INTERNATIONAL SUBCOMMISSION ON JURASSIC STRATIGRAPHY

Newsletter No. 16

Jim

Copenhagen, November 1987

A SUBCOMMISSION OF THE INTERNATIONAL UNION OF GEOLOGICAL SCIENCES (IUGS)

Newsletter 16 November 1987

Report from the business meeting in Lisbon
with some additional remarks

The secretary reported on the last three years' activity. It was further emphasized that due to the statutes a new chairman and secretary have to be nominated before 1989, and that one third of the voting members must retire and a corresponding number of new members nominated. Retiring voting members would become correspondent members.

Enay was proposed as new chairman and Mangold as new secretary (generally accepted by the members present at the meeting). The formal nomination will be arranged by postal ballot in 1988. The present chairman and secretary will be in office until the next I.G.C. in Washington 1989.

Krishna and Roth were proposed as new voting members.

Ager, Holder and Jeletzky were proposed as honorary members. A meeting is intended to take place during the I.G.C. 1989 on "Jurassic system and stage boundaries in America".

A Field Meeting (Middle-Upper Jurassic) in India, autumn 1990, was proposed and accepted.
The 3rd International Symposium on Jurassic stratigraphy was proposed and accepted to take place in France in 1991.

FOOTNOTE

1) At present the following persons have been proposed as new voting members: Krishna, Mangold, Pavia, and Roth; as new correspondent members: Cecca (Italy), Mesezhnikov (USSR), Goy (Spain), Hantzpergue

(France), Gygi (Switzerland), Rakus (CSSR).

2) The procedure for nomination of new chairman, secretary, and voting members will be as follows:

- As soon as possible we will ask the present voting members whether they want to suggest further candidates for the new chairman and secretary.
- When the answers are presented to us (before January 31st) the nomination of a new chairman and a new secretary will be performed by postal ballot. This will probably be primo March.
- When nomination of chairman and secretary has taken place this procedure will be repeated for the retiring members and suggestion and nomination of new voting members.

Report from the working group meeting (Lisbon)

At the opening of the working group meetings the chairman gave some remarks concerning the new guide lines for selecting boundary stratotypes. A long and vivid discussion followed indicating some confusion about the guide lines and the term "zone". We think boundary stratotypes should be selected at localities representing continuous sedimentation and documented by as many fossil groups as possible. The boundary level should be traceable over large distances.

A new Working Group on Jurassic stratigraphy nomenclature has been proposed by A. Riccardi and I. Sapunov. It is now accepted and can go into activity. It is hoped that this group can clear up the confusion mentioned above and contribute to the new edition of the International Stratigraphic Guide.

Triassic-Jurassic boundary working group

Collection of samples is going on from the New York Canyon/Nevada, the only known Triassic-Jurassic section in the world without hiati. Reporting of the work is started.

It was also discussed to use a British type section, and then to place the boundary below the pre-Planorbis sequence. This was not favoured by the non-British scientists, as the megafossil evidences from the Triassic part are very poor.

It was decided that the working group shall report not later than the next meeting, and decisions are postponed until a full documentation of the New York Canyon section has been presented. In the meantime also other countries, especially Canada and South America, should be considered if they yield a continuous Triassic-Jurassic boundary section.

Sinemurian working group

The Sinemurian working group has continued the studies since the Erlangen meeting in 1984, and only a few results have been published. During the Lisbon meeting there were proposals and discussions concerning different horizons at which the stage boundary could be located,- 1) the base of the Conybeari Subzone or 2) the appearance of <u>"Schlotheimia" marmorea</u>. After some discussion the chairman of the subcommission proposed a voting. The majority of the participants voted for the retention of the traditional definition of the stage boundary at the base of the Conybeari Subzone (proposal 1). There was no vote for proposal 2.

A decision on a boundary stratotype was not yet possible. There is a general agreement that by tradition and due to presence of good exposures, that the section at the Dorset coast would be preferable. But the present state of knowledge of the ammonite fauna is insufficient. Therefore, a thorough restudy of the Dorset section and its ammonite fauna is necessary. The restudy will reveal if this section is comparable with sections in East France and South Germany in regard of completeness as well as of diversity and good preservation of the fauna.

Pliensbachian working group:

Since Schlatter was not present, Dommergues reviewed the work going on in the group.

Toarcian working group:

Fischer could not be present, so no discussion took place.

Aalenian working group:

Rieber was not present. The meeting was opened by the chairman and Ohmert gave the report.
There was a vivid discussion on selection of a boundary stratotype. Morton proposed a choice of stratotype in Scotland or South Germany. Ohmert discussed the section and its fauna in Rhein valley. Mouterde proposed a section in Portugal due to the presence of different biogeographic faunal elements.

A. Goy (Madrid) was elected as new convenor, replacing D. Contini.

Bajocian working group:

Pavia presented sections from Italy characterized by first appearance of some nanno-fossils. He asked for contribution of non-ammonite-stratigraphy.

Morton mentioned possible candidates for the type section, but Cap Mondego was given preference.

Pavia proposed a field meeting in Italy, July or October 1988. - Main objectives: Study of boundary stratotype, selection, conclusion (see the announcement of the meeting).

Bathonian working group:

Mangold presented a proposal for a boundary stratotype from SE France (Bas Auron). A proposal for the boundary between Middle and Upper Bathonian was discussed and was accepted unanimously by the colleagues present at this meeting. The boundary is now drawn at the base of the Orbis Zone, resp. the Retrocostatum Zone. The faunal horizon 11 is included in the Blanazense Subzone of the Retrocostatum Zone.

Callovian working group:

Calloman reported many progresses referring to subdivision and correlation of the stage. He explained once more the necessity of two standard zonations, Subborial and Submediterranean. He also mentioned that a boundary stratotype may be found in the Schwäbische Alb.

Oxfordian working group:

Melendez reported about progress and a large number of publications. He mentioned a few proposals for correlation of alternative biozonations with the ammonite zonation. He presented a long list of contributors on different fossil groups. Finally, he summarized a series of topics for the coming activities. - See announcement of a working group meeting.

Kimmeridgian working group:

Atrops could not be present, so Hantzpergue reviewed the problems. The classic propositions reappeared once more and were the matter of vivid discussions. Three main items were proposed and discussed: 1) Different acceptions of the Kimmeridgian stage, 2) the equivalence in Subboreal and Submediterranean provinces of the Oxfordian-Kimmeridgian boundary, and 3) the need for a precise definition of zonal boundaries, namely Divisum and Acanthicum Zones.

It was proposed and accepted by the majority of the participants to limit the extension of the Kimmeridgian stage to the usage in central and southern Europe, since it would allow uniformity of the vertical range of the stage in both Subboreal and Submediterranean provinces. It would, furthermore, have the advantage of making the choice of Tithonian as the terminal stage of Jurassic easier. The proposal will be subject of a formal voting of the subcommission.

Tithonian working group:

The meeting was opened by the chairman, A. Zeiss. A unified usage of a name for the uppermost Jurassic stage was discussed. Most of the participants favoured the usage of the Tithonian, because this term is used in approximately 75% of the world. A formal voting will be arranged by the subcommission in near future.

(The working group has been established formally at the meeting "Fossili, Evoluione, Ambients" in Pergola, 18th October, 1987. Chairman A. Zeiss, secretary F. Cecca).

Jurassic-Cretaceous working group:

See enclosure 6.

<u>Project proposal</u>

The following project proposal is prepared by M. Elias, who intends to apply for IGCP support. He needs a response from colleagues before the application is submitted to the IGCP office. Interested colleagues are asked to take contact with

Dr. Mojmir Eliaš
ÚÚG (Geological Survey)
Malostranski nam.19
Praha 1
118821 CSSR

Proposal: <u>"Jurassic system of the world"</u>

The scope of the proposal of the IGCP "Jurassic system of the World" is the global synthesis of stratigraphy of the Jurassic, correlation between the principal Jurassic areas, general problems of palaeogeography and the synthesis of the crustal development during this system.

The main proposed topics, which may be regarded during the project work are:

1. The global biostratigraphic correlation and chronostratigraphic correlation between the principal area, where the system is developed (including the ocean floor). Application of the concept of event stratigraphy, and the use of the geophysical correlation methods (seismic stratigraphy etc.). Methodological correlations between these methods.

2. The lithologic and palaeontologic characteristics of the main Jurassic facies and/or lithostratigraphic units and their sedimentological and palaeoecological characteristic (including ocean floor). Construction of facial models.

3. Compilation of facies successiosns and palaeogeographic maps in the scale 1 : 10 000 000 or 1 : 50 000 000 for the important chronostratigraphic levels. Compilation of these maps from some important areas may be in more detail scales.

4. The reconstruction of palaeobiogeographic situation for important stages of the Jurassic system.

5. Characteristics of the volcanic events during the Jurassic system.

6. Problems of the economic geology especially with regard to the sedimentary deposits, including coal, oil, and gas.

Some research of this project may be correlated with other IGCP projects and with the "Global sedimentary geology program".

Duration of this project may be 5 years. The tentative work schedule comprises the following items:

1987: Preparation of recommendations from institutions and and individuals which agree in cooperation, togeth-er with the summaries of present stage of the activity and themes and plans of the research which may be done for this project, together with important literature.

1988: Compilation of the project and presending of the proposal to the IGCP Secretariat.

1989-1990: Summary of the material, important stratigraphic correlations, special research.

1991-1992: Preparations of maps, models etc., special research

1993: Compilation of the final report.

Throughout the period: organization of workshops.

Expected results of this project are:

a) in theoretical sciences:

- the precision of global correlation of the Jurassic system of the world,
- global facies, palaeogeographic, palaeobiogeographic and palaeoecologic characteristics of the Jurassic of the world, climatic reconstruction and sea-floor spreading history of the Jurassic,
- correlation of the results of classical stratigraphic methods with event stratigraphic and geophysic methods.

b) in applied science and technology:

- precision of the stratigraphic tools for the purpose of the applied geology (coal, oil, and gas etc.)
- materials for constructions of prognosis for the prospecting of deposit.

Mojmir Eliaš

Announcement of next working group meetings

A meeting of the Bajocian working group is planned to take place in Piobbico (central Italy), 3rd to 6th July, 1988, by G. Pavia, Dipartimento di Scienze della Terra, Corso Massimo d'Azeglio 42, I-10123 Torino, Italy. The preliminary program is as follows:

- Proposal for the choice and formalisation of the Bajocian basal boundary stratotype.
- Presentation and discussion on the Bajocian zonal and subzonal review.
- Bajocian bio-correlations and multidisciplinary scale.
- Excursions on the Jurassic of the Piobbico surroundings and of Monte Nerone.

A meeting of the Oxfordian working group is intended to be organized at Zaragoza (Spain), most probably from September 24th to 28th, 1988, (just after the Spanish Jurassic Congress at Logrono). The meeting will be organized by G. Melendez, Depart. Paleontologia, Fac. Ciencias, Universidad Zaragoza-9, Spain. - The preliminary program includes one day of scientific discussions and three days of excursions (e.g. the classical Oxfordian of Aguilon and Tosos, Callovian and Oxfordian of Ricla, Moneva, and Arino etc.).

Enclosures

1) D. Guy-Ohlson: Swedish Report on Jurassic Research Acitivities (1984-1987).
2) E. Avram: New Data on Jurassic Biostratigraphy/Regional Stratigraphy in Romania.
3) A. Grigelis: New Data on the Stratigraphic Subdivision of the Jurassic by means of Foraminifers in the Baltic Area and East European Platform.

4) J.H. Callomon & G. Dietl: The Middle and early Upper Jurassic succession at Sengenthal, southern Franconian Alb, Germany.
5) G. Westermann: Brief Annual Report 1987.
6) J. Remane: Report on the field meeting of the Jurassic-Cretaceous boundary working group.

Arnold Zeiss Olaf Michelsen

SWEDISH REPORT ON JURASSIC RESEARCH ACTIVITIES (1984-1987)

During the past few years in Sweden there has been increased interest in the Jurassic. This applies not only to the Swedish Jurassic but also to that of other countries. This has been due partly to the commencement of new research projects at different institutes and partly to the number of guest scientists visiting Sweden for varying lengths of time. A brief general survey of the research activities from 1984-1987 is given below in tabular form and followed by a list of references.

NAME	INSTITUTE & ADDRESS	RESEARCH ACTIVITIES & PROJECTS	ADDITIONAL COMMENTS*
Kent Larsson (KL) (Professor)	Dept. of Historical Geology & Palaeontology, Univ. of Lund, Sölvegatan 13, S-223 62 Lund, Sweden	Clay mineral studies of Swedish Upper Jurassic sediments	Work in progress with ME
Mikael Elström(ME) (Research student)	" "	" " " "	" " " KL
Anders Ahlberg(AA) (Research student)	" "	Sedimentological studies of LJ	Manuscript in prep.
		Petrographicical " " "	Together with GP
Sofie Lindström	" "	Lower Jurassic palynomorphs	Report no. 23
Gregor Pienkowski§ (GP) Guest scient.	" "	Sedimet. & petrograph. studies of LJ. Comparison Swed./Poland	Together with AA & KL
Ulf Sivhed (Dr.,Stategeologist	Geological Survey of Sweden, Kiliansgatan 10,223 50 Lund	Jurassic bio- and lithostratigraphy (ostracodes)	Nos. 28-32
Erik Norling (Dr., Docent)	Geological Survey of Sweden Box 670, S-751 28 Uppsala	Jurassic bio-,litho-& chronostratigraphy, structural geology (forams)	Nos. 24-27, 21
Akihiro Kano (Research student)	Section of Palaeozoology, Swed. Mus. Nat. History,Box 50007, S-104 05 Stocholm	Facies studies of SW Japan (Tithonian)	No. 22
Shuying Duan § (Guest scientist)	Section of Palaeobotany, Swed. Mus. Nat. History,Box 50007, S-104 05 Stockholm	Chinese Jurassic floras (megafossils). Comparative studies with Europe & Greenland	Completed PhD (Univ. of Stockholm) Nos. 2-3
Carole T. Gee § (Guest scientist)	" "	Revision of Hope Bay Flora, Antarctica-classic ref.collection for Jurassic S. Hemisphere	Completed PhD (Univ. of Texas at Austin) No. 4
Dorothy Guy-Ohlson (Dr., Docent)	" "	Jurassic biostratigraphy - all plant groups and palynomorphs	Nos. 5-21

§ Present addresses of guest scientists: G. Pienkowski, Geol. Inst., Dept. of Petrography & Mineralogy, Rakowiecka 4, 02-519 Warsaw, Poland; S. Duan, Inst. of Botany, Academi Sinica, Beijing, China and C.T. Gee, Geologisches Institut, ETH-Zentrum, Sonneggstr. 5, CH-8092 Zurich, Switzerland.
* Numbers (nos.) refer to cited literature list. LJ = Lower Jurassic.

CITED LITERATURE

The references included in this list have either been published (1984-1987) or are at present in print or under preparation.

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2. Duan, S., 1987: The Jurassic Flora of Zhaitung, Western Hills of Beijing. Department of Geology, University of Stockholm and Department of Palaeobotany, Swedish Museum of Natural History, Stockholm: 1-95. (Ph.D. thesis).

3. Duan, S., 1987: A comparison between the Upper Triassic floras of China and the Rhaeto-Liassic floras of Europe and East Greenland. Lethaia, 20: 177-184.

4. Gee, C.T., 1987: Revision of the Early Cretaceous flora from Hope Bay, Antarctica. Department of Botany, University of Texas, Austin, Texas: 1-120. (Ph.D. thesis).

5. Guy-Ohlson, D., 1984(a): Lower Jurassic (Toarcian) palynology of the Vilhelmsfält Bore No. 1, NW Scania, southern Sweden. Sixth International Palynological Conference, Calgary, Canada: 58.

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8. Guy-Ohlson, D., 1984(d): Palynology of Swedish Upper Jurassic sediments. American Association of Stratigraphic Palynologists, Annual Meeting, 1984: 9.

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17. Guy-Ohlson, D., Arremo, Y. & Imby, L., 1984: The use of ultrasonic cleaning in the preparation of samples for palynological investigations. Sixth International Palynological Conference, Calgary, Canada, 1984:59.

18. Guy-Ohlson, D. & Malmquist, E., 1985: Lower Jurassic biostratigraphy of the Oppegård Bore No. 1, NW Scania, Sweden. Sveriges geologiska undersökning, Rapporter och meddelanden, 40: 1-27.

19. Guy-Ohlson, D. & Lindqvist, B., 1986: The presence and significance of reworked Carboniferous spores in Swedish Mesozoic sediments. American Association of Stratigraphic Palynologists, 19th Annual Meeting held jointly with Commission Internationale de Microflore du Paleozoique: 14.

20. Guy-Ohlson, D., Ohlson, N.G. & Lindqvist, B., 1986: Fossil palynomorph deformation and its relationship to sedimentary deposition. 17:e Nordiska Geologmötet: 52.

21. Guy-Ohlson, D., Lindqvist, B. & Norling, E., 1987: Reworked Carboniferous spores in Swedish Mesozoic sediments. Geologiska Föreningens i Stockholm Förhandlingar, 109:4.

22. KANO, A., 1988: Facies and depositional conditions of a carbonate mound (Tithonian-Berriasian, SW Japan). Facies, 18:27-48.

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(1984-1987)

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NEW DATA ON JURASSIC BIOSTRATIGRAPHY/REGIONAL STRATIGRAPHY IN ROMANIA

As the major features of the Jurassic stratigraphy in Romania have been established for a long time, the new data concern especially the biostratigraphical correlation of various Jurassic rock-sequences and their structural framework. These data are due to: Aurelia Bădăluţă (ammonites, tintinnids, plant remains), Aurelia Bărbulescu (ammonites, brachiopods), Victoria Culda (plant remains), Ion Preda (ammonites, plant remains), Ovidiu Dragastan (algae, tintinnids) and Eugen Grădinaru (ammonites) - from the University of Bucharest; Ilie Turculeţ and Constantin Grasu (ammonites, aptychus) - from the University of Jassy; Dan Patrulius (ammonites, crustaceans), Elena Popa (ammonites), Camelia Tomescu (microbiofacial studies), Magdalena Iordan (brachiopods), Emil Avram (ammonites, tintinnids), Paulian Dumitrică (radiolarians), Emanoil Antonescu (palynomorphs) and Grigore Pop (tintinnids) - from the Romanian Institute of Geology and Geophysics; Nicolae Balteş and Maria Moldovanu (palynomorphs) - from the Oil Geology Research Institute. The regional studies on the stratigraphy and structure of the Jurassic rock-sequences were completed by Mircea Săndulescu in the East Carpathians, by Sergiu Năstăseanu in the South Carpathians, by Marcian Bleahu, Marcel Lupu and Gheorghe Mantea in the Apuseni Mountains, and by Andrei Drăgănescu in the Moesian Platform - all of them from the Institute of Geology and Geophysics, and also by Eugen Grădinaru - from the University of Bucharest, in the North Dobrogea. Some studies on the ammonite biostratigraphy were also undertaken by Dan Grigore, an young graduate of the Faculty of Geology - University of Bucharest.

In a structural and geographical order (from the inner Carpathian structural units of the Apuseni Mountains, NW Romania, to the Carpathians foreland units in the south and east of Romania), the above mentioned authors' contributions are as follows:

- In the NORTHERN APUSENI MTNS (= Bihor autochthon), the Jurassic rock-sequences were investigated in the last years by Popa (1981), Mantea et alii (1982), Mantea (1985), Popa et alii (1985, 1987), Patrulius (in press - a), with new data in Carixian, Domerian, Toarcian, Bathonian/Callovian ammonite and forams assemblages and also in the Middle and Upper Jurassic brachiopod, pelecypod, algae, chaetetid and hydrozoan assemblages. In the same region, Dragastan et alii (1986) studied the biofacial features and lithofacial variations of the Oxfordian- Lower

Aptian rock-sequences.

- In the SOUTHERN APUSENI MTNS, the micropaleontological and biof cial data of the Metaliferi Mtns Oxfordian and Kimmeridgian calcareous succession were presented by Mantea & Tomescu (1986) besides some contributions on the structure of the mentioned area; in the Drocea Mtns, Dumitrică investigated the Upper Jurassic radiolarians, in order to de cipher the stratigraphy of the flysch deposits and to establish the ag of the ophiolite flows (data in preparation,as part of more extensive paper by Lupu, Avram, Dumitrică and Antonescu concerning the stratigra phy and structure of the Jurassic-Cretaceous rock-sequences of the Dro cea Mtns, to be printed).

- Between the"classical"Upper Jurassic fossiliferous sites of the EAST CARPATHIANS, that of the Hăghimaş (Transylvanian) nappe in the Bi caz Gorges-Lacul Roşu area was revised by Turculeţ (198o), who listed all the Uppermost Oxfordian-Lower Tithonian species of ammonites, belemnites, brachiopods, etc., here recorded in some 1oo years of paleon tological studies. Southwards, in the Perşani Mtns, the similar Transylvanian rock-sequences offered a rich brachiopod assemblage of presu med Rhetian age, described by Patrulius (in press - b). In the norther East Carpathians Bucovinian nappe, the Uppermost Jurassic rock-sequences yielded some tintinnid assemblages, published by Pop (1987).

- The SOUTH CARPATHIANS Middle Jurassic ammonite assemblages of the Getic Nappe were investigated in the Reşiţa syncline by Năstăseanu & Bădăluţă (1984); in the same region, the Uppermost Jurassic microbio facies were studied by Bucur (in Bucur et alii, 1981, and in Avram et alii, 1987) and some Lower Jurassic plant remains are in preparation for printing, by Bădăluţă, Preda and Culda. At the eastern end of the cropping area of the same structural unit - in the Dîmbovicioara-Braşo region - a rich assemblage of Oxfordian-Kimmeridgian ammonite species was recorded by Dan Grigore, some Middle Jurassic ammonite assemblages from the Codlea region are being studied by Grădinaru (unpublished yet) and also, a few Uppermost Kimmeridgian ammonite species were described by Avram (in press - a). The South Carpathians Danubian units (= Marginal Dacids sensu Săndulescu, 1984) offered some Lower Jurassic plant remains in the Sirinia (Pregheda), Obîrşia Cloşani and Schela regions, stu died and partly published (in 1985) by Preda, Culda, Bădăluţă and Stre gă; in the same region, the tintinnid assemblages of the Jurassic-Cret ceous boundary beds in Svinița area were published by Avram (1984) and by Pop (1986) and also, the Bathonian-Callovian ammonite assemblage of the classical fossiliferous site of Saraorschi valley is now revised by Bădăluţă and Avram.

- As for the CARPATHIANS FORELAND UNITS, some palynological studies, carried out in the Moesian Platform and Bîrlad depression (=Scythyan Platform, in Săndulescu, 1984), were published by Moldovanu (1982, 1984, 1987 in press) and by Antonescu (in Iordan et alii, 1987), a sedimentological and paleontological study of the Middle Jurassic in the Central Dobrogea was published by Drăgănescu & Beauvais (1985) and a description of the Middle Jurassic ammonite assemblages of the Moesian Platform is in preparation for printing, by Bădăluţă & Muţiu; at last, the Jurassic stratigraphy of the North Dobrogea was revised and completed by Grădinaru (1981, 1984).

Finally, besides the above mentioned studies, some others refer to more general subjects of the Jurassic stratigraphy and/or biostratigraphy in Romania: Patrulius (in press - c) and, respectively, Dragastan (1985), Dumitrică (in press) and Avram (in press - b).

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Enclosure 3

NEW DATA ON THE STRATIGRAPHIC SUBDIVISION OF THE JURASSIC BY MEANS OF FORAMINIFERS IN THE BALTIC AREA AND EAST EUROPEAN PLATFORM

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New data were obtained currently on foraminifers and the stratigraphic subdivision of the Jurassic of Baltic and East European platform. The establishment of foraminiferal zones has resulted from the study of the Baltic Jurassic; and the correlation of the zonal units exemplified by the Upper Jurassic of the East European platform.

1. The recognition of Foraminiferal Zones

Three major criteria: biozonation, phylogenies and stages, revealing the nature and composition of the zones,- have been used by the establishment of foraminifer zones (Grigelis, 1985a).

The Biozonation Criterion. By establishing foraminiferal zones, the species biozones serve as the first principal criterion. The Jurassic foraminifer biozones are established empirically. A usual discontinuous distribution pattern of particular species, the recognition of complete biozones is inferred from the analysis of 6-10 sections. The biozones are dated using key sections by means of stratigraphic units based on other faunas groups. Thus generalized biozones within a paleobasin are frequently combined of several different intervals abstracted from certain sections and correspond to a known extent (Fig. 1). The species biozones may vary from basin to basin due to the migration paths of the fauna. Only complete sections are to be used for biozone recognition. The analysis of the foraminifer species biozones for the Baltic Jurassic shows that from the Middle Callovian to Kimmeridgian, 91 species out of 199 exsisted during the formation of a zone (i. e. about 1-1.3 m. y.), 60 species - of two zones, and 21 species - of three and four zones and 6 species of five zones. The recognition of biozones of scarce, scanty species is less reliable.

The biozones of stratigraficaly important species of the Baltic Jurassic are shown in Figure 2. The biozones of these and a number of other species known elsewhere on the East European platform and from West Europe can be considered as fairly true. Thus we substantiate a choice

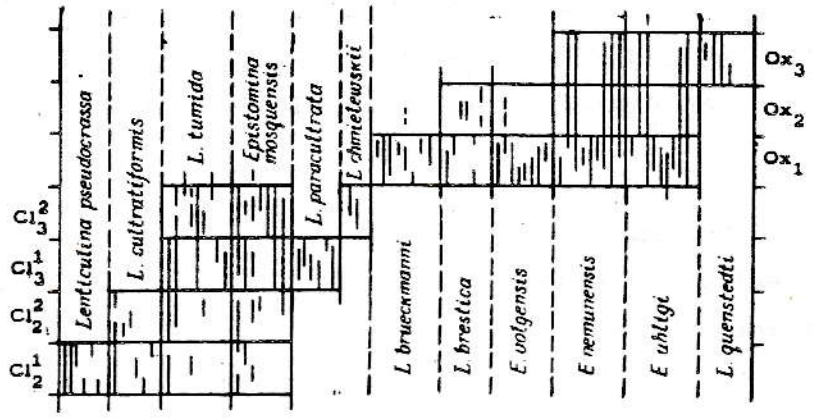

Fig. 1. The distribu tion of some foramin fera species in the Callovian–Oxfordian sections of the Balti area (after Grigelis 1985a).

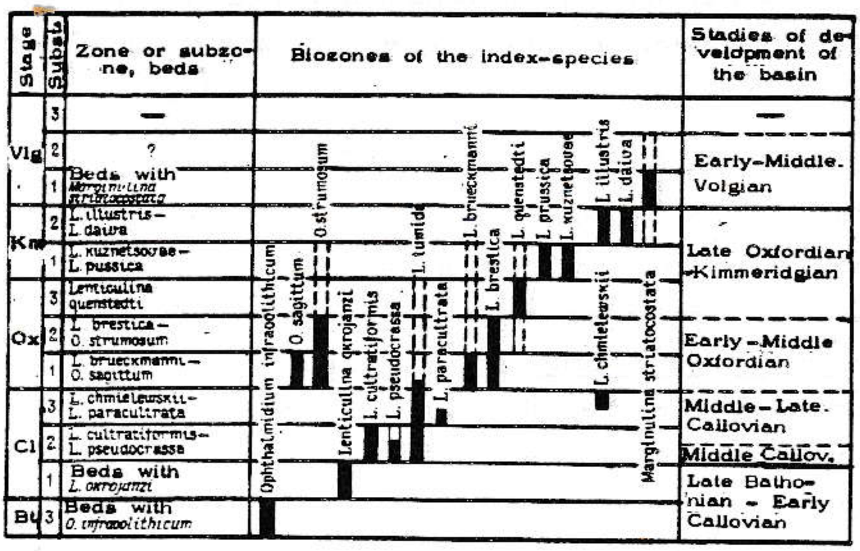

Fig. 2. Index-specie biozones for the Bal tic Jurassic: black – the Baltic; dotted lin – Europe (after Grig lis, 1985a).

of index-species for zones to be established. It should be noted that the biozones range of species Lenticulina tumida Mjatliuk, L. brueckmanni (Mjatliuk) and L. quenstedti (Gümbel) are greatly extended (see Fig. 2, dotted line) because they are considered in a vary broad sense. Paleontological studies show that this statement is groundless and other species were found within the intervals discussed / Lenticulina sublenticularis (Schwager), L. sambica Grigelis, L. prussica Grigelis / (Grigelis, 1985b).

The Phylogeny Criterion. Owing to the well known Jurassic systematics and the morphology of foraminifers the evolution of many probable lineages and groups can be traced. Importance for zonal stratigraphy are the following lineages of genera: Ophthalmidium, Lenticulina, Astacolus, Saracenaria, Planularia, Citharina, Citharinella, Marginulina, Marginulinopsis, Pseudolamarckina, Paulina, Epistomina, Mironovella and others characteristic of the nodosariid-epistominid type Boreal fauna (Grigelis, 1982).

In recent years the main specific groups have been studied from the Upper Jurassic of the Baltic and other areas of the East European platform. These groups are: Lenticulina tumida, L. cultratiformis, L. polonica, L. brueckmanni, L. lithuanica, Astacolus russiensis, Pseudolamarckina rjasanensis, Epistomina mosquensis, E. elschankaensis, E. callovica, E. volgensis. Their relations to the Middle Jurassic foraminifers was found. Their lineages makes possible to more reliably locate a taxon in the evolutionary series and to reveal missing links or in some cases to find them as well as to better determine the composition of stratigraphic units.

Among the descrete characters many are used in phylogenetic analysis: diameter and thickness of tests, shape of chambers, convexity and sutures slope, ornamentation, medium height of the aperture surface, the number of chambers in a whorl. Besides, sincrete characters are determined in each group: length, thickness, relative height of the aperture surface, convexity of the sides (in trochoid forms). By the analysis of a phylum as a whole, similar morphometric characters, a regular trend in their change and that of morphologic characters (ornamentation very often) are revealed; other groups, when the species are compared, exhibit irregular size and only some individual parameters show a regular trend.

Thus, for instance, in a large group Lenticulina tumida, characteristic of the Callovian-Kimmeridgian (Fig. 3), a genetic similarity of the species is reflected in such common characters of the structure as unornamented tightly rolled test, average in size, rounded or slightly elongate (D:d is 1.14 to 1.18), thick, with a low or medium relative height of the aperture surface (ham:D = 0.25–0.35). Species of the group are frequently diagnosed using insignificant differences in size and proportions of a test, the change in the shape of chambers, a slope of sutures their convexity and width. Morphogenesis of a group is reflected in the increase of thickness, medium height of the aperture surface and the overall diameter of a shell. The above qualitative features change as well.

Of interest is the most abundant group Lenticulina brueckmanni known throughout the Late Jurassic because of its phylogeny. In our opinion this group is a lineage originating from early Bathonian – early Callovian Lenticulina parvula Hoffman (Fig. 3). The representatives of the Volgian relate the phylum to those of Early Cretaceous. L. brueckmanni tests are relatively large and thickwalled unlike thinwalled tests of L. polonica, medium to large in size with differently ornamented septal sutures, in umbilical area and on the wall surfaces. They are moderately or considerably elongate (D:d = 1.18–1.45),thick, mainly with relatively high aperture surface (ham:D = 0.35–0.61). The keel on the peripheral margin of the test is formed repeatedly. The evolution is displayed in the change of ornamentation the dicrease of length and a relative height of the aperture surface. The size of the test changes irregularly.

The representatives of the group Epistomina mosquensis including species with original two-layered wall of the test have a rounded convexo-convex test (D:d = 1.11–1.21; d:H = 1.56–2.08) with well developed lamellar ribs in place of the spiral and septal sutures, a thin wall having thorns or tubercles (Fig. 4). The evolution of the group was reflected in the Callovian and Oxfordian in a more complex ornamentation, flattenne test and number of chambers of the last whorl. And in the Kimmeridgian (Epistomina arkelli) ornamentation became simpler, size smaller and a number of chambers in the last whorl decreased. The Early Cretaceous (Aptian–Albian) Epistomina spinulifera Reuss seems to belong the phylum

A very large and complex group Epistomina callovica contains 17 species of the Callovian–Volgian age. Four lineages can be traced in the evolution of the group. On the whole, it is moderately or strongly biconvex tests (D:d = 1.04–1.23; d:H = 1.43–2.08) with a smooth wall and broad raised septal sutures. Apart from size and proportions of tests, the width of whorls, the width of septal sutures, shape and extent of chamber lobes are diagnostic characters of the species. The evolution of the group displays the increase of overall size and the change in the outline of a test, in the shape of chambers and sutures.

In addition to above, there are phyla represented by a small lineages of species. The affinity is evident from their morphology.

<u>The Criterion of Stage Pattern.</u> Stages in the evolution of the faun is a principal criterion used for substantiation of stratigraphic boundaries. The stages are related to the periodicity of geological events and caused by biotic and abiotic factors, the former determines the evolutionary changes proper and the latter affects a peculiar aspect of the fauna, which is obvious but less important for the purposes of zonal stratigraph

In our opinion, it is possible to distinguish the nature of evolutionary changes from those due to ecology may be showing relations between the development of a paleobasin and the stages in the evolution of foraminifera. For examples, the evolutionary features of the Jurassic foraminifers known from different parts of the East Europe may be due to distribution of numerous species of the genera Lenticulina and Marginulinopsis in the Late Callovian, Citharina in the Early Kimmeridgian, Epistomina and Mironovella in the Late Kimmeridgian basins. Sporadic

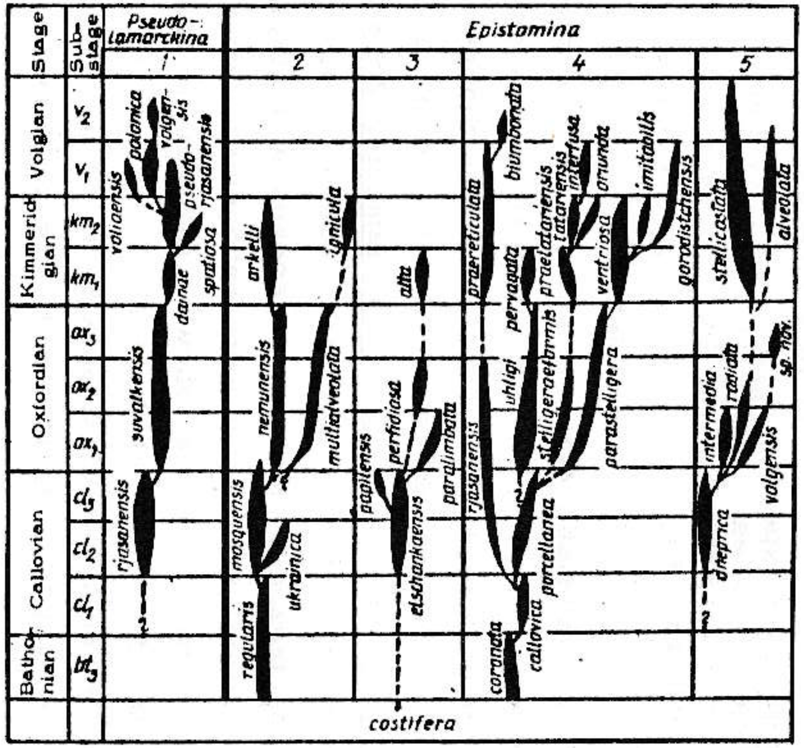

Fig. 4. Phylogenetic lineages of the Late Jurassic foraminifers for the groups: 1 – Pseudolamarckina rjasanensis; 2 – Epistomina mosquensis; 3 – E. elschankaensis; 4 – E. callovica; 5 – E. volgensis (after Grigelis, 1982).

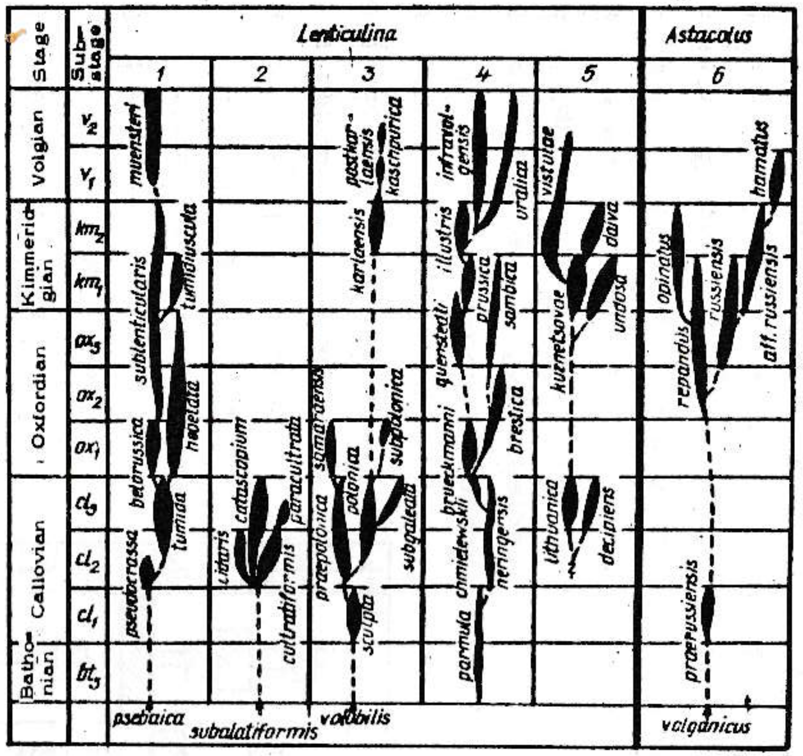

Fig. 3. Phylogenetic lineages of the Late Jurassic foraminifers for the groups: 1 – Lenticulina tumida; 2 – L. cultratiformis; 3 – L. polonica; 4 – L. brueckmanni; 5 – L. lithuanica; 6 – Astacolus russiensis (after Grigelis, 1982).

appearance of the agglutinated species of foraminifera in the Upper Callovian and Upper Kimmeridgian, genus Ophthalmidium in the Oxfordian, abundant Lenticulinidae in reefal facies of the Middle and the Upper Oxfordian are also classed as the ecologic characters due to local migration and the occupation of the empty niches.

Stages in the evolution of foraminifer fauna in the Baltic Late Jurassic basin are established on the ratioes of the appearing, surviving and disappearing species,taking into account their abundance and the change in their systematic composition (Fig. 5). The data prove that against the background of a fairly gentle (if it is approximated) curve showing the changes in the overall number of species corresponding to an important stage in the evolution of the foraminifer fauna as a whole we can recognize five stages: Late Bathonian-Early Callovian, Middle Callovian, Late Callovian, Oxfordian, and Kimmeridgian-Early Volgian. The early interval of each stage is marked by predominance of new species (from 59 to 97 per cent), and later intervals are dominated by surviving and disappearing species. Therefore, the stages are devided into 12 small phases. Two or three in each stage. The systematic composition of foraminifers is not so less contrasting because the evolutionary changes of this essentially uniform fauna mainly occur at a specific level, and the changes in the generic composition, with rare exceptions are due to migration.

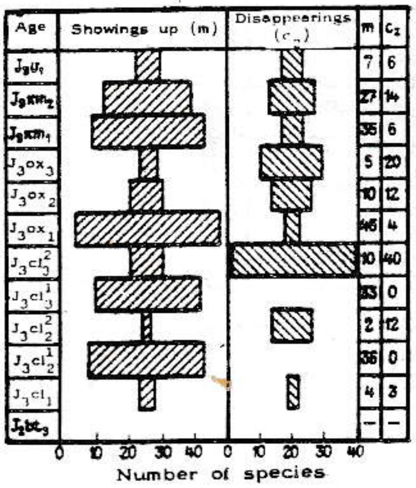

Fig. 5. Appearing to disappearing foraminifer species ratio in the Baltic Jurassic (excluding transit species) (after Grigelis, 1985a).

The Nature and Composition of Foraminifer Zones. The development of the zonal stratigraphic scheme is based, as it is shown, on the study of species biozones, their phylogeneses and stages of the evolution. Hence the foraminifer zones were recognized owing to the detailed regional studies. They have the following features in common.

The foraminifer zones of the Baltic Jurassic are established using the combination of species, a fairly large number of species being in our disposal (Fig. 6). The units are determined by the specific taxa distribution resulted from stages in their evolution. Since the systematic composition of foraminifers shows that the most important features are persistant within the basin studied, and in general within the

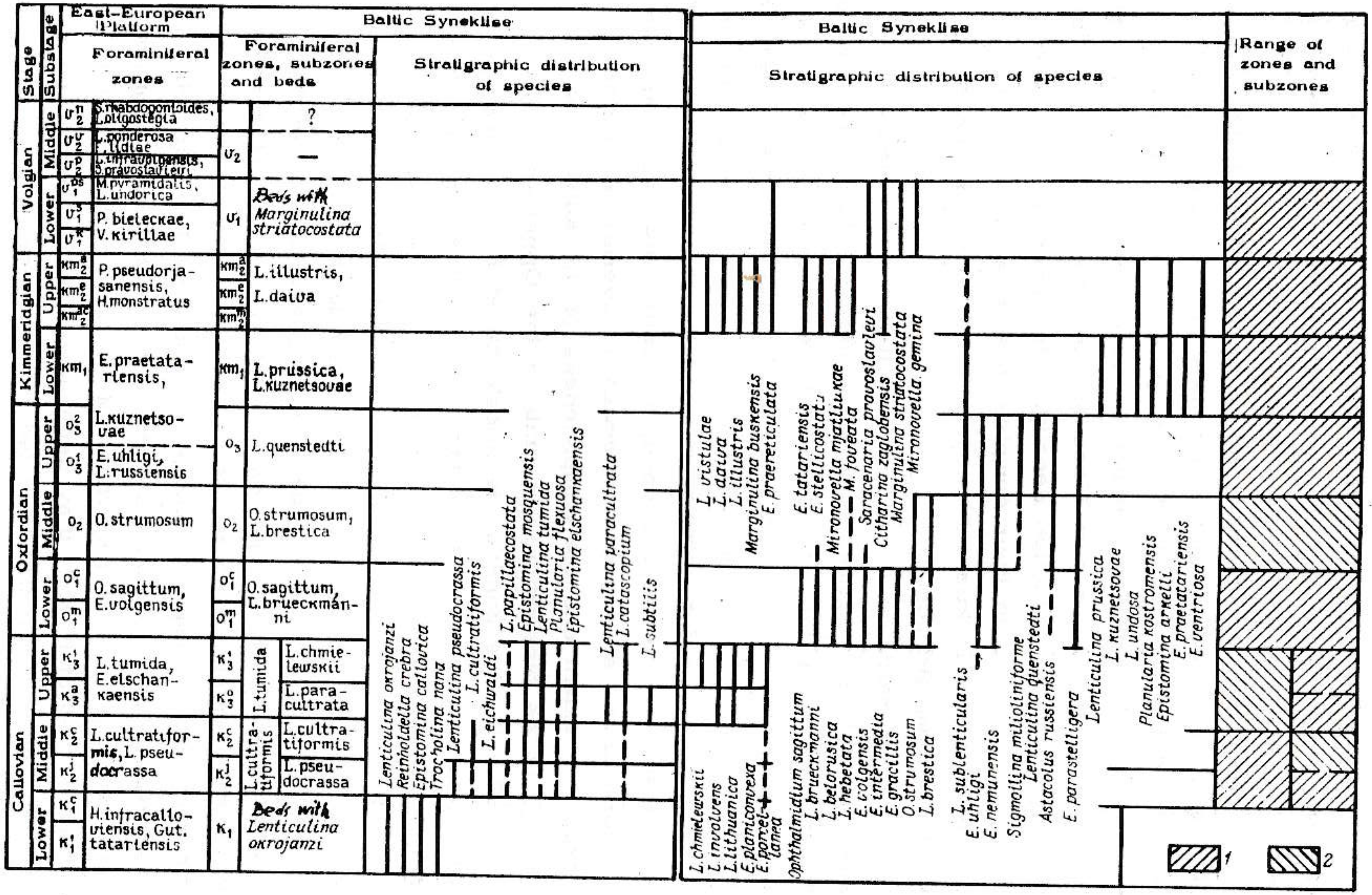

Fig. 6. Foraminifer zones of the Baltic Jurassic and the regular change of zonal assemblages: 1 - range zones; 2 - concurrent range zones (after Grigelis, 1985a).

Boreal-Atlantic realm then evolutionary change of species took place in the same time and hence we can draw isochronous zonal boundaries. This conclusion is an important premise for the biostratigraphic correlation of zones within a realm (or within a province) of the distribution of a single paleobiogeographic type of fauna.

The second important feature of foraminifer zones is a possibility to use for their substantiation the data on phylogeny of many reliable species groups. Lineages of many genera form a continuous succession of species. Therefore, a zonation is based on index-species equivalent not only to the well-known biozones, to a certain step of a lineage and having a certain population density. Index-species have interval in a sec tion corresponding to their complete biozones (Lenticulina cultratiformis, L. quenstedti or L. kuznetsovae) or to an acme (L. tumida, L. brestica, Ophthalmidium strumosum).

The foraminifer zones have at least two important features. First, they have distinct elements of phylozones but the former are substantiated by many phylogeneses and index-species of adjacent zones can be taken from the same or different phylums. A zonal scheme based on lineages lessens the importance of local factors (ecological including) and allows for wider correlation, predetermining a continuous (standard) succession of intervals. Second, the zones discussed are polytaxa and conform to the stratigraphic intervals of overlapping ranges of several taxa. The extent and the completeness of the substantiation permit to rank them as biostratigraphic units of the Oppelzone type.

Finally, the zonation is substantiated by the stages in the faunal evolution. However, different stages are interrelated with respect to a similarity of their taxonomic composition. Hence, the choice of a zonal assemblage or community even the closest units (adjacent subzones) should strongly emphasize both their similarity and difference.

The study of biozonation and phylogeneses gives the insight into age succession and uniqueness of the composition of zonal assemblages while the analysis of zonal communities of different age shows a taxonomic rank and an important stage in evolution. The subdivision of zonal assemblages into components make possible the establishment of a similarity and a degree of renovation of the assemblages and to substantiate a rank of a straton wich they determine. The difference and similarity between zones is clearly reflected in a regular change of appearing and disappearing species (Fig. 7).

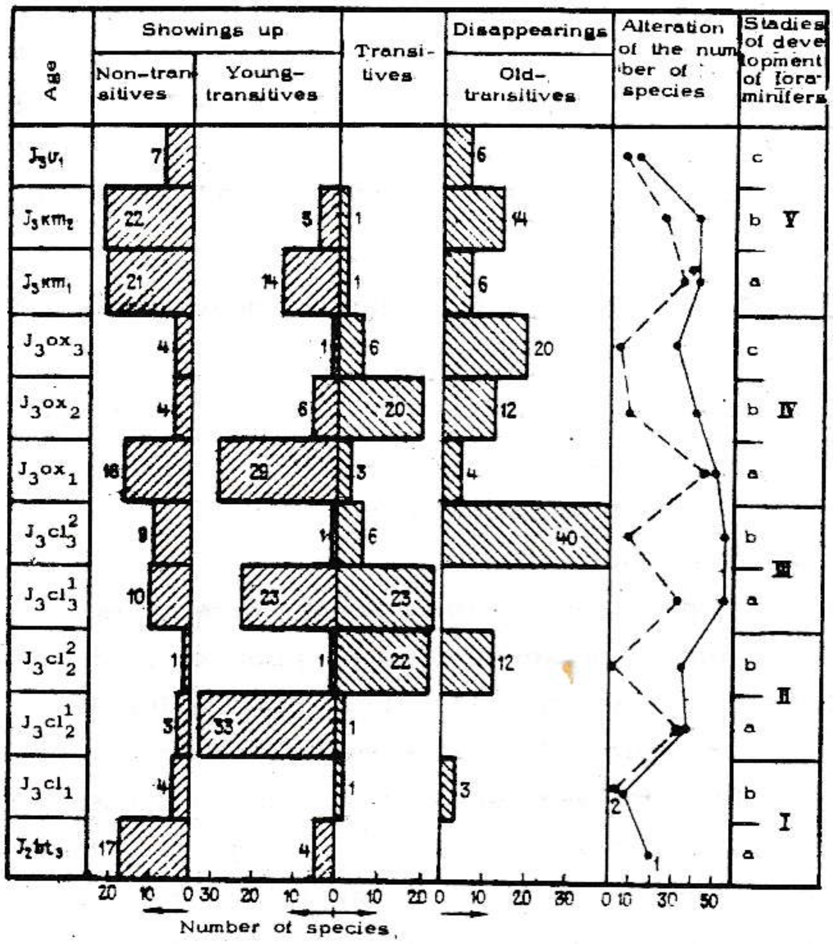

Fig. 7. The structure of the associations and the stages of the development of foraminifers in the Baltic Jurassic: To the right – the curves showing the change in the overall number of species (1) and of the first appearance species (2) (after Grigelis, 1985a).

The data on the Baltic Jurassic make it possible to define two gradations for adjacent stratigraphic units of the Long coefficient (RL)*. 1) When RL 0.8 stratigraphic units differ to a rank of subzone; assemblages do not renovate considerably ($m.100/n \leqslant 18$ per cent); 2) When $RL < 0.8$ stratigraphic units differ to a rank of zone, with $RL < 0.2$ boundaries of the adjacent zones differ greatly and the next assemblage is renovated almost completely ($m.100/n \geqslant 80$ per cent), and with $RL = 0.8-0.2$ zone boundaries are still rather distinct, the renovation amounts to 20–65 per cent.

The foraminifer zones for the Boreal Upper Jurassic are determined their zonal assemblages based on the species lineages which are fairly uniform within the Boreal-Atlantic paleozoogeographic province. These

$$*RL = \frac{C(n_1 + n_2).100}{2(n_1.n_2)},$$

where C, the number of species common for 2 assemblages; n_1, the number of species in a larger assemblage; n_2, the number of species in a smaller assemblage; m, appearing species; n, the overall number of species.

stratons differs in ratioes of intransit and transit species, appearing and disappearing of certain levels, which allows the rank of a zone and to be objectively assessed. An accurate diagnosis of zonal assemblage defining a given zone is very important for a foraminifer zone determination.

The zonal foraminiferal scale for the Upper Jurassic is evolutionary by nature and polytaxa by its content.

2. Correlation of the Jurassic Zonal units by means of Foraminifers

The Biostratigraphic Correlation Criteria. Among different approaches to biostratigraphic correlation of the Meso-Cenozoic, including Jurassic foraminifers, the best results are provided by a method of assemblages (communities), whose conclusions may be verified and refined by a quantitative assessment (Grigelis, 1985a).

There are regional and interregional correlations.

The determination of specific composition of local assemblages within a paleobasin, their comparison and establishing of local zones should precede a regional correlation. The data available form a basis for a regional correlation. It involves the analysis of the composition of zonal communities not related to a particular section within a range of a biogeographic type fauna. The comparison of community compositions provides to ground a rank of regional zones and to assess a similarity and differences of their specific content. The objectivity of the assessment is verified by the calculation of the community coefficient.

The interregional correlation is used for different paleogeographic realms and various foraminifer faunas. Naturally, the correlation criteria will be different. For the Jurassic foraminifers correlative levels may be distinguished where the migration and shifting of the paleozoochoric boundaries take place or where individual species to straddle biogeographic boundaries.

The data available allows us to draw a conclusion that regional correlation, practically, is the correlation of zonal communities using taxa common for adjacent regions. In case of the interregional correlation we use those areas where zones of adjacent regions i.e. various paleobiogeographic provinces are established. The Pechora syneklise ("West-East" correlation) and the North Caucasus ("North-South" correlation) are such regions for the zonal correlation for the Upper Jurassic of the East European platform and adjacent areas.

The sequence of Foraminifer Zones in the Jurassic of the East European Platform. The zonal subdivision of the Jurassic deposits of the East European platform by means of foraminifers was carried out by a group of specialists during the period of 1970-1979. As a result, the first zonation for the Callovian-Volgian was adopted. (Grigelis, ed., 1982). A standard succession of foraminifer zones in the region was found and it was correlated with biozones of index-species and zonal species, many of wich are represented by a certain part of a given phylum (Table 1).

The Correlation of Foraminifer Zones of the Boreal Realm. The criteria of the interregional correlation help to understand and assess the possibilities of correlation of the Jurassic foraminifer zones within the USSR. It is based on the zoogeography of the Jurassic foraminifers. There are three main types of the Jurassic benthic foraminifers forming the largest communities. The distribution areas of foraminifer faunas on the whole comply with paleozoogeographic zonation of the Jurassic seas recognized using other faunal groups: Cyclammininae - Pavonitid type occur in the Tethys realm, Nodosariid - Epistominid type in the Boreal-Atlantic area, and Nodosariid - Ammodiscid type in the Arctic area of the Boreal paleozoogeographic realm (Fig. 8). Notal, essentially Nodosariid - Epistominid fauna is found in the Southern Hemisphere. The zoogeography

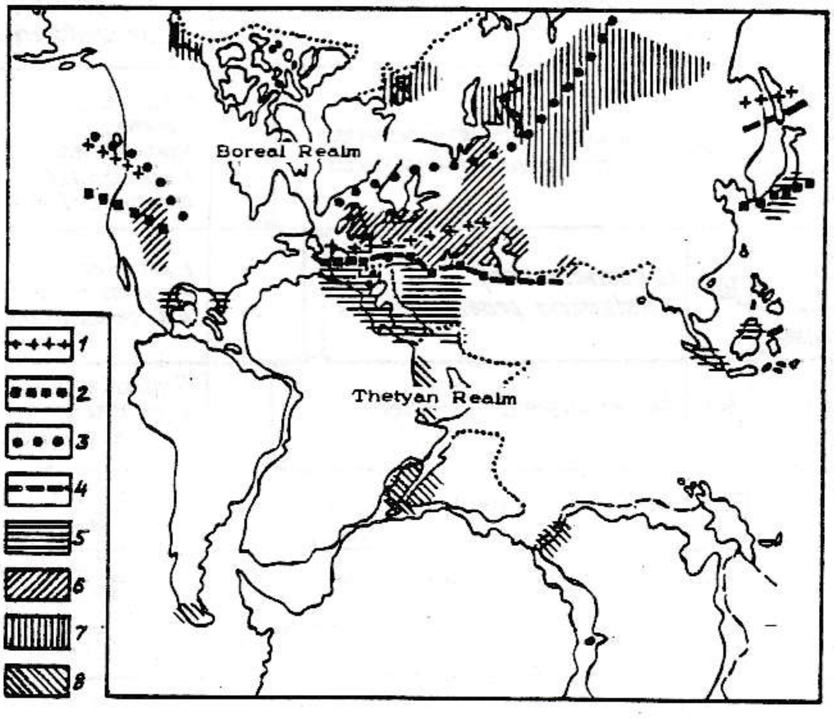

Fig. 8. The Tethyan and Boreal realms in Tithonian-Volgian (1), Callovian (2), Bathonian (3), and Pliensbachian (4) (from A.Hallam, 1978); the distribution of foraminifer faunas (from V.A. Basov, 1974): 5 - Cyclammininae-Pavonitid type, 6 - Nodosariid-Epistominid type, 7 - Nodosariid-Ammodiscid type, 8 - foraminifers in Notal(?) area (chiefly Nodosariid-Epistominid type) (after Grigelis, 1985a).

of the Jurassic foraminifers was also studied by W.A.Gordon (1970), who established shelf and Tethyan communities and distinguished faunal types by means of dominant taxa. He has not studied the Arctic faunas.

The foraminiferal fauna discussed is equivalent to shelf communities or to the Nodosariid - Epistominid type, tentatively called Boreal though on the basis temperature of their environment (moderate positive bottom temperature) they should be classified as sub-Boreal (sub-Atlan-

Table 1

Standard succession of the Upper Jurassic foraminiferal zones of the East - European platform

Absolute age, Ma	Standard scale and regional* distribution			No of zone	Foraminiferal zones: Index-species	Foraminiferal zones: Additional species
132	Volgian	Upper	nodiger	Js 16	Lenticulina muensteri	
			subditus	Js 15	Ast. aquilonicus / Marg. impropria	
			fulgens	Js 14	Placopsilina sp. / Ast. polyhymnius	
		Middle	nikitini	Js 13	Spirofrond. rhabdogonioides / L. oligostegia	
			virgatus	Js 12	L. ponderosa / Flabelam. lidiae	
			panderi	Js 11	L. infravolgaensis / Sarac. pravoslavlevi	L. ornatissima, Sarac. kasanzevi
		Lower	pseudoscythicus	Js 10	Marginulinita pyramidalis / L. undorica	Marg. striatocostata, Cith. zaglobensis, Miron. gemina, E. gorodistchensis
			sokolovi	Js 9	Pseudolam. bieleckae / Vern. kirillae	
			klimovi			
140	Kimmeridgian	Upper	autissiodor.	Js 8	Pseudolam. pseudorjasanensis / Haplophragmium monstratus	L. illustris, L. daiva, Marg. buskensis, E. stellicostata, Miron. mjatliukae
			eudoxus			
			mutabilis			
		Lower	kitchini* — ? — novosselkensis*	Js 7	L. kuznetsovae / Epistomina praetatariensis	L. prussica, Plan. kostromensis, Ast. gerassimovi
146	Oxfordian	Upper	alternans*	Js 6	Ast. russiensis / E. uhligi	Ophthalm. stuifense, L. quenstedti, E. nemunensis
		Middle	zenaidae*	Js 5	Ophthalm. strumosum / L. brestica	Sigm. milioliniforme, L. sambica
		Lower	cordatum	Js 4	O. sagittum / L. brueckmanni	Globulig. oxfordiana, E. volgensis
			mariae			
150	Callovian	Upper	lamberti	Js 3	L. tumida / E. elschankaensis	L. chmielewskii; E. papilensis
			athleta			L. paracultrata; L. lithuanica
		Middle	coronatum	Js 2	L. cultratiformis / L. pseudocrassa	Pseudolam. rjasanensis, E. mosquensis
			jason			
		Lower	calloviense	Js 1	Haplophragmoides infracalloviensis / Gutt. tatariensis	L. tatariensis, C. tjeplovkaensis
153			elat. u macroc.			

I - limit of distribution of species; I - the same, more than in the zone tic?). J. Th. Groiss' (1976) concept of the Boreal fauna is very similar. His southern boundary of the area for the Oxfordian runs from the Pyrenees along the Alps, Dinarides to the Crimea peninsula.

The above shows that in case of the interregional correlation of the Jurassic foraminifer zones two conditions are to be taken into accoun 1) provincial zones and 2) fauna of the same type. According to the first condition by means of the Late Jurassic benthic foraminifers are interregionally correlated zone-by zone; according to the second condition the direct interregional correlation only is used for individual levels in different areas within a single paleobiogeographic province (for example, Boreal-Atlantic and Arctic areas of the Boreal Realm, represented by different foraminiferal faunas)(Fig. 9). For the correlation of zonal units

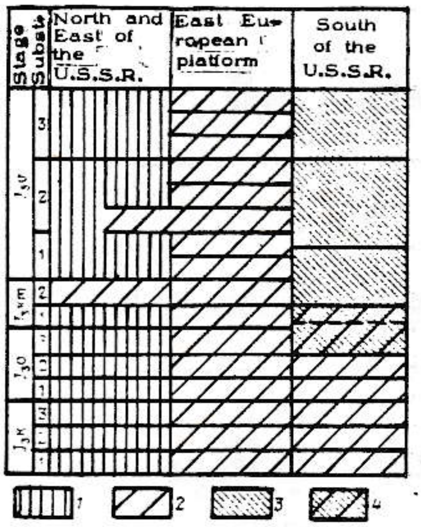

Fig. 9. Interregional correlation of the Upper Jurassic zones: 1 - Nodosariid-Ammodiscid type; 2 - Nodosariid-Epistominid type; 3 - Northern (mixed) subtype of Cyclammininae-Pavonitid type; 4 - distribution of Nodosariid-Epistominid and Cyclammininae-Pavonitid types (after Grigelis, 1985a).

of provinces or realms belonging to different paleobiogeographic areas we can use adjacent regions where horizons yielding mixed fauna are found, in case, of the Late Oxfordian those are of north western margins of the Donets basin or the North Caucasus.

The Callovian, Oxfordian and Kimmeridgian foraminiferal faunas of the East European platform, the adjacent Mangyshlak and, the Pechora syneklise including, can undoubtedly be ranked as the Nodosariid-Epistominid type. Using the accepted terminology we assign these regions of the Jurassic epicontinental sedimentation to the East European province of the Boreal-Atlantic Realm. Based on taxonomic composition of the assemblages and common features of the communities, the East-European-Mangyshlak and Pechora subprovinces can be recognized however, the differences began to disappear in the Kimmeridgian (Fig.10).

The Callovian and Oxfordian foraminifer communities of the southern parts of the USSR exception for endemic Lituolid-Nodosariid fauna of the South West Gissar, can be also classified as the Nodosariid -

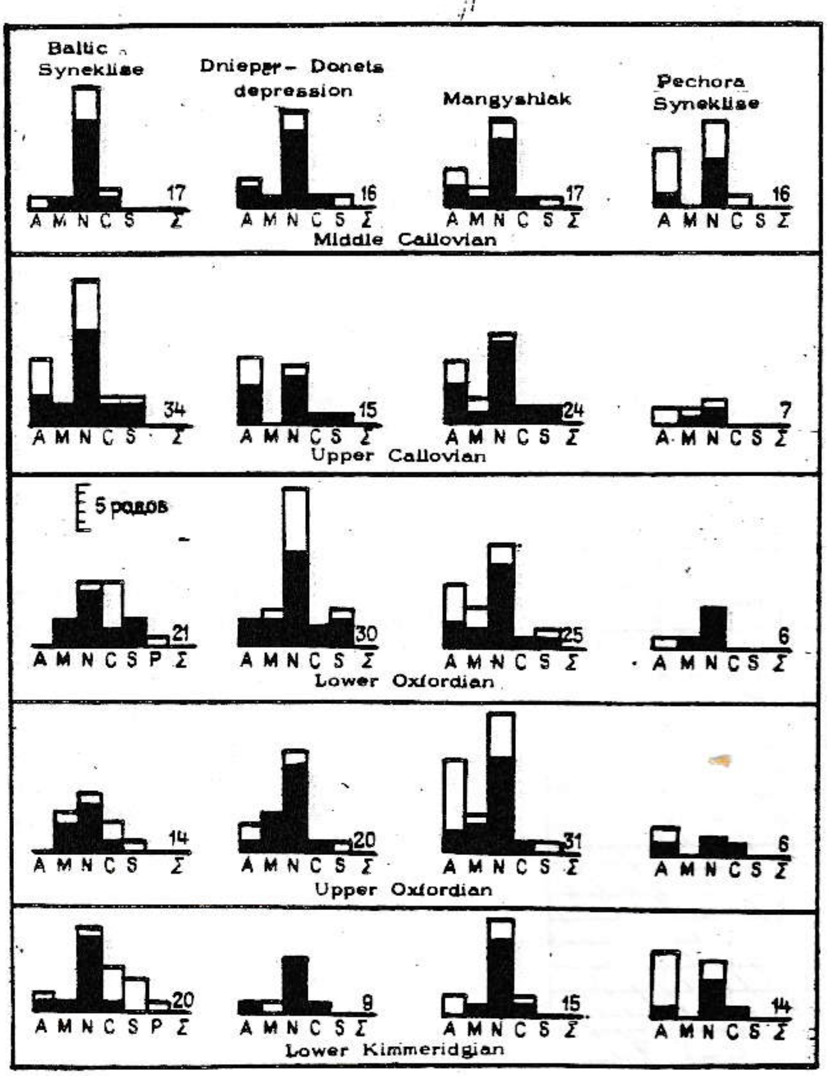

Fig. 10. The taxonom composition of the Upper Jurassic fora- minifer assemblages in the East European province: A-agglutina- ting; M-Miliolid; N-Nc dosariid; C-Ceratobu- liminid; S-Spirillinid; P-planktonic; Σ - the number of genera; black - the number of common taxa (afte Grigelis, 1985a).

Epistominid type. V.N.Sacks (1971) and A.Hallam (1978) attribute it to a wide southward migration of the Boreal faunas in time of the extensive Callovian transgression and to the expansion of the Boreal Realm. The southern elements represented by the genera Alveosepta, Everticyclam- mina, Torinosuella, Nautiloculina appear in the foraminifer communities of boundaries of the Tethys shifted North in Late Oxfordian-Early Kimme- ridgian time and continue to exist till the end of the Jurassic. The re- presentatives of the Feurtillia and Pfenderina genera species of the Glo- bulina, Eoguttulina, Trocholina genera unknown from the East European platform make their appearance in Tithonian time. Inspite of the presen- ce of some European species in the Volgian province (Lenticulina, Sara- cenaria, Epistomina) important for correlation, the Kimmeridgian-Tithonian fauna of the southern USSR should be assigned to the Northern (mixed) subtype of the thermophilic tropical fauna known as the Cyclammininae - Pavonitid type which inhabited the Tethyan paleobiogeographic realm.

The Late Jurassic foraminifers of the eastern and northern USSR are represented by the Nodosariid - Ammodiscid type.

The above data permit to correlate the Jurassic foraminifer zones of the USSR in regions belonging to different paleobiogeographic areas of the Boreal and Tethyan realms. The data used for the compilation of the above schemes provide corrèlative levels, wich can be further involved into the stratigraphic foraminiferal scale for the entire Boreal Realm. Such levels are clearly defined in some provinces (Grigelis,1982)

The first level is represented by the Lenticulina cultratiformis-Lenticulina pseudocrassa Zone in the Middle Callovian of the East European platform and Mangyshlak. Common species (Lenticulina pseudocrassa, L. polonica, L. lata, L. cultratiformis, Pseudolamarckina rjasanensis, Epistomina mosquensis) allow this zone to be reliably correlated with the Sigmoilina costata-Lenticulina lata Zone of the Middle Callovian of the Caucasus. Above comes the Upper Callovian Lenticulina tumida-Epistomina elschankaensis Zone it has index-species common of the East European province and the southern USSR. The common species are: Lenticulina tumida, L. uhligi, Pseudolamarckina rjasanensis, Epistomina mosquensis and E. elschankaensis. The similarity of the Middle and Upper Callovian zones in these regions complies with the idea about the distribution of the foraminiferal fauna of the Nodosariid - Epistominid type in the Callovian.

Between the East European and North Siberian provinces in the Callovian only one correlative level (in the lower Lower Callovian) can be used, here common species Ammodiscus pseudoinfimus and Riyadhella sibirica are found in the Arcticoceras kochi zone of the Pechora syneklise and on the West Siberian plate. This foraminifer assemblage is unknown from other areas of the East European platform. The boundary between the Boreal and Tethyan realms at that time was in the north like in the Bathonian (50^0 N) and the Pechora syneclise was a part of the Arctic area.

It should be noted, that thermophilic species (and stenobiontic?) representatives of Ceratobuliminacea (Epistomina, Pseudolamarckina) and Spirillinacea (Spirillina, Trocholina) are absent from the Middle-Late Callovian foraminifer assemblages in the Pechora syneclise. In the Oxfordian the fauna of the East European province and that of the Mediterranean area still remains similar where with except for the Caucasus foraminifers appear in the Stryi depression on the south-western margin of the East European platform. However, the faunal composition begins to change. There remain common species: Ceratolamarckina speciosa, Lenticulina brueckmanni, L. compressaeformis in the Early Oxfordian;

Trocholina transversarii, Ophthalmidium dilatatum, Epistomina nemunensis - in the Middle Oxfordian, L. russiensis, L. attenuata, E. nemunensis - in the Late Oxfordian.

The southward migration of some species is observed. For example, the Callovian Marssonella jurassica in the southern parts occurs in the lower zone of the Oxfordian; the epiboles of the species Trocholina transversarii and Epistomina nemunensis are shifted by one-two zones upwards. The above can be ascribed to northward shifting of the boundaries of the Tethyan realm, wich is also confirmed by the appearance of the Mediterranean genera in Stryi depression (Alveosepta jaccardi, Mesoendothyra izjumiana) and on the north-western margin of the Donets basin and in the Dnieper-Donetsk trough (Mesoendothyra, Pseudocyclammina) in the Late Oxfordian.

Thus the Oxfordian foraminifer zones of the East European platform and the southern USSR according to the data available cannot be reliably correlated. For example, the zone Ophthalmidium sagittum-Lenticulina brueckmanni-Epistomina volgensis the level easily discernible on the platform cannot be recognized as concerns zonal assemblages in the southern sections. However, the established shifting of the boundary between the Boreal and Tethyan realms as well as mixed foraminiferal fauna of the sub-Boreal (sub-Tethyan) type allow the correlation of the Upper Jurassic sections of the areas. The Dnieper-Donetsk trough, the Crimea, the Stryi depression, the Precaucasus, the northern margin of the Georgian Massif are the promising regions for the correlation.

In the Kimmeridgian foraminiferal faunas of the East European province and southern regions are represented by different types: Boreal and Tethyan. Therefore, despite easily recognizable throughout the Boreal-Atlantic area (and in the Volga and Portland provinces) the Lenticulina kuznetsovae-Astacolus major-Epistomina praetatariensis (the Lower Kimmeridgian) and Pseudolamarckina pseudorjasanensis-Haplophragmium monstratus (the Upper Kimmeridgian) zones in the Tethyan realm only occasional Boreal forms such as Lenticulina russiensis and L. tumida(?) are known in the Lower Kimmeridgian from the northern margin of the Georgian Massif which makes difficult the direct correlating of the areas.

Nevertheless, the Lower Oxfordian Ceratolamarckina speciosa-Marssonella jurassica, the Middle Oxfordian Ceratolamarckina subspeciosa-Trocholina transversarii, the Upper Oxfordian Alveosepta jaccardi-Epistomina nemunensis, and the Lower Kimmeridgian Alveosepta personata-Torinosuella peneropliformis zones can be recognized and correlated throughout the entire the southern USSR.

In the Oxfordian Nodosariid - Ammodiscid fauna containing Lenticulina subpolonica Gerke et Scharovskaja, L. involvens (Wisniowski), L. compressaeformis (Paalzow) common with European species still occur in the northern and eastern parts of the North Siberian province. However, on the whole a peculiar taxonomy of the Arctic type fauna (no representative of the superfamily Ceratobuliminacea, Spirillinacea) suggests a considerable biogeographic isolation.

In the Late Oxfordian, the influence of sub-Boreal forms becomes evident in the northern Atlantic seas of the East European province, however, the West Siberian species Recurvoides disputabilis occurs together with index-species Lenticulina russiensis and Epistomina uhligi in the Pechora basin, permiting the correlation at the top of the Oxfordian.

In the Kimmeridgian the composition of foraminifer assemblages becomes even more uniform in the Boreal-Atlantic area. The Lenticulina kuznetsovae-Epistomina praetatariensis zone is known from the Early Kimmeridgian of the Pechora syneclise; in the Late Kimmeridgian, the representatives of Pseudolamarckina come into the North Siberian province via the Polar Transural area they permit the correlation (using vacariants) Pseudolamarckina pseudorjasanensis and Pseudolamarckina lopsiensis zones between the East European and North Siberian provinces. Thus, the Pechora syneclise and Polar Transural area are the areas most important for west-east correlation.

From the discussed criteria for the biostratigraphic correlation and that of the zonal units it is inferred that the interregional correlation of the Upper Jurassic deposits by means of benthic foraminifers can be used for similar levels, defined by the biogeography of foraminifer faunas as well as for area yielding mixed fauna, controlled the shifting of the paleozoochoric boundaries with time.

A striking taxonomic diversity of the wellknown Jurassic foraminifers provides the minute subdivision of sections and reliable recognition of foraminifer zone of the Boreal shelf area (marked by a rather uniform sedimentogenesis) of the Boreal-Atlantic provinces. Because of these reasons the discussed area having of the stage stratotypes seems the most promising for the establishment of a standard succession of foraminifer stratons. Therefore, the Boreal-Atlantic area are considered as standard sections for establishing of provincial zones and can be used in future for the Jurassic chronozonal scale based on foraminifers.

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(A.Grigelis)

Enclosure 4

The Middle and early Upper Jurassic succession at Sengenthal, southern Franconian Alb, Germany.

Report of a stratigraphical investigation supported by the International Subcommission, 1985-86.

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G Dietl *(Staatliches Museum für Naturkunde, Stuttgart)*

The Jurassic of Franconia has provided one of the foundation-stones of generalized Jurassic stratigraphy since the earliest times of geology. Yet good exposures in the Lower and Middle Jurassic, Lias and Dogger, or Black and Brown Jura, are relatively uncommon. Hence, although the ammonite faunas have been abundantly described, few have so far been recorded from measured sections with the stratigraphical precision needed for modern revisions in the framework of wider, extraregional chronostratigraphic correlations. The excursions associated with the International Symposium held at Erlangen in 1984 provided an opportunity to see a fine section ranging from Bajocian to Kimmeridgian exposed in quarries for cement-making at Sengenthal near Neumarkt, 40 km SE of Nürnberg (KOLB, 1965; GROISS, in ZEISS, 1984, ed., p.157, 162). The assembled specialists could recognize so many features with which they were particularly familiar that it was decided to organize a further, more extended visit to the locality, to undertake a detailed stratigraphical study of the succession. Accordingly, two visits each of three days were made, in September 1985 and April 1986. The parties consisted of G DIETL and H-J NIEDERHÖFER (Staatl. Museum für Naturkunde, Stuttgart), A GALACZ (Budapest) and J H CALLOMON (London), ably and enthusiastically supported by M KAPITZKE, P RIEDELE and M RIETER (Stuttgart), R HUGGER (Albstadt) and K N PAGE (London). Over a thousand ammonites were collected in place and are now in Stuttgart. Many others, particularly in the soft sediments of the Callovian, that could not be recovered were identified in the field or photographed. In addition, the material thus obtained could be successfully combined with a considerable further collection made in situ over some years by H GRADL (Nürnberg) under the supervision of A ZEISS (Erlangen). Ammonites in the Callovian are not particularly abundant or well preserved at Sengenthal, and a collection put together in this way over an extended period therefore contains many forms that would not have been found during just two brief visits. This collection is now in the Palaeontological Institute of the University of Erlangen.

A detailed account of the section is being published (CALLOMON et al., 1987). Active working for cement-making was discontinued in Summer 1986, and the exposures are rapidly being obliterated through infilling with refuse.

Summary of results

The succession through the Middle Jurassic and the Upper Jurassic to the top of the Middle Oxfordian is highly condensed. From the first horizon with ammonites in the Humphriesianum Zone to the top of the Bathonian is barely 2.8 m. The whole of the Callovian spans 4.6 m; the Lower Oxfordian (incomplete) 0.4 m; and the Middle Oxfordian (also incomplete) 0.7 m. Yet with the exception of the Subfurcatum Zone of the Bajocian, representatives of all the other 19 standard ammonites Zones *dichotoma* which ranged upwards, to be joined slightly higher by *G. (G.) garantiana*. This association indicates exclusively the lowest, Dichotoma Subzone of the Garantiana Zone. Of the intervening, highest parts of the Humphriesianum Zone and the whole of the Niortense/Subfurcatum Zone there is no indication, although the occurrence of some rolled pebbles at the level of overlap may attest to their former presence. Higher parts of the Garantiana Zone are also missing.

After a sharp break there follows the brick-red iron-oolitic "Parkinsoni-Oolith", long famous for the richness and preservation of its fossils. The ammonites have been described on a number of occasions (DORN, 1927; SCHMIDTILL & KRUMBECK, 1931) and indicate the Parkinsoni Zone of the Upper Bajocian. The bed is divisible into three parts, each representing a distinct faunal horizon. The lowest two, designated successively as the horizons of *Parkinsonia depressa* and *P. neuffensis* respectively, indicate the (middle) Parkinsoni Subzone (Truellei Subzone in Anglo-Norman usage). The third contains the fauna of the (top) Bomfordi-Subzone, terminating the Upper Bajocian. Of the (lowest) Acris Subzone (still included in the Garantiana Zone in Britain) there was no sign.

The Bathonian begins with an iron-oolitic marly limestone only 5 cm thick resting directly on the Parkinsoni-Oolith. It contains an unusually diverse fauna of the (lowest) Convergens Subzone of the Zigzag Zone, including *Parkinsonia convergens*, *Oxycerites*, *Procerites*, *Siemiradzkia* and *Cadomites*. The next 40 cm of marls contain crushed *Morphoceras*, *Ebrayiceras*, *Parkinsonia (Oraniceras)* and *Procerites* of the Macrescens Subzone.

There follows a highly condensed bed 10-20 cm thick containing the ammonites of the highest parts of the Lower Bathonian, such as *P. (Oraniceras) gyrumbilica, Ox. yeovilensis, Asphinctites tenuiplicatus, Lissoceras psilodiscus* and *Oe. (Paroecotraustes) fuscus*, as well as those of the middle and late Middle Bathonian, mainly *Tulites* and *Morrisiceras*, indicating the Subcontractus and Morrisi Zones. There was no evidence of the Progracilis Zone. At some places the Lower and Middle Bathonian faunas could be separated stratigraphically in correct sequence. Elsewhere they appeared to be completely mixed, probably through intense bioturbation, the implication being that the sediments remained unconsolidated for very long periods of time.

The Upper Bathonian is also relatively fossiliferous by south German standards. The Orbis Zone appears to be represented by two faunal horizons. The lower of these contains, besides autochthonous elements, occasional rolled and encrusted ammonites derived by reworking from the Lower and Middle Bathonian below. The Bathonian terminates with a non-condensed concretionary oolitic limestone, the "Orbis-Oolith". Although only sparsely fossiliferous, it has yielded a significant fauna thanks to the extent of the exposure. This fauna includes a number of important elements. Besides Perisphinctids of still unambiguously Bathonian aspect, the commonest ammonite is *Oxycerites orbis*. The rarer, ancillary forms include *Bullatimorphites*, *Prohecticoceras*, *Paroecotraustes*, *Hemigarantia*, some small but authentic *Macrocephalites* and, most surprisingly, a specimen of *Kepplerites* close to forms known hitherto only from the Boreal Upper Bathonian of East Greenland. The fauna of the Orbis-Oolith of Sengenthal thus consists of a mixture of Boreal, Sub-boreal and

Submediterranean provincial elements. Because of its exceptional interest and its implications for palaeobiogeographic connections and close correlations between Boreal, NW European and Submediterranean standard zonations in the Upper Bathonian, these faunas will be fully described and discussed in a separate publication. Their evaluation is currently in progress.

II. Callovian (J H CALLOMON)

The Bathonian-Callovian boundary was carefully examined along 300 m of continuous outcrop. The topmost bed of the Bathonian contains ammonites of the Orbis Zone. It is immediately overlain by the lowest member of the Macrocephalen-Oolith with *Kepplerites keppleri*, which characterizes the basal Callovian over much of Europe, particularly in Swabia. The boundary is very sharp although the change in facies is slight. It seems to mark a non-sequence cutting out the Discus Zone of the topmost Bathonian, unless the bed below the break already belongs to this Zone, the characteristic *Clydoniceras* being absent on ecological grounds. The marly, ferruginous, oolitic Macrocephalen-Oolith, 0.60 m thick, is subdivisible into several clearly separable units, the highest of which contains, besides an abundance of *Macrocephalites*, rare *Cadoceras* and *Gowericeras* of the lower Calloviense Zone. It is terminated by a sharp break and major change in facies, to be followed by the so-called "Ornatenton".

The "Ornatenton" consists of 4.0 m of monotonous and very uniform fine-grained non-oolitic siltstones with only minor constituents of carbonate and clay. It is subdivided into a number of distinct units separated by sharp but inconspicuous boundaries probably marking minor breaks in sedimentation. More important breaks are suggested by layers of phosphatic concretions, pebbles and glauconite, although the lithological boundaries have been destroyed by bioturbation. But the main indicators of time are the ammonites. The lowest 0.20 m, still somewhat oolitic and with bored pebbles, probably by reworking from below, contains *Sigaloceras enodatum*, *Kosmoceras anterior* and *Macrocephalites tumidus*, indicating the Enodatum (top) Subzone of the Calloviense Zone. Thereafter, both Jason and Coronatum Zones are well-developed, the latter marked by numerous large and well-preserved *Erymnoceras*. The top Coronatum and lowest Athleta Zones appear to be highly condensed, but thereafter the rest of the Athleta Zone and the Lamberti Zone are well-developed, both Subzones of the Lamberti Zone being clearly recognizeable.

The provincial affinities of the ammonites are predominantly Boreal throughout the Callovian, so that the most appropriate chronostratigraphic classification in the region is the standard Sub-boreal zonation of northern Europe. Submediterranean elements such as Reineckeiidae and Oppeliidae are however sufficiently common to permit also close correlation with the Submediterranean standard, as worked out in western France. Besides ammonites, the rest of the fauna is very sparse. It seems unlikely that Franconian biostratigraphy will add much to the existing standards in the Callovian.

III. Oxfordian (J H CALLOMON)

The top of the Callovian is marked by another sharp change in facies. It is followed by less than half a metre of dark, soft, glauconitic, silty clays much burrowed by *Chondrites* and containing now a fairly abundant benthonic fauna of bivalves. Sparse ammonites indicate a Lower Oxfordian age, from the Scarburgense Subzone of the Mariae Zone to the lowest, Bukowskii Subzone of the Cordatum Zone. These clays are truncated by a major disconformity marking the sharp change from Brown to White Jura. They are followed by highly glauconitic, condensed calcareous marls or marly limestones beginning with ammonites indicating the Antecedens (upper) Subzone of the Plicatilis Zone in the Middle Oxfordian. The disconformity has therefore cut out most of the Cordatum Zone and the Vertebrale (lower) Subzone of the Plicatilis Zone. These relations are regionally widespread, throughout most of Franconia and Swabia, and one has to go south as far as the Swiss border before the missing zones are found again (see reviews by ZEISS, 1984, MUNK & ZEISS, 1985). In this respect Sengenthal has added nothing new. What it has provided, however, is an unusually clear opportunity to examine these lowest glauconitic beds of the Middle Oxfordian in detail. They were exposed over a large area as the working base of the upper quarry.

The "Grünoolithbank" has been famous for its ammonites since the time of GÜMBEL (1865), whose *Ammonites chlorooolithicus* was one of the earliest new species of *Perisphinctes* to be added to what was up to then still a short list, dominated by *Amm. plicatilis* and *Amm. biplex*. Another species most of whose type-series came from these beds was *Amm. martelli* Oppel (1863). The most comprehensive description of the fauna was given in a monograph by DORN (1930). Unfortunately, however, although he gave descriptions of a number of sections, including one not far from Neumarkt (p.116, Profil III), he recorded neither the localities nor the horizons from which his material came. This has now been largely rectified by new collections from Sengenthal. The 70 cm of marls and limestones could be subdivided into five beds in which four successive faunas could be clearly distinguished. The main elements are:

IV. *Per. (Dichotomoceras) bifurcatus* (Quenstedt - auctt.) (abundant

Trimarginites arolicus (Oppel) [M] - *stenorhynchus* (Oppel) [m]

Gregoryceras fouquei (Kilian) [M]

III. *Per. (Dichotomosphinctes)* cf. and aff. *wartae* Bukowski

- *(Dichotomoceras) stenocycloides* Siemiradzki

II. *Per. (Perisphinctes) martelli* (Oppel)

- - *densecostatus* Enay

- - *panthieri polonicus* Malinowska

- *(Aureimontanites) borealis* Malinowska

- *(Subdiscosphinctes) kreutzi* Siemiradzki

- - *mindowe* Siemiradzki

- *(Dichotomosphinctes) elizabethae* de Riaz. and spp. aff.

- - *wartae* Bukowski

Gregoryceras riazi Grossouvre

Cardioceras excavatum (Sowerby)

I. *Per. (Perisphinctes) chloroolithicus* (Gümbel)

- *(Dichotomosphinctes) antecedens* Salfeld

- *(Kranaosphinctes)* sp. cf. *promiscuus* Bukowski

Although the lithologies once again indicate a strong degree of condensation, the faunas give the impression of being quite homogeneous, i.e. representing each only a relatively short period of time. Fauna I clearly represents a horizon in the Antecedens Subzone of the Plicatilis Zone. There is no sign of the Parandieri Subzone of the Transversarium Zone as usually understood and well characterized in France and Britain. Fauna II is of considerable general interest. The list of perisphincted morphospecies could be considerably extended, for there are intermediates between almost all of the ones cited; yet they share common nuances in the style of ribbing, suggesting that they are closely related, probably as no more than variants of a single (dimorphic) biospecies over a narrow stratigraphical interval. This helps to establish the stratigraphically well-defined identity of a fauna whose members have long been known individually from scattered localities over much of Europe, where they have usually been included in a rather comprehensive Parandieri Subzone. Although some forms, here assigned to *P. mindowe*, bear a certain resemblance to the subgenus *Larcheria* there are systematic differences in the differentiation of primary and secondary ribbing that are easy to recognize. No true *Larcheria* was found at Sengenthal, indicating that the Schilli Subzone of the Transversarium Zone is also missing. Faunas III and IV clearly represent the Stenocycloides and Grossouvrei Subzones of the Bifurcatus Zone in the currently standard Submediterranean zonation and call for no special comment.

The thin green and yellow beds of the Middle Oxfordian are immediately followed by some 30 m of thick Upper Oxfordian and Kimmeridgian white limestones and marls, largely in algal and sponge-reef facies, which were not examined further. They have been summarized by ZEISS (1977) and GROISS (in ZEISS, 1984). An *Epipeltoceras* indicating Bimammatum Zone was found already in the lowest 4 m.

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Enclosure 5

BRIEF ANNUAL REPORT 1987

Duration and Status: 1980-(1985) On extended term

Achievements of the Project This Year

(A) Range Charts Project -- Eds., G. E. G. Westermann and A. C. Riccardi

The following 6 manuscripts dealing with the Soviet Union and China, are now in press (Newsletters on Stratigraphy):

I. Soviet Union:
- Ia. Lower and Middleton Jurassic of the North-East.
- Ib. Callovian and Upper Jurassic of the North-East.
- Ic. Ammonites and bivalves of the Far East.
- Id. Radiolarians of the Far East.
- Ie. Ammonites, bivalves, conchostracans, and plants of Transbaikalia and Yakutiya.

II. China (Peoples' Rep.):

The following parts are in preparation: Would the Seminar authors listed below please, inform me about the current stand.

III. Japan and South-East Asia (T. Sato): ammonites done, remainder 1988?

IV. Australasia (G. Stevens?): (1988-89?)

V. South America and Antarctic Peninsula (A. C. Riccardi): a. Lower and b. Middle Jurassic complete, c. Upper Jurassic (H. Leanza?) 1988.

VI. North America and Cuba: 1988.

(B) Book on "The Jurassic of the Circum-Pacific" -- Author/editor, G. E. G. Westermann (Cambridge University Press). -- MS to be submitted to publisher in 1988. Principal chapters and primary contributors are:

Regional geol. and stratigr. framework -- T. Sato, Y. Wang, S. Wang, V. Zakharov, T. Poulten, A. C. Riccardi, A. v. Hillebrandt

Ammonite biozones and correlations -- J. Callomon, A. v. Hillebrandt, G. E. G. Westermann

Other chronostratigr. useful taxa -- E. Pessagno, W. A. S. Sarjeant, S. Wang, V. Zakharov.

Diastrophism, transgressions, regressions -- K. Ichikawa or S. Mizutani (organizer?), J. Frutos, V. Zakharov (no reply from J. C. Vicente!).

Paleogeography -- A. C. Riccardi, T. Sato, D. Taylor, Y. Wang, S. Wang, V. Zakharov

Paleobiogeography and paleoecology -- L. Beauvais, W. Braun, A. Cione, W. A. Clemens, S. E. Damborenea, Z. B. de Gasparini, T. Kimura, M. O. Mancenido, E. Musacchio, W. Volkheimer, (G. E. G. Westermann)

Climate and ocean current -- J. T. Parrish (replacement for A. Hallam), W. Volkheimer.

(C) Book: G. Ya. Krymholts and H. S. Mesezhnikov "The Jurassic Zones of USSR (1982)" has been translated into English, revised (to 1986), and 17 plates illustrating the index ammonites have been added. G. E. G. Westermann has been added to the editors. The new title is: "Jurassic Ammonite Zones of Soviet Union", Geol. Soc. Amer. Mem. (submitted August 1987).

Summary

The Project is being concluded by the publication of three major works. A continuing series in the Newsletters on Stratigraphy on Jurassic Taxa Ranges and Correlations of the Circum-Pacific (Ia-e, II in press); a new book (Cambridge Univ. Press) on The Circum-Pacific Jurassic; and a English edition of "Jurassic Ammonite Zones of the Soviet Union"..

Gerd Westermann

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Gerd Westermann

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IUGS · SUBCOMMISSION ON CRETACEOUS STRATIGRAPHY
IUGS · SUBCOMMISSION ON JURASSIC STRATIGRAPHY

WORKING GROUP ON THE JURASSIC-CRETACEOUS BOUNDARY

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REPORT ON THE FIELD MEETING OF THE JURASSIC-CRETACEOUS BOUNDARY WORKING GROUP

From Monday, 28th September 1987 (departure from Moscow) until Saturday 3rd October (return to Moscow) the International Working Group on the Jurassic-Cretaceous Boundary held a field meeting in the Northern Caucasus, with the participation of members from Canada, UK, Denmark, Federal Republic of Germany, Switzerland, Spain, Bulgaria, Poland, the Netherlands, and, of course a great number of Soviet stratigraphers.

During the outdoor part of the meeting two sections were visited and sampled in detail, the one in the Baksan valley, the other along the Urukh river. In the Baksan succession the Tethyan Jurassic-Cretaceous boundary is not observable due to a gap corresponding to the lower Berriasian, but the rest of the succession is highly fossiliferous. The Urukh section is continuous from Tithonian to Valanginian. The great interest of these sections lies in the fact that subboreal ammonite genera like Euthymiceras and Riasanites occur together with Tethyan ammonites and calpionellids.

Many samples could be taken and will provide an opportunity to study in more detail the correlation between the Tethyan and the Boreal province. This will be completed by materials from Mangyshlak put at the disposal of J. Remane.

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Many papers were presented and discussed during indoor meetings at the Elbrus Glaciological Research Center and at Ordzhonikidse. General discussions came to the following results :

(1) Although progress has been made in Tethyan-Boreal correlation (HOEDE-MAEKER, 1987) it remains doubtful, whether the Tithonian-Berriasian boundary or a level just above (base of the Occitanica Zone) can be followed precisely enough up into the Boreal realm. Therefore the possibility should be considered to place the Jurassic-Cretaceous boundary at the level of the Berriasian-Valanginian boundary, if necessary.

(2) Further research is in any case necessary. Within the next 2-3 years this shall be conducted by individual teams, but later on these should be grouped together under the common heading of an IGCP project.

Neuchâtel, the 9th of December, 1987 Jürgen Remane