STUDIES ON THE BASE OF THE PROTRITICITES ZONE.
A REPORT ON SCCS PROJECT GROUP 5

Elisa VILLA, Vladimir I. DAVYDOV, Maria V. KONOVALOVA & Svetlana REMIZOVA

(6 figures)

ABSTRACT. A progress report is presented for the Working Group on the base of the Protriticides 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 distribution, e.g. conodonts and ammonoids.

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

RESUME. Recherches à la base de la zone à Protriticides. 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, du Nord du Timan, du Timan-Pechora, du Bassin du Donetz et de la Chaîne Cantabrique ont fourni des données détaillées sur leur contenu fossile, surtout en ce qui concerne les fusulinidés, mais aussi sur les brachiopodes, les coraux, les ammonoides, 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 ammonoides.

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 Protriticiones 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
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 VNIIGRI, Ukhta, Russia), Jürgen Kullmann (Geologisch-Paläontologisches Institut, Tübingen, Germany), Svetlana Remizova (Institute of Geology, Syktyvkar, Russia), Jasenka Sremac (University of Zagreb, Croatia), Katsumi Ueno (University of Tsukuba, Japan), Kozo Watanabe (Shinjuku, Japan) 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. Afanasieva (Palaontological Institute, RAS), M. Kh. Makhina (Moscow Geological Survey), O.L. Kossovaya (St. Petersburg Geological Institute) and A. A. Shkolin (Palaontological 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
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 Llaceras) 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 pseudomontiparush-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 Llaceras 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 Llaceras 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 Llaceras, 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 (summarised 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
<table>
<thead>
<tr>
<th>STAGE</th>
<th>FUSULINID ZONES (standard zonation)</th>
<th>FUSULINID ZONES (Remizova, this report)</th>
<th>BED No.</th>
<th>MOST RELEVANT FIRST OCCURRENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kasimovian</td>
<td><strong>Rauserites quasiarcticus</strong></td>
<td><strong>Rauserites</strong></td>
<td>134</td>
<td><strong>† Rauserites</strong></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>133</td>
<td><strong>† Rugosofusulina</strong></td>
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<tr>
<td></td>
<td><strong>Montiparus montiparus</strong></td>
<td><strong>Montiparus</strong></td>
<td>132</td>
<td><strong>† Triticites</strong></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>131</td>
<td><strong>† Montiparus</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Protriticites pseudomontiparus</strong></td>
<td></td>
<td>124</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Obsoletes obsoletus</strong></td>
<td><strong>Praeobsoletes-Obsoletes</strong></td>
<td>115</td>
<td><strong>† Obsoletes</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Fusulinella bocki-Fusulina</strong></td>
<td><strong>Praeobsoletes</strong></td>
<td>104</td>
<td><strong>† Praeobsoletes, Protriticites</strong></td>
</tr>
<tr>
<td></td>
<td><strong>cylindrica</strong></td>
<td></td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>Moscovian</td>
<td><strong>Fusulinella bocki-Fusulina</strong></td>
<td><strong>Fusulinella bocki-Fusulina</strong></td>
<td>93</td>
<td></td>
</tr>
</tbody>
</table>

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-Obsoletes 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.
### Table

<table>
<thead>
<tr>
<th>Stage/Horizon</th>
<th>Fusulinid Zones (Davydov, this report)</th>
<th>Ammonoid Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kasimovian</td>
<td>Protriticites pseudomontiparus Obsoletes obsoletus</td>
<td>Dunbarites Parashumardites</td>
</tr>
<tr>
<td>(Krevyakinsky)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indeterminate interval</td>
<td>Protriticites ovatus Praeobsoletes tethydis Quasifusulinoides quasifusulinoides</td>
<td>Pseudoparalegoceras Wellerites</td>
</tr>
<tr>
<td>Moscovian</td>
<td>Fusulinella bocki</td>
<td></td>
</tr>
<tr>
<td>(Myachkovsky)</td>
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</table>

### 2.3. Cape Chaika Section, Pai-Khoi
(summaryised 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 Yugorsk Peninsula. The succession is mainly composed of reeal limestone with 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 yugorskenisis, Pseudofusulinella hayasakai, Ps. pseudozelleri, Ps. dissorta, Ps. ardmoresis, Ps. alta, Ps. kottlowskii, Ps. alaskensis, Ps. nevadensis, Ps. hatcherensis, Ps. horribila, Ps. zelleri, Ps. rata, Ps. condensa, Ps. amdermensis, Ps. logandaliensis, 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. timnicus tumbasaensis, O. burkensis, Eowaeringella castigata, E. reprentina and Pseudofusulinella aff. prolifica.* The three species of *Obsoletes* occur in the lower part of the zone.
2.5. BOREHOLES IN THE TIMAN-PECHORA REGION (summarised 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 late Moscovian (Myachkovsky) and Kasimovian ages, viz. those of 1) Fusulinella bocci. 2) Fusulina consobrina-F. quasicylindrica. 3) Protriticites pseudomontipar-us 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, Fusiliella typica, F. lancetiformis, Pulchrella oopulchra, P. pulchra, Eowaeringella? ex gr. usvae, Beedeina elegans, B. elegans longa, B. nytivca, B. nytvica callosa, B. truncatulina, Fusulina consobrina, F. ultinensis, F. pseudocylinidica, F. quasicylindrica, F. cylindrica timanica

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

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

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

Two Carboniferous sections in Spitsbergen, i.e. the Koloseum and Trollfuglifjella 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.
According to Konovalova, the Moscovian/Kasimovian boundary is placed at the base of the beds with Eowaerinaella usvae and Pseudotriticitic 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, Lay and Salyuka-Makarikha areas.

2.6. KALINOVO SECTION, DONETZ BASIN (summarized 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_61 to Limestone O_41.

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_61), first Obsoletes (Limestone N_61), first Montiparites (Limestone O_41) and first Rausertes (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-Qausifusulinitoides quasifusulinitoides-Præobsoletes tethydis Zone. Beds assigned to the higher Protriticites pseudomontiparites-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_61.

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 Llaceras 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 Llaceras, 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 Llaceras, 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 Pseudotriticitic spp. and Kannereaia 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.
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 *Trilites*) Zone. *Protriticites* has not been reported so far in the Carboniferous of North America, thus presenting a considerable impediment to potential correlations, whereas the *Trilites* 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.

### 6. BIBLIOGRAPHY


ENGELE, B., 1992. - The SCCS Global Correlation Program. 
Newsletter on Carboniferous Stratigraphy, 10: 13-14.

KONOVALOVA, M. V., 1991. - Stratigraphy and fusulinids of the 
Upper Carboniferous and Lower Permian of the Timan-Pechora 
oil and gas-bearing Province (in Russian). Nedra Publishing 
House, Moscow: 1-201.

NIKOLAEV, A. I., 1980. - Fusulinids from the reef-forming deposits of 
the Middle Carboniferous of Cape Chalka (in Russian). In: 
"Microfauna and biostratigraphy of the Phanerozoic of the oil- 
bearing areas of the USSR". Trans VNIGRI, Leningrad: 50-60.


SHCHEGOLEV, A. K. & KOZITSKAYA, R. I., 1984. - The 
paleontological basis of the Upper Carboniferous Standard Scale 
Project in Europe and Central Asia (in Russian). In: The Upper 
Carboniferous of the USSR (Ed. by V. V. Menner and A. D. 
Grigoreva). Transact. Interdep. Strat. Comittee of the USSR, 

SOLOVIEVA, M. N., 1984. - The lower boundary of the Upper 
Carboniferous on the foraminifers in the Yugorsky Peninsula 
(in Russian). In: The Upper Carboniferous of the USSR (Ed. by 
Comittee of the USSR, Moscow, 13: 121-158.

STEPANOV, D. L., SULTANAEV, A. A., GROZDILEVA, L. A., 
DEGTIAYREV, D. D., KRUCHINA, O. N., LAPINA, N. N., 
MUROMTSEVA, V. A., NIKOLAEV, A. I., POPOV, A. V., 
SIMAKOVA, M. A. & TKACHEVA, I. A., 1977.-. New data about the 
Middle Carboniferous of South-Western Pai-Khoi (in 

VILLA, E., GINKEL, A. C. van, LEYVA, F., MARTINEZ- 
CHACON, M. L., MENDEZ, C., RODRIGUEZ-GONZALEZ, R. 
M., RODRIGUEZ, S. y SANCHEZ DE POSADA, L. C., 1993 - 
Fossil contents of the Moscovian-Kasimovian boundary in a 
section of the Picos de Europa area (Carboniferous, NW Spain). 