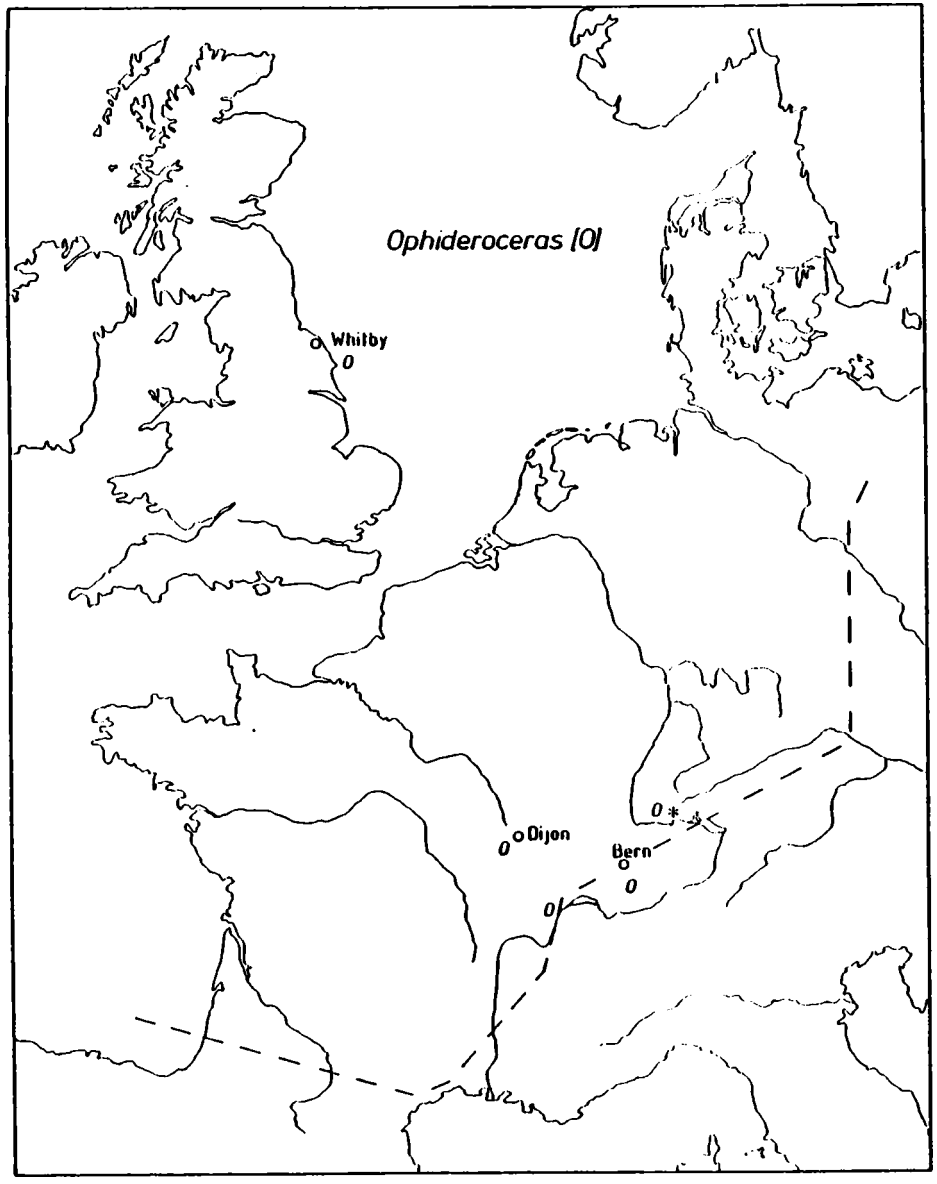

Fig. 7. Ophideroceras

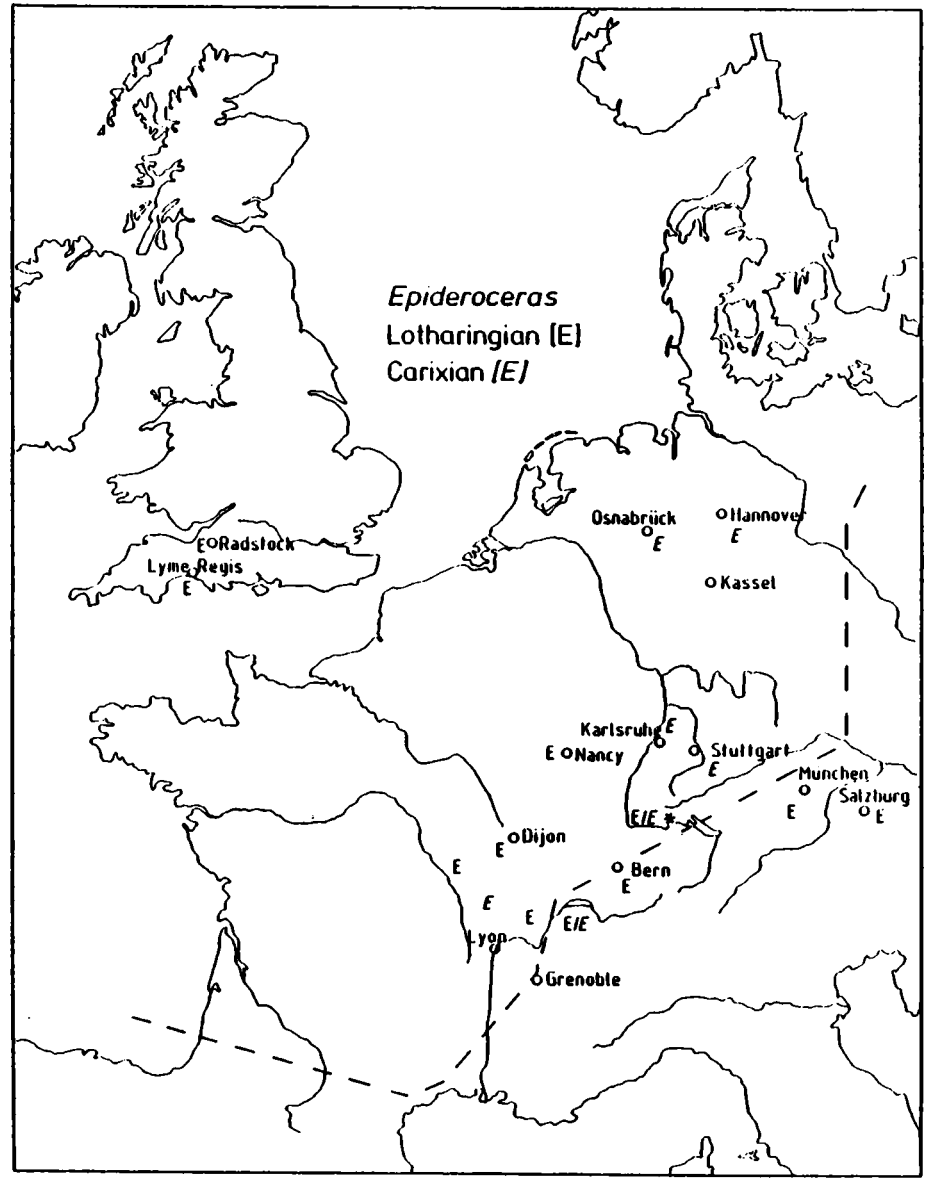

Fig. 8. Epideroceras (L,C)

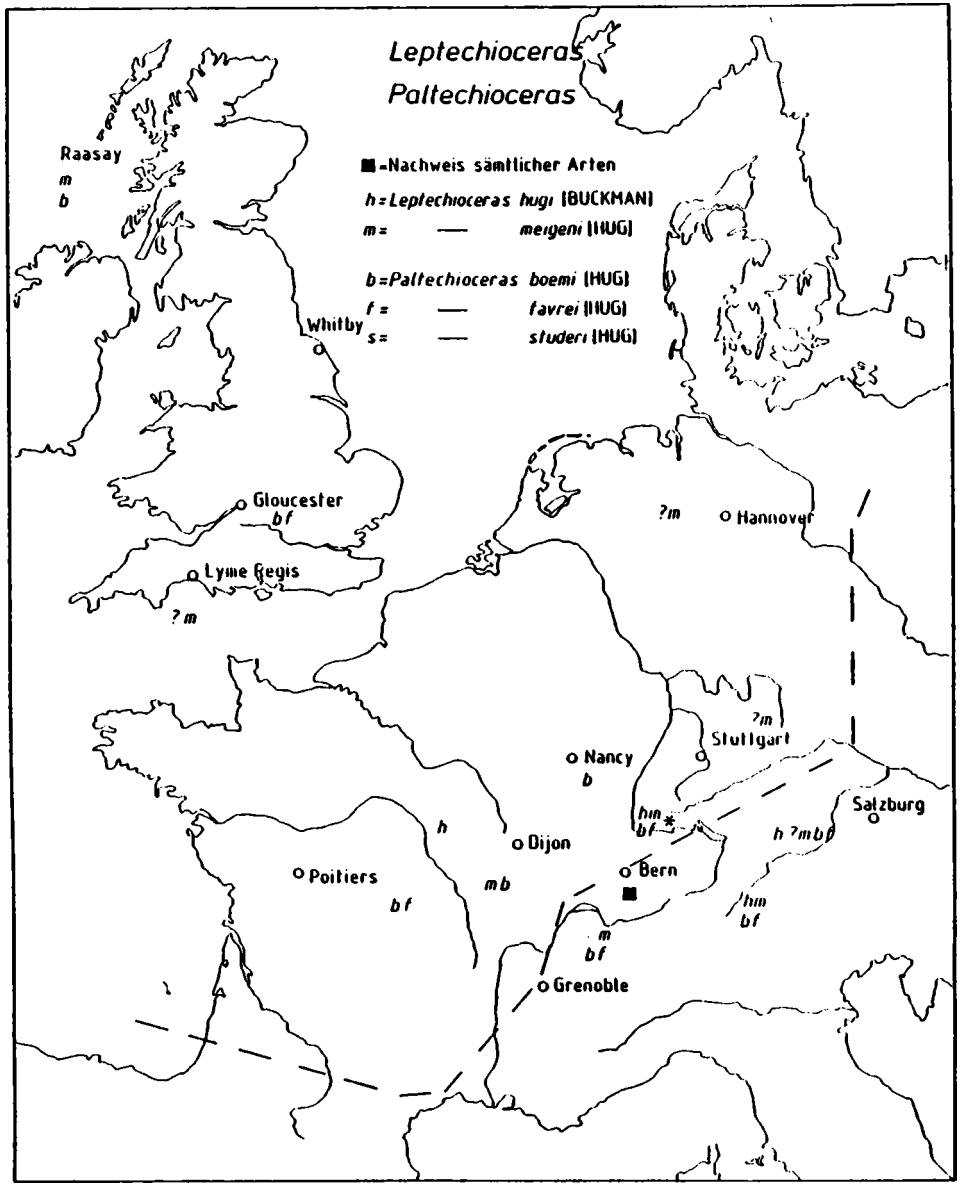

Fig. 9. Leptechioceras, Paltechioceras

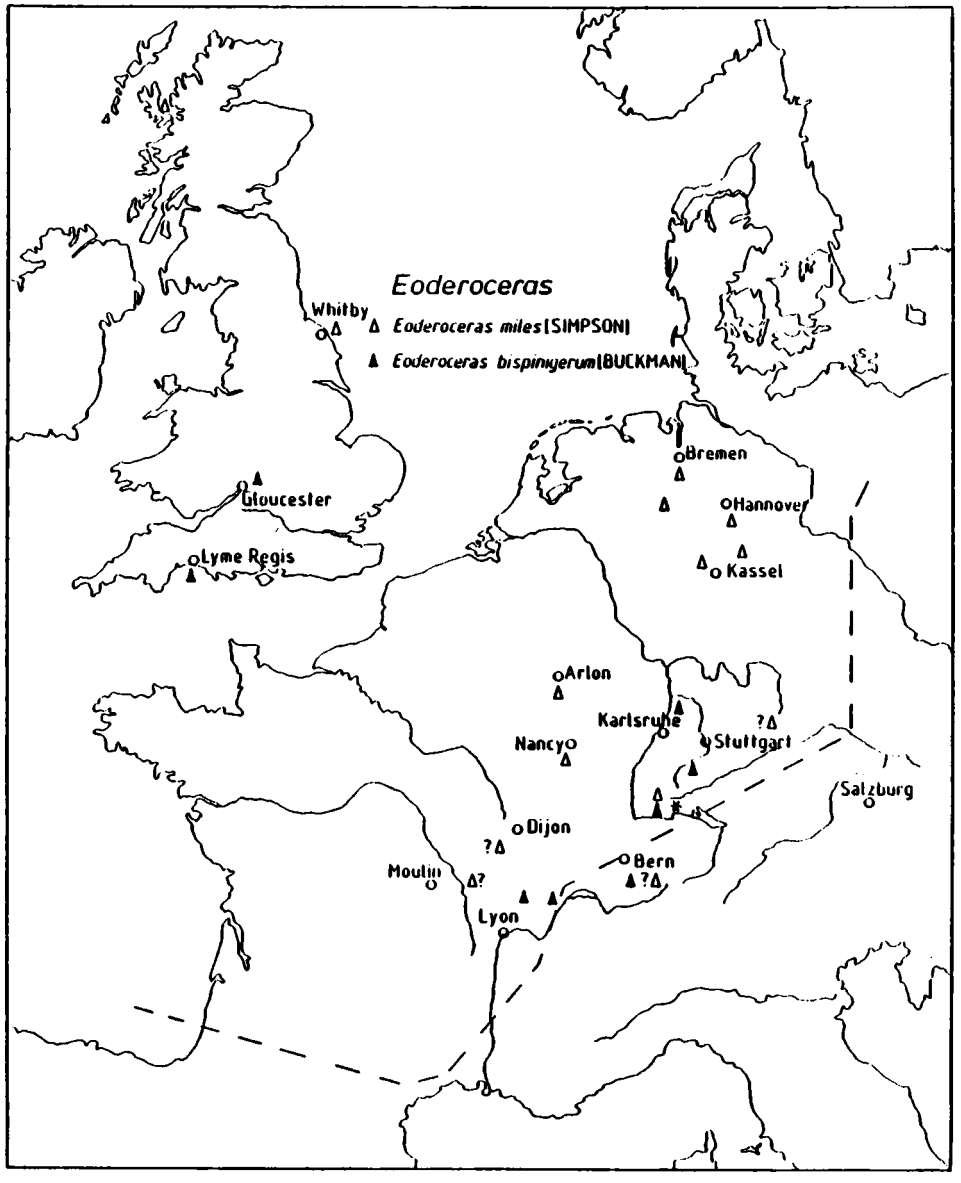

Fig. 10. Eoderoceras

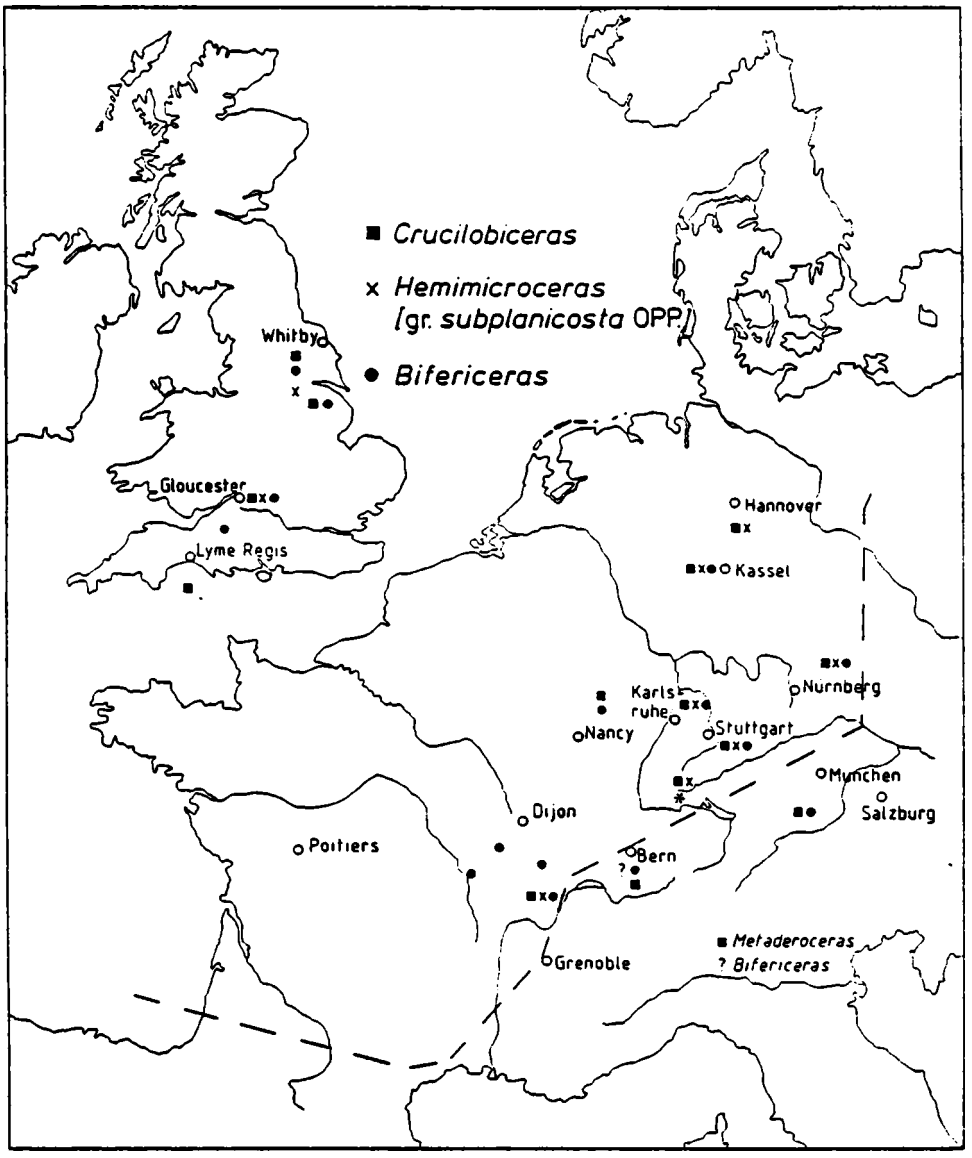

Fig. 11. Crucilobiceras, Hemimicroceras, Bifericeras

The great picture is given in the table 1 which shows the geographic distribution of the most important genera present in the obliqua-Schichten.

Explanatory note: Broken line indicates rare occurrence.
? not investigated or questionable records.

Table 1

Genera	Wutach/Klettgau	NW-European Province (generalized)	Median Prealps Langeneckgrat	Eastern Alps
Echioceras [raricostatum group]	———	———	- - -	?
Leptechioceras	———	———	———	———
Paltechioceras	———	———	———	———
Oxynoticeras	- - -	———	- - -	- - -
Gleviceras	———	- - -	———	———
Paroxynoticeras	- - -	- - -	?	———
Eoderoceras	———	———	- - -	———
Ophideroceras	- - -	- - -	?	?
Metaderoceras	- - -	- - -	?	———
Apoderoceras	———	———	?	?
Epideroceras	———	- - -	———	———
Hemimicroceras	- - -	———	?	?
Bifericeras	?	———	?	?

BIOSTRATIGRAPHY: The table 2 shows the biostratigraphic relations between the Middle Swabian Alb and the area south of the Danube (Baar, Wutach, Klettgau) in the transition Lotharingian/Carixian.

Table 2 Explanatory note: The species in brackets means no proof of the occurrence of the index-species. In this case it is very useful to indicate the characteristic ammonite assemblage.

	DEAN et al. 1961	Swabian Alb adapted from URLICHS 1977	Wutach/Klettgau	horizons
Carixian	taylori-Subzone	taylori	(taylori)	nodogigas
Lotharingian	aplanatum-Sz.	no proof	aplanatum	aplanatum/nobile Gleviceras, Epideroceras
	macdonnelli-Sz.		macdonnelli	macdonnelli, Orthechioceras ssp.
	raricostatoides-Sz.	raricostatoides + densinodulum subplanicosta	raricostatoides (densinodulum)	raricostatoides, delicatum, subplanicosta
	oxynotum-Subz.	oxynotum	(oxynotum)	?
	simpsoni-Subz.	praecursor	simpsoni	simpsoni, polyophyllum Eoderoceras bispinigerum (BUCKMAN)

REFERENCES

Works containing comprehensive references are marked by an asterisk [*]

* DEAN, W.T., DONOVAN, D.T. & HOWARTH, M.K. (1961): The Liassic ammonite zones and subzones of the North-West European province.- Bull. Brit. Mus. Nat. Hist., Geology, 4/10, p. 438-505, pls. 63-75; London.

DOMMERGUES, J.-L. (1982): Epideroceras (Coeloderoceras) ponticum (PIA) 1913, une Ammonite du Carixien inférieur, caracteristique de la marge nord de la Téthys.- Eclogae geol. Helv., 75/3, p. 795-805, 1 pl., 4 figs.; Basel.

* DONOVAN, D.T. (1958): The Lower Liassic Ammonite fauna from the Fossil bed at Langeneckgrat, near Thun (Median Prealps).- Schweiz. palaeont. Abh., 74/2, 58 pp., 7 pls., 11 figs.; Basel.

* - (1967): The geographical distribution of lower Jurassic ammonites in Europe and adjacents areas.- Systematics Assoc. Publ., 7, Aspects of Tethyan Biogeography [Ed. C.G. Adams & D.V. Ager], p. 11-134, 5 figs.; London.

* GETTY, T.A. (1972): Revision of the Jurassic ammonite family Echioceratidae (Cephalopoda, Ammonoidea).- Thesis Univ. London, 319 pp., 15 pls., 22 figs., 2 tabs., 2 maps; London [mscr.].

- (1973): A revision of the generic classification of the family Echioceratidae (Cephalopoda, Ammonoidea) (Lower Jurassic).- Paleont. Contr. Univ. Kansas, 63, p. 1-32, 5 pls., 4 figs.; Kansas.

* HÖLDER, H. (1964): Jura.- Handb. stratigraph. Geol., 4, 603 pp.; Stuttgart (Enke).

* HOFFMANN, K. (1964): Die Stufe des Lotharingian (Lotharingium) im Unter-Lias Deutschlands und allgemeine Betrachtungen über das "Lotharingien".- In: Colloque du Jurassique à Luxembourg 1962, p. 135-160, 1 fig., 1 tab.; Luxembourg.

* SCHLATTER, R. (1983): Ein Fund von Aegasteroceras ex gr. simile SPATH (Ammonoidea) aus dem Lotharingium des Wutachgebiets (Baden-Württemberg).- Jber. Mitt. oberrhein. geol. Ver., N.F., 65, p. 243-256, 3 figs., 1 tab.; Stuttgart.

* SCHLATTER, R. (1984): Paltechioceras hoffmanni n. sp. (Ammonoidea) aus dem Ober-Lotharingium von Sunthausen (Baar, Baden-Württemberg).- Stuttgarter Beitr. Naturk., B, 29 pp., 5 pls., 6 figs., 1 tab.; Stuttgart.

* SÖLL, H. (1956): Stratigraphie und Ammonitenfauna des mittleren und oberen Lias- (Lotharingian) in Mittel-Württemberg.- Geol. Jb., 72, p. 367-434, pl. 17-20, 49 figs., 2 tabs.; Hannover.

* URLICHS, M. (1977): The Lower Jurassic in Southwestern Germany.- Stuttgarter Beitr., B, 24, 41 pp., 6 pls., 11 figs., 2 tabs.; Stuttgart.

PLIENSBACHIAN BRACHIOPOD ZONES IN THE BAKONY MTS./HUNGARY/ AND THEIR CORRELATION WITH OTHER EUROPEAN AREAS

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PLIENSBACHIAN BRACHIOPOD ZONES IN THE BAKONY MTS. /HUNGARY/ AND THEIR CORRELATION WITH OTHER EUROPEAN AREAS

Attila VÖRÖS

The author established three tentative brachiopod zones in the Pliensbachian of the Bakony Mts /Hungary/: /1/ Cuneirhynchia ? palmata zone /= uppermost Sinemurian + Uptonia jamesoni Zone/ /2/ Lokutella kondai zone /= Tragophylloceras ibex Zone + Prodactylioceras davoei Zone/ and /3/ Apringia ? stoppanii zone /= Amaltheus stokesi Zone to Pleuroceras spinatum Zone/. These zones are equivalent to the brachiopod zones published from southern France and Bulgaria from the same time-interval but the zone boundaries are shifted. It seems that the faunal changes commenced a little earlier in the Bakony /Mediterranean province/ than in the other two areas /NW-European province/.

Brachiopods, generally and traditionally, have been regarded as "facies fossils" consequently of very limited biostratigraphical significance. However, palaeoecological evaluation of many brachiopod faunas revealed that brachiopods were not true facies fossils; on the other hand, the great specimen number and the wide distribution are two important factors enhancing their importance in stratigraphy.

In Palaeozoic sequences brachiopods are significant biostratigraphical markers: this subject was reviewed by WATERHOUSE /1977/. For Mesozoic times the phylum Brachiopoda lost a bit from its importance, nevertheless, attempts have been done to construct brachiopod zonal schemes, e.g. in the Jurassic sediments of western Europe /ALMÉRAS et al. 1971/.

Turned to the Pliensbachian, here the number of well-studied and well-documented brachiopod faunas is regrettably little.

Even more restricted the number of detailed biostratigraphical studies where the brachiopod distribution data are based on sound ammonoid biostratigraphy. The surveys by REVERT /1971/, TCHOUMATCHENCO /1972/ and ALMÉRAS & MOULAN /1979, 1982/ meet the above requirements /though the two latter deal only with terebratulids/. All these works are focused on faunas of NW-European character.

Only a few NW-European brachiopod species can be found in the Mediterranean province therefore brachiopod biostratigraphy has to be developed on new basis here. On the classical terrains of the Mediterranean Jurassic /in the Alps and in peninsular Italy/ modern, bed-by-bed collections of brachiopods were not carried out so far, therefore the Bakony Mts. /Hungary/ appeared to be a suitable starting point. A very fortunate quality of the Pliensbachian brachiopod fauna of the Bakony Mts. is that the brachiopods have been collected in almost all localities together with abundant ammonoids. This is due to the uniquely detailed and voluminous collecting work done by Dr. J. KONDA and his co-workers. The ammonoid fauna has been investigated and evaluated very thoroughly by GÉCZY /1970, 1976/ and this enables us to establish the stratigraphical ranges of our Mediterranean brachiopod species more precisely than ever previously.

The results of this work were published quite recently by the author /VÖRÖS 1982, 1983/. Stratigraphical distribution of 101 species was investigated. Many of the species were represented by only one or a few specimens occurring in a single bed of one section. There were, however, 24 species with relatively short ranges and frequent and widespread occurrence which were regarded as really important stratigraphically. On the basis of the numbers of appearances vs. disappearances at ammonoid zone boundaries, three brachiopod zones were outlined:

1. Cuneirhynchia ? palmata zone. Characteristic taxa /beside the name-species/ are Septocrurella ? uhligi, Gibbirhynchia ? sordellii and Aulacothyris ? amygdaloides. Extends from the Sinemurian to the Pliensbachian; its probable time-span: uppermost Sinemurian to Uptonia jamesoni Zone.

2. Lokutella kondai zone. Characteristic taxa /beside the name-species/ are Kericserella inversaeformis and Gibbirhynchia orsinii. An important feature of this zone is the abundant occurrence of smooth Spiriferinids. Time-span: Tragophylloceras ibex Zone + Prodactylioceras davoei Zone.

3. Apringia ? stoppanii zone. Characteristic taxa /beside the name-species/ are Stolmorhynchia ? reynesi, S. ? bulga, Apringia fraudatrix, A. ? atlaeformis, A. ? suetii, Linguithyris cornicolana and /probably/ Apringia ? altesinuata. An important feature of this zone is the locally abundant occurrence of the concavo-convex Koninckinids. Time-span: Amaltheus stokesi Zone to Pleuroceras spinatum Zone /Domerian substage/.

Table I. shows the correlation of these zones with the above mentioned brachiopod zones of southern France and Bulgaria. It is clearly seen from the correlation chart that the length of these zones - both in the NW-European /Bulgaria, Causses/, and in the Mediterranean /Bakony/ provinces - is considerably longer than that of the ammonoid zones: one brachiopod zone corresponds to two to five ammonoid zones. The only exception is the Gibbirhynchia curviceps zone of southern France /equalized to the Ibex Zone/, but this can be considered local subzone because the "zone marker" occurs in definitely older beds in other parts of Europe /Jamesoni Zone, England: AGER 1956-67; Villány: AGER & CALLOMON 1971/. After this reduction, three brachiopod zones correspond to the upper Sinemurian to Pliensbachian time-interval both in the NW-European, and in the Mediterranean provinces. The zone boundaries are synchronous in the two NW-European areas but in the Bakony Mts. they set in a little earlier.

This shift in the brachiopod zonation can be due to palaeogeographical and evolutionary factors. There is an old idea /clearly proved in the case of ammonoids: GÉCZY 1976, 1984; ENAY & MANGOLD 1982/ that the majority of taxa have an earlier appearance and a longer range in the Tethyan areas of relatively stable environment than in the European shelf and epicontinental seas. A similar interpretation seems to be reasonable in our case too.

During investigation of this problem on the species level we meet the difficulty arising from provinciality. The brachiopod faunas with 64 species from the Causses /southern France/ and with 101 species from the Bakony Mts. /Hungary/ have only 6/!/ species in common. The ranges of these common species are shown in Fig. 1. It is apparent that /except the two terebratulids/ the species appear a little earlier in the Bakony than in the Causses. In contrast to the ammonoids, however, these brachiopod species disappear earlier in the Tethyan locality than in the NW-European one. Although this evidence is regrettably scarce, we may suppose

	Ammonoid zones	Bulgaria /Tchoumatchenco 1972/	Causses /Revert 1971/	Bakony /Vörös 1983/
TOARCIAN	Tenuicostatum	HOMOEORHYNCHIA ACUTA	-	-
PLIENSBACHIAN	Spinatum		HOMOEORHYNCHIA ACUTA	APRINGIA STOPPANII
	Margaritatus			
	Stokesi	ZEILLERIA CORNUTA	CIRPA BRISEIS	
	Davoei			LOKUTELLA KONDAI
	Ibex	TETRARHYNCHIA DUNROBINENSIS	GIBBIRHYNCHIA CURVICEPS	
	Jamesoni		TETRARHYNCHIA "TETRAEDRA"	CUNEIRHYNCHIA PALMATA
UPPER SINEMURIAN	Raricostatum			
	Oxynotum			
	Obtusum			? ? ?

Table I. Correlation between Lower Jurassic brachiopod zones of Bulgaria, southern France and the Bakony Mts. /Hungary/

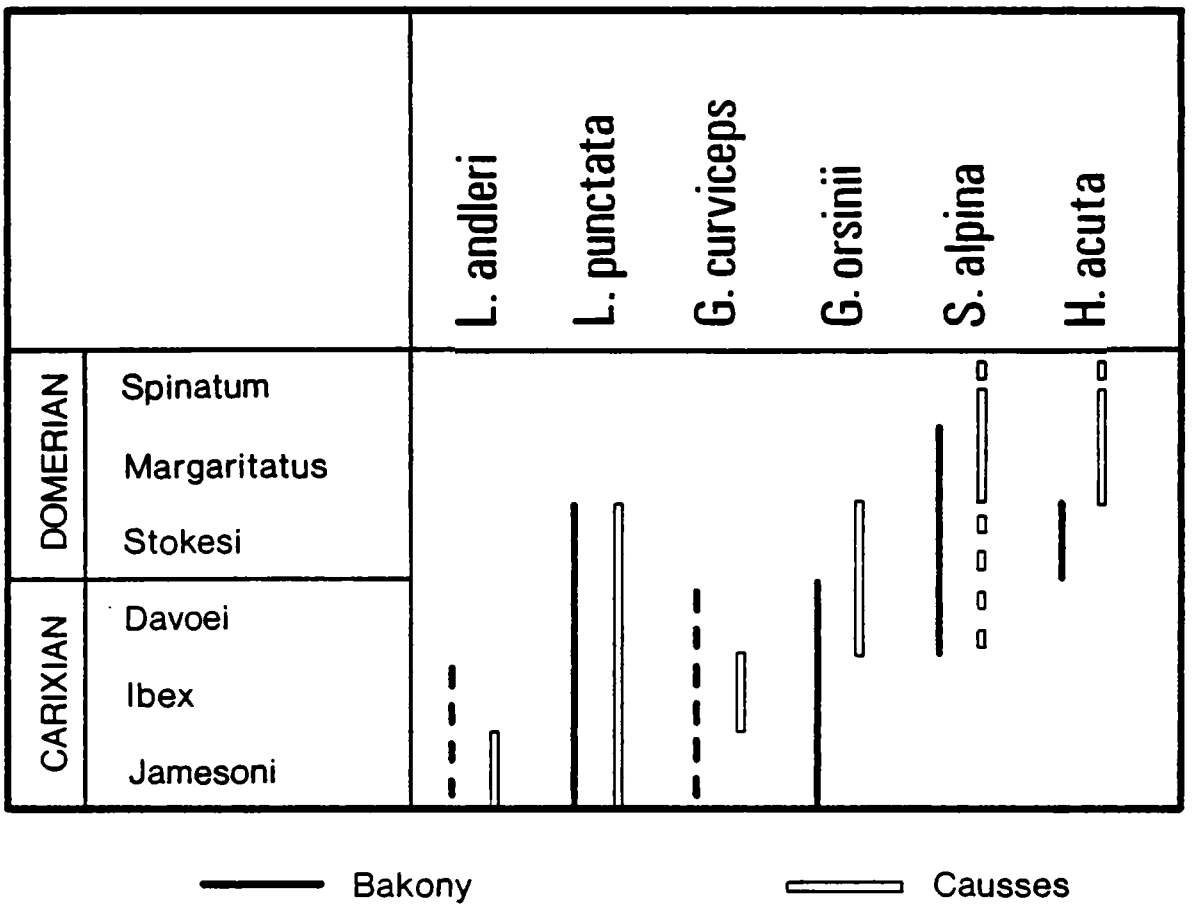

Fig. 1. Stratigraphical distribution of the Pliensbachian brachiopod species occurring both in the Bakony and in the Causses

that the shift in the brachiopod zonation is in connection with the faunal changes commencing earlier in the Tethyan region.

REFERENCES

AGER, D.V. /1956-67/: A monograph of the British Liassic Rhynchonellidae. - Palaeontogr. Soc. London, 172 p.

AGER, D.V. & CALLOMON, J.H. /1971/: On the Liassic age of the "Bathonian" of Villány /Baranya/. - Ann. Univ. Sci. Budapest., Sec. Geol., XIV. 5-16.

ALMÉRAS, Y., DELANCE, J.-H. & ROLLET, A. /1971/: Utilisation chronostratigraphique de quelques Brachiopodes jurassiques /exemples pris dans le Jura et Bourgogne/. - Mém. B.R.G.M. Fr., No. 75. 97-102.

ALMÉRAS, Y. & MOULAN, G. /1979/: Biostratigraphie des Terebratulidae et Zeilleriidae du Lias et du Dogger de la région Toulonnaise /Var, France/. - Géobios, 12. 6. 893-897.

ALMÉRAS, Y. & MOULAN, G. /1982/: Les térébratulidés liasiques de Provence. Paléontologie, biostratigraphie, paléoécologie, phylogénie. - Docum. Lab. géol. Lyon, No. 86. 1-365.

ENAY, R. & MANGOLD, Ch. /1982/: Dynamique biogéographique et évolution des faunes d'Ammonites au Jurassique. - Bull. Soc. géol. Fr., /7/ 24. 5-6. 1025-1046.

GÉCZY B. /1970/: Zones d'Ammonites pliensbachiennes dans la Montagne du Bakony. - Földt. Közl., 100. 3. 248-258. /in Hung./

GÉCZY B. /1976/: Les Ammonitines du Carixien de la Montagne du Bakony. - Budapest, 223 p.

GÉCZY B. /1984/: Provincialism of Jurassic Ammonites: examples from Hungarian faunas. - Acta Geol. Acad. Sci. Hung., 28. /in press/

REVERT, J. /1971/: Les brachiopodes du Lias moyen du Bassin des Causses. Étude biostratigraphique. - Géobios, 4. 3. 199-221.

TCHOUMATCHENCO, P. /1972/: Répartition stratigraphique des brachiopodes du Jurassique inférieur du Balcan Central et Occidental et du Kraiste /Bulgarie/. - Bull. Geol. Inst., Ser. Stratigr. Lithol., 21. 63-84. /in Bulgarian/

VÖRÖS A. /1982/: Stratigraphic evaluation of the Pliensbachian brachiopod fauna of the Bakony Mts. /Hungary/. - Földt. Közl. 112. 4. 351-361. /in Hungarian/

VÖRÖS A. /1983/: The Pliensbachian brachiopods of the Bakony Mts. /Hungary/: a stratigraphical study. - Fragm. Min. et Pal., 11. 29-39.

WATERHOUSE, J.B. /1977/: Chronologic, ecologic and evolutionary significance of the phylum Brachiopoda. - In: KAUFFMANN, E.G. & HAZEL, J.E. /Eds./: Concepts and methods of biostratigraphy. 497-518. Dowden, Hutchinson & Ross, Stroudsburg, Penns.

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