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STUDIES ON THE BASE OF THE *PROTRITICITES* ZONE. A REPORT ON SCCS PROJECT GROUP 5[1]

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(6 figures)

ABSTRACT. A progress report is presented for the Working Group on the base of the *Protriticites* Zone. It gives the first results obtained from various sections in Spitsbergen, the Yugorsky Peninsula, Northern Timan, Timan-Pechora, the Donetz Basin and the Cantabrian Mountains. Although the fusulinids are the group studied most extensively thus far, the brachiopods, corals, ammonoids, conodonts, spores, algae and plant megafossils have also been investigated. Research on additional areas has started already. Future plans envisage extending the range to higher stratigraphic levels and placing special emphasis on groups of wide geographic dsitribution, e. g. conodonts and ammonoids.

KEY-WORDS: Carboniferous, correlation, stratigraphy, fusulinids.

RESUME. Recherches à la base de la zone à *Protriticites*. Un rapport du projet 5 de la SCCS.- Les premiers travaux réalisés sous les auspices du Projet 5 de la SCCS dans les coupes du Spitsberg, de la Péninsule de Yugorsky, Nord du Timan, du Timan-Pechora, du Bassin du Donetz et de la Chaîne Cantabrique ont fourni des données détaillées sur leur contenu fossilifère, surtout en ce qui concerne les fusulinidés, mais aussi sur les brachiopodes, les coraux, les ammonoïdes, les conodontes, les spores, les algues et les plantes. A présent d' autres coupes et d' autres régions carbonifères commencent à être étudiées. En même temps on essaie d'étendre les recherches vers des niveaux plus modernes, et de favoriser l'étude des groupes à plus vaste distribution géographique tels que les conodontes et les ammonoïdes.

MOTS-CLES: Carbonifère, corrélation, stratigraphie, fusulinidés.

1. INTRODUCTION

The Subcommission on Carboniferous Stratigraphy, at its meeting in Provo (September, 1989), selected several stratigraphic intervals which should be worthy of further palaeontological investigation worldwide, the aim being to detect evolutionary changes in various fossil groups which could be of potential use in establishing global correlation. One of the selected intervals was that roughly equivalent to the Moscovian/Kasimovian transition, for the study of which the SCCS promoted the creation of the Working Group on the base of the *Protriticites* Zone.

For nearly three years the leader of the Working Group struggled to obtaining the collaboration of a group of specialists capable of dealing with the main groups of fossils and the main Carboniferous areas in the world. First attempts were rather discouraging, since affirmative answers were slow to arrive. It was

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particularly difficult to establish positive contacts with specialists from such areas as China and the former Soviet Union, which are very important for Carboniferous stratigraphy. In other cases, affirmative answers were not followed by any report.

The first list of members who agreed to participate is as follows: Robert Coquel (France), Adriaan van Ginkel (The Netherlands), Hisayoshi Igo (Japan), Bernard Mamet (Canada), Mª Luisa Martínez-Chacón (Spain), Charles A. Ross (USA), Rui Lin (Canada), M. N. Solovieva (Russia), Robert H. Wagner (Spain), Cor F. Winkler Prins (The Netherlands) and Elisa Villa, leader of the Working Group, (Spain) (see *Newsletter on Carboniferous Stratigraphy*, vol. 9)

However, last year brought a good crop of new members, including some specialists who came forward voluntarily offering to join their investigations to those of the Working Group. So, we are now able to add the following names: Vladimir I. Davydov (VSEGEI, St. Petersburg, Russia), Maria V. Konovalova (TPO VNIGRI, Ukhta, Russia), Jürgen Kullmann (Geologisch-Paläontologisches Institut, Tübingen, Germany), Svetlana Remizova (Institute of Geology, Syktyvkar, Russia), Jasenka Sremac (University of Zagreb, Croacia), Katsumi Ueno (University of Tsukuba,Japan), Kozo Watanabe (Shinjuku,Japon) and Xiangning Yang (University of Nanjing, China).

We recently learned that James E. Barrick (Texas Tech University), Darwin R. Boardman (Oklahoma State University), Philip H. Heckel (University of Iowa), Garner L. Wilde (Texas) and Igor Barskov (Moscow State University) are also willing to cooperate, the latter together with a research team which includes A. S. Alekseev (Moscow University), N.V. Goreva (Geological Institute, RAS), T.N. Isakova (Geological Institute, RAS), G. A. Afanasjeva (Palaeontological Institute, RAS), M. Kh. Makhlina (Moscow Geological Survey), O.L. Kossovaya (St. Petersburg Geological Institute) and A. A. Shkolin (Palaeontological Institute, RAS). All this is most encouraging.

The list is still open to others who may be interested, especially those working in regions such as the Carnic Alps, Carboniferous areas of America and China, Korea, etc., or groups (e. g., conodonts, ammonoids) which seem insufficiently represented.

2. REPORTS FROM LOCAL WORKING GROUPS

Some reports summarise the first results of investigations carried out in various sections in Spitsbergen, the Yugorsky Peninsula, Northern Timan, Timan-Pechora, the Donetz Basin and the Cantabrian Mountains (Fig. 1). In some cases, the sections under study are either inaccessible by normal

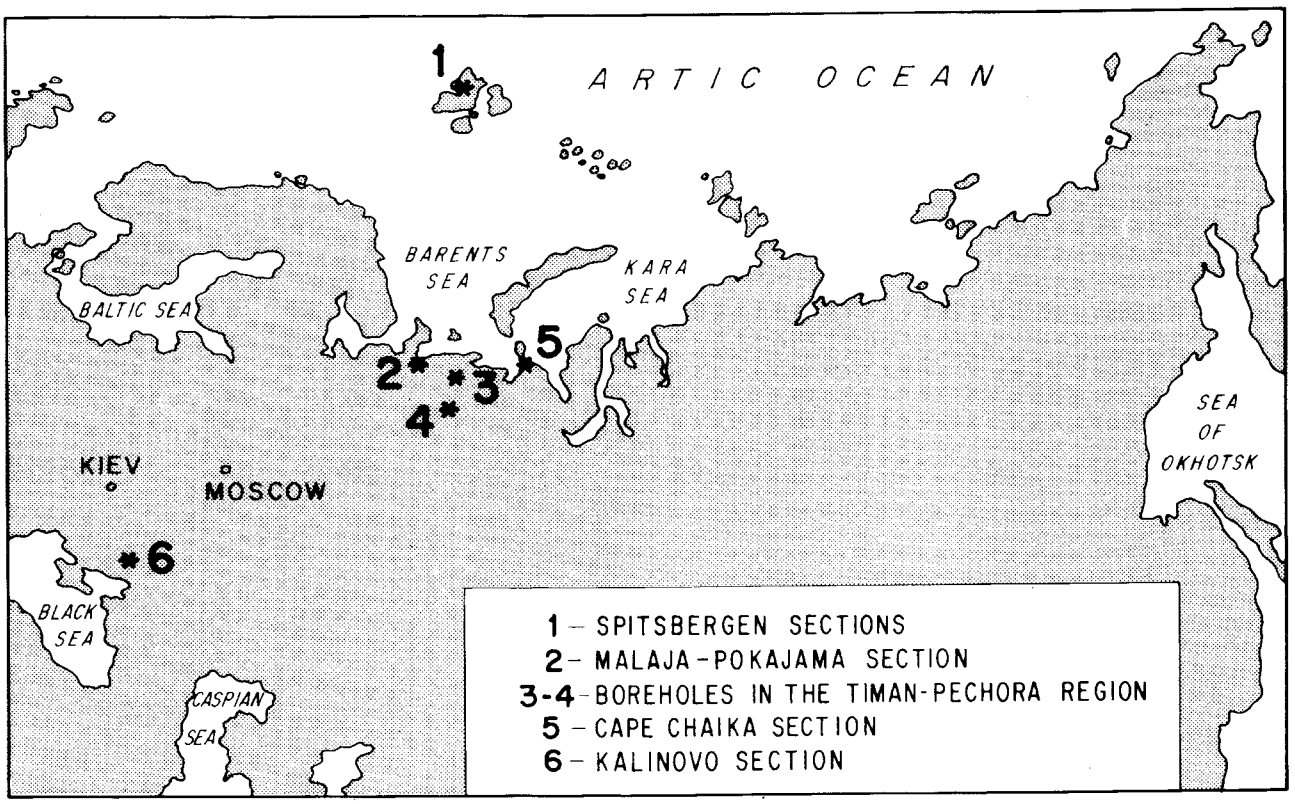

Fig. 1.- Geographical location of the sections reported (excepting Las Llacerias section of the Cantabrian Mountains)

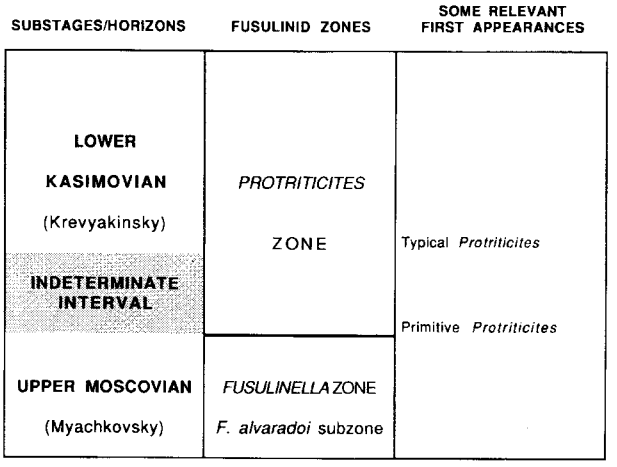

Fig. 2.- Biostratigraphic and chronostratigraphic boundaries in the Las Llacerias section.

transport (e. g., Cape Chaika) or they correspond to strata encountered in boreholes (e. g., Timan-Pechora), thus not following the recommendations of the SCCS (Engel, 1992). However, the aim of the Working Group, in this preliminary phase, is to obtain the palaeontological characterisation of a stratigraphic interval. Therefore, any significant palaeontological information, affecting this interval, has been very welcome. Proposals for a stratotype can only follow when our work gets to a more advanced stage.

2.1. CANTABRIAN MOUNTAINS

The group of specialists working on the Cantabrian Mountains is constituted by several of the members mentioned above, who, with the collaboration of other specialists (Carlos Méndez, Rosa Mª Rodríguez, Sergio Rodríguez and Luis C. Sánchez de Posada) have started studying several sections considered worthy of detailed investigation. First results were presented at the Carboniferous Congress in Buenos Aires (Villa *et al.*, 1993); a summary of that paper was published in *Newsletter on Carboniferous Stratigraphy,* vol. 10.

The main efforts of the Cantabrian group have been directed towards the analysis of the fusulinid, conodont, brachiopod, coral and spore contents of a section (Las Llacerias) showing a continuous development of limestone beds throughout the Moscovian/Kasimovian transition.

So far, the most promising data have come from the fusulinids. The section, composed of a relatively thick and undisturbed carbonate succession, provides the opportunity to study the *Fusulinella* - *Protriticites* lineage in a some detail, showing the gradual replacement of *Fusulinella* by its descendant genus *Protriticites*. The first *Protriticites* faunas display a «primitive» wall and appear at a lower level than standard *Protriticites* with characters usually considered as typical of the genus.

Stratigraphic schemes of the Moscow Platform Basin generally show the Moscovian/Kasimovian boundary as coincident with the base of the *Protriticites pseudomontiparus-Obsoletes obsoletus* Zone. This zone apparently contains abundant species of *Protriticites* displaying typical characters. However, different proposals have been made by various authors, as summarised in Villa *et al.* (1993). The data from the Las Llacerias section, mentioned above, show that the Moscovian/Kasimovian boundary is difficult to establish with precision. Instead, an interval of indeterminate attribution appears between levels of unquestionable Moscovian and Kasimovian ages (Fig. 2).

Further studies on fusulinids (E. Villa and A.C. van Ginkel), spores (R. Coquel and R.M. Rodríguez), conodonts (C. Méndez) and algae (B. Mamet) are in progress in the Las Llacerias section. Unfortunately, the search for ammonoids (J. Kullmann) has been unsuccessful thus far, but additional sections in the same area will be examined.

Although studies on the Carboniferous areas of the Cantabrian Mountains are quite extensive, our efforts in relation with the Project 5 have focused on a few key sections. Besides that of Las Llacerias, other carbonate successions (e.g. at Tabla de Lechugales Peak, in the Picos de Europa) are being investigated. Additional to these wholly marine successions, research on alternating marine and terrestrial strata in the Carboniferous areas of Palencia is continuing by R. H. Wagner (flora), C. F. Winkler-Prins (brachiopods), R. Coquel (spores) A. C. van Ginkel and E. Villa (fusulinids).

The Kasimovian sections of the Cantabrian Mountains are being analysed up to Dorogomilovsky horizon, since some evidence points at the existence of perhaps more significant palaeontological events at levels higher than the base of the *Protriticites* Zone.

2.2. MALAJA-POKAJAMA SECTION, NORTHERN TIMAN (summarysed of a report by S. Remizova)

Exposures of the Malaja-Pokajama section along the lower reaches of the Volonga River, in northern Timan, show a continuous succession of marine strata. A stratigraphic interval, including the Upper Moscovian and the Kasimovian, has been sampled

STAGE	FUSULINID ZONES (standard zonation)	FUSULINID ZONES (Remizova, this report)	BED No.	MOST RELEVANT FIRST OCCURRENCES
KASIMOVIAN	*Rauserites quasiarcticus*	*Rauserites*	134	↑ *Rauserites*
			133	↑ *Rugosofusulina*
	Montiparus montiparus	*Montiparus*	132	
			131	↑ *Triticites*
			125	↑ *Montiparus*
	Protriticites pseudomontiparus *Obsoletes obsoletus*	*Praeobsoletes-Obsoletes*	124	
			115	↑ *Obsoletes*
MOSCOVIAN	*Fusulinella bocki-Fusulina cylindrica*		104	↑ *Praeobsoletes, Protriticites*
			103	
			98	

Fig. 3.- Fusulinid zonation at Malaja-Pokajama section

in detail. These rocks have yielded abundant fusulinid faunas, showing a gradual replacement of assemblages.

A recent paper (Remizova, 1992) has proposed the genus *Praeobsoletes* to include some species with intermediate characteristics between those typical of *Fusulinella* and *Obsoletes. Praeobsoletes* would thus represent a transitional genus in the lineage leading from *Fusulinella* to *Obsoletes*. With respect to the fusulinid phylogeny proposed by Davydov (1990), *Praeobsoletes* is placed at the base of one of the two divergent lineages which depart from *Fusulinella*. The first occurrence of *Praeobsoletes* is therefore considered to belong to beds older than those with the first *Obsoletes*. Accordingly, a new fusulinid zonation is proposed for the Malaja-Pokajama section (Fig. 3). This new zonation considers the *Praeobsoletes-Osoletes* Zone as embracing the upper part of the *Fusulinella bocki-Fusulina cylindrica* Zone as well as the entire *Protriticites pseudomontiparus-Obsoletes obsoletus* Zone.

Some other noteworthy facts concerning the distribution of fusulinid faunas, are summarised below:

a) The first *Protriticites* and the first *Praeobsoletes* occur in Bed 104, in association with abundant Moscovian fusulinid species.

b) The first appearance of *Obsoletes* is recorded in Bed 115. From this bed up to bed 124 (interval equivalent to the *Protriticites pseudomontiparus-Obsoletes obsoletus* Zone) various fusulinids, usually considered to be of Moscovian age, are still present.

c) The first appearance of *Montiparus* occurs in Bed 125.

d) Whereas transitional forms are observed between *Fusulinella* and *Protriticites*, sharper changes seem to take place in the lineage linking *Protriticites* and *Montiparus.*

e) The first *Triticites* are recorded in Bed 131, within the *Montiparus* Zone.

f) Changes in the lineage *Fusulinella-Praeobsoletes-Obsoletes* are gradual, whilst more abrupt modifications occur between *Obsoletes* and *Triticites.*

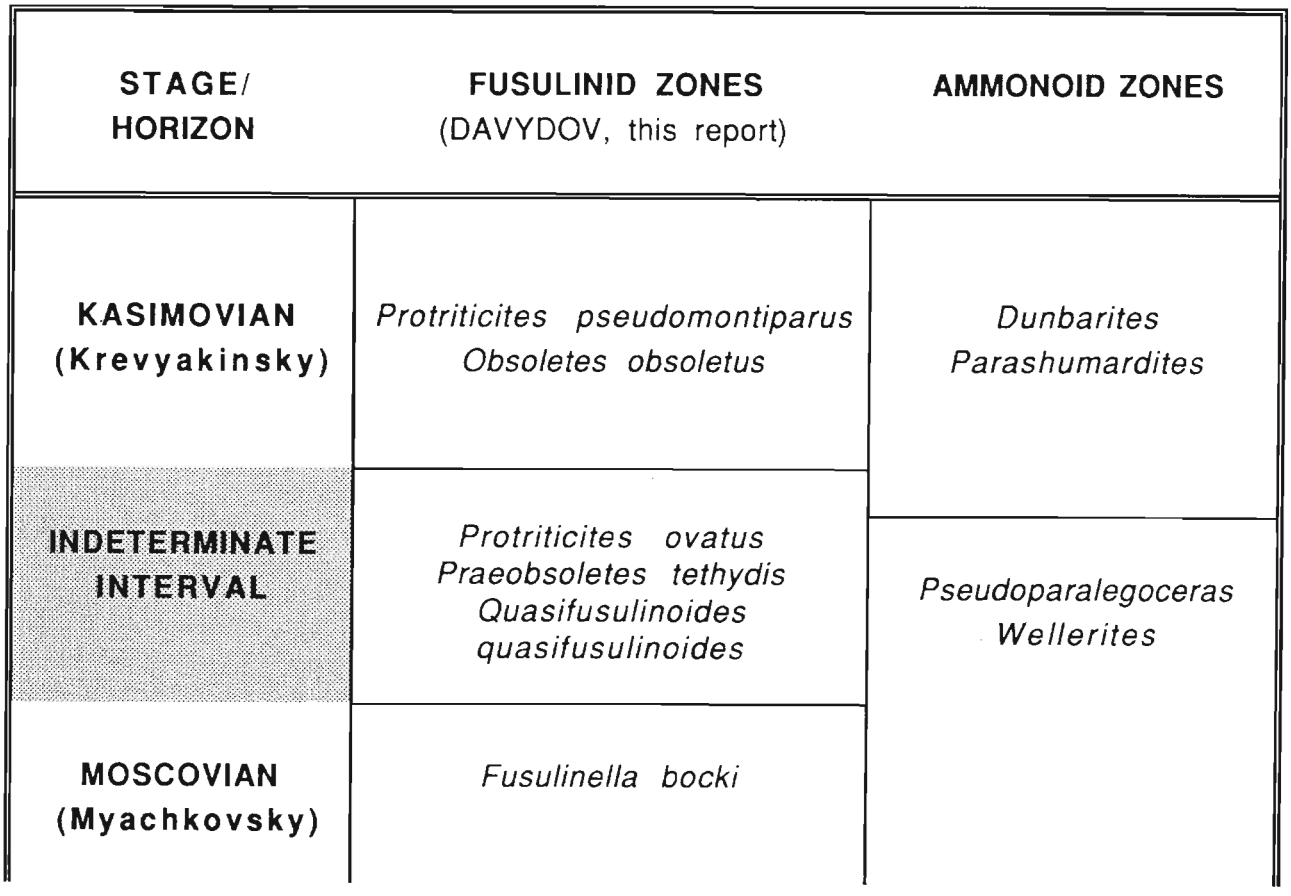

Fig. 4.- Correlation between fusulinid and ammonoid zones in Cape Chaika section

2.3. CAPE CHAIKA SECTION, PAI-KHOI (summarysed of a report by V. I. Davydov)

This section is situated on the shore of the Barents Sea, where a carbonate succession containing the Moscovian/Kasimovian boundary crops out along the western side of the Yugorsky Peninsula. The succession is mainly composed of reefal limestones containing ammonoids (Stepanov *et al.*, 1977), fusulinids (Nikolaev, 1980; Solovieva, 1984), brachiopods, bivalves, ostracods, bryozoans and rugose corals (Stepanov *et al.*, 1977; Dimitriev & Manankov, 1980). Conodonts have been studied by I. S. Barskov and L. I. Kononova (1983).

Data from the authors mentioned above are compiled and reviewed in this paper, with emphasis on the stratigraphic significance of fusulinids. The following fusulinid zones, ranging from uppermost Moscovian to lower Kasimovian, have been established in the higher part of the section:

***Fusulinella bocki* Zone.** These strata contain *Fusulinella bocki, Fusulinella subcolaniae, Pseudofusulinella* ex gr. *pulchra, Wedekindellina uralica, W. ultimata* and *Hanostaffella paradoxa.*

***Protriticites ovatus-Praeobsoletes tethydis-Quasifusulinoides quasifusulinoides* Zone.** This level has yielded *Fusulinella nipperensis yugorskensis, Pseudofusulinella hayasakai, Ps. pseudozelleri, Ps. dissorta, Ps. ardmorensis, Ps. alta, Ps. kottlowskyi, Ps. alaskensis, Ps. nevadensis, Ps. hatchetensis, Ps. horribila, Ps. zelleri, Ps. rata, Ps. condensa, Ps. amdermensis, Ps. logandalensis, Ps. zimmermani, Ps. ozawai, Praeobsoletes tethydis* (the latter occurring only in the lower part of the zone) and *Praeobsoletes? orbiculatus* (higher part).

***Protriticites pseudomontiparus-Obsoletes obsoletus* Zone.** Rocks assigned to this zone have yielded many of the species of *Pseudofusulinella* which also occur in the zone below, and which are here associated with *Fusulinella spatiosa, Obsoletes teres, O. timanicus tumbasalensis, O. burkemensis, Eowaeringella castigata, E. reprentina* and *Pseudofusulinella* aff. *prolifica.* The three species of *Obsoletes* occur in the lower part of the zone.

As in the Las Llacerias section of the Cantabrian Mountains, a fusulinid assemblage which cannot be assigned irrefutably to either the Moscovian or the Kasimovian, occurs between rocks with clear Moscovian or Kasimovian faunas, thus marking an «indeterminate interval», which coincides with the *Protriticites ovatus- Praeobsoletes tethydis-Quasifusulinoides quasifusulinoides* Zone.

A very remarkable fact in this section is the presence of two ammonoid beds in the higher part of the *Protriticites ovatus- Praeobsoletes tethydis-Quasifusulinoides quasifusulinoides* Zone. The lower one has yielded *Glaphyrites boreus* and *Pseudoparalegoceras aquilonae* and belong to the *Pseudoparalegoceras-Wellerites* Zone, whilst the higher one, in addition to the two taxa mentioned above, provided *Stenopronorites* ex gr. *uralensis, Proshumardites* sp. and *Dunbarites larus,* which allow assigning this bed to the *Dunbarites-Parashumardites* Zone. The joint occurrence of fusulinids and ammonoids allows correlating the fusulinid and ammonoid zones as shown in Fig. 4.

The base of the *Protriticites ovatus- Praeobsoletes tethydis- Quasifusulinoides quasifusulinoides* Zone coincides with the first occurrence of *Streptognathodus oppletus*. Other significant conodonts, such as *Streptognathodus excelsus, S. elegantulus, S. gracilis, S.* aff. *oppletus* and *Idiognathodus toretzianus,* are recorded at levels slightly higher than the base of the *Protriticites pseudomontiparus-Obsoletes obsoletus* Zone.

The data from Cape Chaika are regarded as extremely important for the palaeontological characterisation of the horizons considered. So, it would be highly desirable to carry out further investigations, especially detailed studies on the conodonts. Unfortunately, the area is inaccessible by normal motor transport, so the financial costs of field work are potentially high.

2.4. SPITSBERGEN SECTIONS (summarysed of a report by V.I. Davydov and Inger Nilsson)

Two Carboniferous sections in Spitsbergen, i. e. the Kolosseum and Trollfugifjella sections, have been studied most recently. Detailed information has been obtained on the distribution of fusulinids from Moscovian upwards into Permian strata, and this includes the stratigraphic levels of interest to the Working Group. All this stratigraphic information, based entirely on fusulinids, is already available to the Working Group on the base of the *Protriticites Zone.* It will be generally available after its publication in the coming months.

2.5. BOREHOLES IN THE TIMAN-PECHORA REGION (summarysed of a report by M. V. Konovalova)

The fusulinid contents of strata in four boreholes in the Timan-Pechora region have also been analysed. Two of these boreholes are situated in southern Timan (Burkem area), whilst the other two are in northern areas of the Timan-Pechora province (Narian-Mar and Laya-Vozh). Based on these data and on other information published by Konovalova (1992), it has been possible to establish five different fusulinid zones for rocks of latest Moscovian (Myachkovsky) and Kasimovian ages, viz. those of 1) *Fusulinella bocki.* 2) *Fusulina consobrina-F. quasicylindrica.* 3) *Protriticites pseudomontiparus-Obsoletes obsoletus.* 4) *Montiparus montiparus.* 5) *Triticites acutus*. These fusulinid zones correspond to those of the standard stratigraphic scheme of the Russian Platform, excepting the *Fusulina consobrina- Fusulina quasicylindrica* Zone which is a local one. This zone replaces the *Fusulina cylindrica* Zone of the Russian Platform because the first occurrence of *Fusulina cylindrica* is earlier in the Burkem area where it is found already in the Podolsky, as against Myachkovsky in the Russian Platform area.

The fusulinid assemblages in the three zones occurring in the stratigraphic interval of interest to Project 5, can be summarised as follows:

***Fusulina consobrina-F. quasicylindrica* Zone** (upper Myachkovsky). This zone contains *Neostaffella sphaeroidea, Fusiella typica, F. lancetiformis, Pulchrella eopulchra, P. pulchra, Eowaeringella?* ex gr. *usvae, Beedeina elegans, B. elegans longa, B. nytvica, B. nytvica callosa, B. truncatulina, Fusulina consobrina, F. ulitinensis, F. pseudocylindrica, F. quasicylindrica timanica*

***Protriticites pseudomontiparus-Obsoletes obsoletus* Zone** (established in lower Kasimovian, Burkemsky Horizon): the lower beds contain *Pseudotriticites* spp., *Eowaeringella? usvae, Pulchrella pulchra* and *Kanmeraia ozawai,* whilst the upper ones have yielded *Kanmeraia dissorta, Eowaeringella? usvae, Protriticites* ex gr. *sphaericus* and *Obsoletes timanicus.*

***Montiparus montiparus* Zone** (Kasimovian, Odessky Horizon). This zone contains *Pulchrella pulchra mesopachys, Eowaeringella usvae, Montiparus montiparus, M. umbonoplicatus, M. subcrassulus, M. sinuosus, Triticites noinsky, T. petschoricus,* as well as other fusulinids.

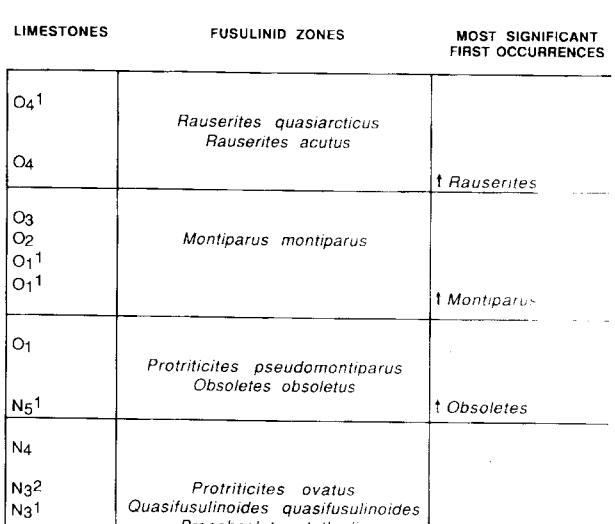

Fig. 5.- Fusulinid zonation at Kalinovo section

According to Konovalova, the Moscovian/ Kasimovian boundary is placed at the base of the beds with *Eowaeringella usvae* and *Pseudotriticites* spp. It is remarkable that, in the boreholes of South Burkem, species of *Protriticites* and *Obsoletes* first appear at levels higher than the Moscovian/ Kasimovian boundary. The same faunal distribution seems to be present in other parts of the northern Timan-Pechora region, e. g. the Shapkino-Yuryakha, Laya and Salyuka-Makarikha areas.

2.6. KALINOVO SECTION, DONETZ BASIN (summarysed of a report by V. I. Davydov).

The Kalinovo Section is situated in the Lugan River Valley, where the well known marine and terrestrial succession of the Donetz Basin crops out along an interval from Limestone N_2^1 to Limestone O_4^1.

The report summarises the fusulinid and conodont contents of marine beds, as well as plant megafossil occurrences in continental strata, according to data of Davydov (1992) (for fusulinids) and Shchegolev & Kozitskaya (1984) (for terrestrial flora and conodonts). Description of the section is borrowed from the Field-Trip Guide of the 8th ICC (1975).

Figure 5 shows the new fusulinid zonation established for this interval, which could be of potential importance for the correlation of the Donetz Basin with other areas.

It is interesting to point out some significant first occurrences in this section, such as the first *Protriticites* (Limestone N_2), first *Obsoletes* (Limestone N_5^1), first *Montiparus* (Limestone O_1^1) and first *Rauserites* (Limestone O_4).

Conodonts reported by Kozitskaya (in Shchegolev & Kozitskaya, 1984) show the occurrence of *Idiognathodus acutus, Neognathodus inaequalis* and *Streptognathodus* aff. *excelsus* in beds belonging to the *Protriticites ovatus-Quasifusulinoides quasifusulinoides-Praeobsoletes tethydis* Zone. Beds assigned to the higher *Protriticites pseudomontiparus-Obsoletes obsoletus* Zone have yielded *Idiognathodus acutus, Streptognathodus oppletus* and *Streptognathodus sagittalis.* Most important among the conodont data is the presence of *Streptognathodus oppletus* at Limestone N_5^1.

3. PRELIMINARY RESULTS

Some of the fusulinid zones mentioned in the reports are tentatively correlated in Fig. 6. It includes the fusulinid zonation of the Las Llacerias section, Cape Chaika section and Malaja-Pokajama section. The zonation established for Cape Chaika is also applicable to the Kalinovo section.

From a biostratigraphic point of view, the most noteworthy information gained in this reports refers to the existence of a gradual transition in the lineage *Fusulinella-Protriticites* (or *Fusulinella* and *Obsoletes*, according to certain authors). These transitional forms had already been reported from Las Llacerias, but were found to be present also in most of the sections studied. Some of these forms, viz. those with a thinner wall, lacking an outer tectorium, have been included by Remizova (1992) in her new genus *Praeobsoletes.* The existence of transitional forms increases the difficulty to establish a valid boundary between the *Fusulinella* Zone and the *Protriticites* Zone and, hence, for considering the first appearance of *Protriticites* as a reliable marker for recognising a potential chronostratigraphic boundary.

In most sections, the strata containing these transitional forms (i.e. the forms attributed to *Praeobsoletes* and to primitive *Protriticites*) cannot be correlated to either the upper Moscovian or the lower Kasimovian. Consequently, an indeterminate interval between these two chronostratigraphic units has been recognised in the Las Llacerias, Cape Chaika and Kalinovo sections. This interval is probably represented in the Malaja-Pokajama section by the beds containing the first *Praeobsoletes;* however, this part of the section is attributed provisionally to the uppermost Moscovian. Although the lower beds in the Burkemsky Horizon of southern Timan, containing *Pseudotriticites* spp. and *Kanmeraia ozawai,* are correlated tentatively with the lowermost Kasimovian, these strata are probably also equivalent in age to the indeterminate interval of the other sections mentioned.

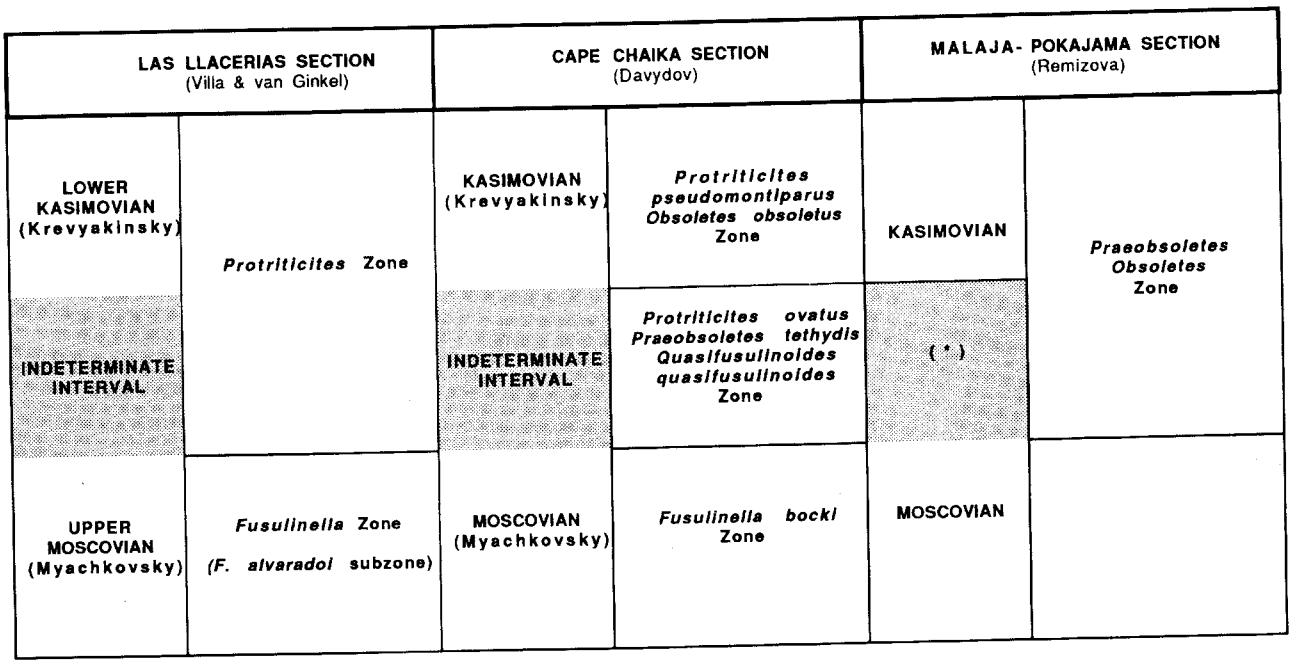

Fig. 6.- Tentative correlation between the various fusulinid zones mentioned in this report.
(*) Interval attributed to the Moscovian by Remizova

In order to establish a better defined Moscovian/ Kasimovian boundary, which is essential for a more accurate correlation involving these chronostratigraphic units, the type sections in the Moscow Basin need to be restudied. This revision has been undertaken by a team of Russian specialists linked to SCCS Project Group 5.

4. FUTURE PLANS

Other studies, which are in progress in different parts of the world, are expected to be finalised in the near future, thus providing more global information about the palaeontological characterisation of levels roughly equivalent to the base of the *Protriticites* Zone. These will be reported on later.

Our future plans should include a more intensive study of other groups of fossils, e. g. conodonts and ammonoids, which have a larger (geographical) distribution than the fusulinids. At the same time, we also should continue, in our respective areas, the search for sections containing as many different groups of fossils as possible.

Finally, it would appear that our investigations should be extended to an interval approximately equivalent to the Khamonichesky Horizon, including the base of the *Montiparus* (or *Triticites)* Zone. *Protriticites* has not been reported so far in the Carboniferous of North America, thus presenting a considerable impediment to potential correlations, whereas the *Triticites* Zone is recognised both in Eurasia and America. Therefore, with regard to the fusulinids, the base of latter zone may well offer better perspectives for worldwide correlation. Of course, data from other groups may possibly provide different indications.

5. ACKNOWLEDGEMENTS

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We wish to express our gratitude to all the members of the Working Group for their efforts to further the aims of our Project.

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