

CORRELATION OF THE MYACHKOVIAN AND KASIMOVIAN IN THE U.S.S.R.  
WITH THE WEST EUROPEAN SUBDIVISION

BY

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ABSTRACT

The Myachkovian and Kasimovian chronostratigraphic units in the U.S.S.R. are correlated with similar units as used in western Europe. This correlation is here established through northwestern Spain, where fusulinid faunas and plant fossils enable a comparison with the U.S.S.R. and western Europe. It is shown that the lower- and upper limit of the Myachkovian correlate with some level in the Westfalian D and the middle Cantabrian respectively and that the top of the Kasimovian may probably be equated with some level in the Stephanian B.

INTRODUCTION

It is a happy coincidence that the Carboniferous of northwestern Spain not only supplies floras which may express relative ages in terms of west European chronostratigraphy, but also fusulinid faunas which offer similar possibilities with regard to Russian chronostratigraphic subdivisions. It is for this reason that the Carboniferous of northwestern Spain is of particular interest since it offers an opportunity to correlate the chronostratigraphic subdivisions as used in western Europe with those adopted for the Moscow platform basin in the U.S.S.R.

A correlation of west European and Russian Carboniferous subdivisions has previously been made (van Ginkel, 1965). Evidence from most of the major fossil groups entered in the construction of this correlation although the number of data available and pertinent to this goal was admittedly small. It is clear therefore that the probable correctness of this correlation may still considerably be enhanced by including new information relevant to the subject. Taking into account the relatively few data with regard to relative age as yet present for the Carboniferous of northwestern Spain, it is by no means impossible that in a later analysis the discrepancy with a similar correlation through the Donetz basin (Aisenverg et al., 1960) will be less evident.

A comparison of plant fossils and fusulinid foraminifera has shown that the boundary between the Moscovian and the Gzhelian – including the Kasimovian as its lowermost subdivision – corresponds approximately to that between the Westfalian and the Stephanian (van Ginkel, 1965, p. 212). The uncertainty with respect to the correlation of both boundaries was

partly due to a number of floral assemblages dated as: "either late Westfalian D or early Stephanian A" (e. g. Wagner and Wagner-Gentis, 1963, p. 157). New or revised data on fusulinid foraminifera (van Ginkel, 1971) and plant fossils (Wagner, 1966-1972) as well as the introduction of a Cantabrian stage\*\* between the Westfalian D and the Stephanian A,

\*\* The Cantabrian Stage was provisionally introduced by Dr. R. H. Wagner during the meeting of the Subcommittee on Carboniferous Stratigraphy held in Sheffield in 1965. Its use has been sanctioned by the I.U.G.S. Subcommittee on Carboniferous Stratigraphy at its meeting in Krefeld in 1971.

The Cantabrian stage constitutes the basal part of the Stephanian series. It is followed by the Stephanian A stage and follows upon the Westfalian D stage. Its stratotype is in northwestern Spain and contains both marine- and continental-type rocks. According to Dr. R. H. Wagner these rocks fill the time-gap which apparently exists between the Westfalian D and Stephanian A stages as based on stratotypes in France, i. e. the Sarre-Lorraine area and the Loire area respectively. His conclusions are mainly based upon paleobotanic investigations in northwestern Spain and subsequent comparison with floras in French Coal Basins. Additional evidence concerns the limnic fauna and the nature of rock successions in both France and Spain (Wagner 1966(1)(2), Bouroz et al., 1970).

It has been proposed to choose as the stratotype of the Lower Cantabrian a succession of rocks in the northern flank of the Tejerina syncline in Leon province (Wagner, 1969). At the congress meeting in Krefeld (1971) it has been decided, however, that as the stratotype of the lower part of the Cantabrian should be considered a rocksequence of about 1000 m in the Casavegas syncline (Palencia) and that its base should coincide with the base of the Lores Limestone Member. A succession of rocks of about 1800 m immediately following the Brañosera Limestone up to the base of the Carboneros Coal Member was designated as stratotype of the upper part of the Cantabrian stage. The latter succession is in the Barruelo area in the valley of the Río Rubagón (Palencia).

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force us to reconsider the probable time-equivalents of the Myachkovian and the Kasimovian in terms of west European chronostratigraphic units.

There are two areas in northwestern Spain which may yield the necessary information to establish the correlation of Myachkovian and Kasimovian with west European chronostratigraphic subdivisions. These are the upper Río Pisuerga area in the province of Palencia and the lower Río Cares area (Cabrales) in the province of Oviedo (Asturia).

The conclusions reached in the present note are based almost entirely on the results obtained by Dr. R. H. Wagner with regard to the relative age of floral assemblages and on fusulinid identifications by the present author. Additional data on algae, brachiopods and pelecypods pertinent to the scope of this note, we owe to Rácz (1965), Winkler Prins (1971) and Butusova (1965, written comm.).

### THE UPPER RÍO PISUERGA AREA (PALENCIA)

#### *Casavegas syncline*

*Urbaneja Limestone.* – The fusulinid fauna is poor. The most probable equivalents in the U.S.S.R. of the Urbaneja Limestone are: top of Myachkovian (Moscow platform);  $N_1$  or  $N_2$  Limestone of the  $C_3^1$  (N) = Isaev suite (Donetz basin) (van Ginkel, 1971, p. 119, 120).

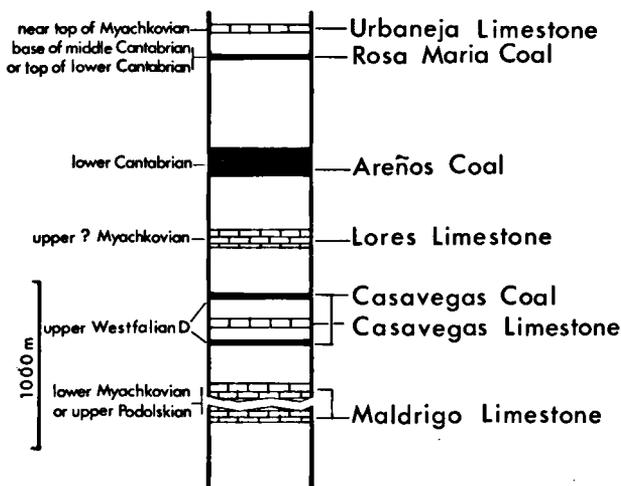


Fig. 1.

*Rosa Maria Coals.* – The correlation diagram of post-Leonian successions in northern Palencia comprising the interval from Upper Westfalian D to Stephanian A (Fieldmeeting on the Carboniferous of northwestern Spain, 19–26 sept. 1970, after Wagner and Varker, 1972, in print) shows that the Rosa Maria Coals may be correlated with basal strata in the Barruelo section about 100–200 m above the hiatus at the top of the Brañosera Limestone. Comparison with the Barruelo

section as shown in figure 2 of Bouroz, Gras and Wagner (1970) suggests that these basal strata are considered to be deposited either during the end of the lower or beginning of the middle Cantabrian. A similar position of the Rosa Maria Coals is also suggested in figure 5, p. 34 of Wagner (1972) if we take into account that in this figure the base of the Cantabrian should be placed slightly lower i. e. at the base of the Lores Limestone. About 600 m SE of San Salvador plant fossils of middle Cantabrian age have been found, stratigraphically probably slightly above the Rosa Maria Coals of the Casavegas syncline (Wagner, 1972, p. 27).

We may conclude that all recent data published up to now are suggestive of an age for the Rosa Maria Coals near the limit of the lower and middle Cantabrian.

*Areños Coals.* – Plant fossils of the Areños Coals tentatively suggest a basal lower Stephanian age i. e. lower Cantabrian (Wagner, 1972, p. 27, citing Wagner and Varker, in print). The Areños Coals form now part of the stratotype of the Cantabrian according to the decision of the Subcommittee on Carboniferous Stratigraphy at the Krefeld meeting (1971). This decision by definition excludes an upper Westfalian D age and we may therefore safely assume a lower Cantabrian age for the Areños Coals.

*Lores Limestone.* – Fusulinid foraminifera point to a Myachkovian age for the Lores Limestone. The presence of *Fusiella praelancetiformis* Safonova and *Fusulinella loresae* van Ginkel which latter species is close to species of the group *F. schwagerinoides* (Deprat) suggest the upper part of the Myachkovian. Stratigraphically below the Lores Limestone brachiopod faunas have been collected which pending further investigations do not yet warrant a definite correlation with the Myachkovian; some Kasimovian-type species are also present (Dr. C. F. Winkler Prins, oral comm.).

*Casavegas Coals.* – The Casavegas Coals yielded a well preserved flora to Dr. R. H. Wagner which he considers to be of upper Westfalian D age (Wagner, 1972, p. 26).

*Maldrigo Limestone.* – The fusulinid species *Fusulinella maldrigensis* van Ginkel from this limestone is related to a number of species of this genus which together range from the middle part of the Podolskian to the lower Myachkovian.

The hiatus within the Maldrigo Limestone (van de Graaff, 1971) may be considered to represent a small interval of time of nondeposition at approximately the limit of the Podolskian and the Myachkovian.

#### *Sierra Corisa syncline*

*San Felices Coals.* – The San Felices Coals and the Peñacorba Coals (Barruelo area) have an associated flora of similar age (Wagner, 1955, fig. 1 and p. 166;

Wagner and Winkler Prins, 1971, p. 501). The Peñacorba Coals yielded an upper Cantabrian flora (p. 4).

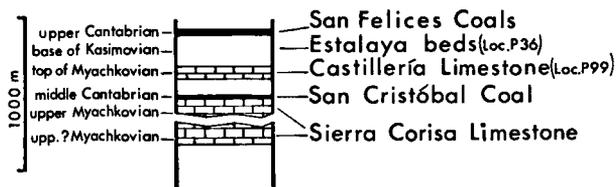


Fig. 2.

*Estalaya beds.* – Considering the assemblage of fusulinid foraminifera of the Estalaya beds among which the genus *Protriticites* is present, its most probable equivalents in the U.S.S.R. are the base of the Kasimovian (Moscow platform) and the  $N_3$  Limestone of the  $C_3^1$  (N) = Isaev suite (Donetz). The Estalaya beds moreover contain gastropods which have been identified by Dr. Butusova who concluded upon a Kasimovian age for these strata (van Ginkel, 1971, Loc. P 36, p. 120–121).

*Castillería Limestone.* – The Castillería Limestone\* has been sampled for fusulinid forams by Dr. A. Breimer in 1955. Subsequent examination of one of his samples showed the presence of only numerous specimens of the genus *Staffella*. Although this fauna provides no clue as to the exact age, it was nevertheless assumed that the Castillería Limestone should be of lower to middle Kasimovian age (van Ginkel, 1965). The decision was based on the comparable stratigraphic position of the Castillería Limestone and the Estalaya beds. Reexamination of the fusulinid fauna of the Estalaya beds (Loc. P 36) as well as the find of a single sagittal section of *Fusulinella* in Breimer's material forced me to reconsider the previous conclusions with regard to the age of the Castillería Limestone (van Ginkel, 1971, p. 120, 121). Subsequent sampling of this limestone from the same locality (Loc. P 99) yielded a fair amount of spindle-shaped fusulinids. Thin sections revealed the presence of specimens which are doubtless precursors of *Protriticites* sp. as described from the Estalaya beds and which are quite close if not identical to *Fusulinella praesimplex* Lee. In view of the presence of the latter species occurring in the Yanghukou Limestone of the Penchi series and taking into account the basal Kasimovian age of the Estalaya beds, we may expect the limit between the Myachkovian and the Kasimovian at the level of the Castillería Limestone or perhaps

\* In the valley of the Río Castillería isolated outcrops of limestone occur south of this brooklet. These limestones at approximately the same stratigraphic level are known to some authors as the Vañes Limestone. To avoid confusion with the "serie de Vañes" of Nederlof and de Sitter (1957) which is a formation of predominantly siliciclastic rocks below the Corisa Formation, the name Castillería Limestone is here proposed for these limestones.

even slightly higher. As a provisional conclusion we might equate this limestone with the  $N_1$  or rather the  $N_2$  Limestone of the  $C_3^1$  (N) = Isaev suite of the Donetz basin. The Urbaneja Limestone (Casavegas syncline) is of the same age or slightly older. Both limestones contain algae of the same Algal Zone VI of Rácz (Rácz, 1965, p. 250, fig. 4).

*San Cristóbal Coals.* – The San Cristóbal Coals yielded a flora to Dr. R. H. Wagner which he regards as middle Cantabrian or older but most probably middle Cantabrian (Wagner and Winkler Prins, 1971, pp. 500, 501). Approximately time-equivalent strata may be found near the top of the sequence in the Casavegas syncline (Rosa-Maria Coals) and above the Brañosa Limestone near the base of the sequence in the Rubagón valley (Barruelo area) (Wagner and Breimer, 1958, p. 11, 12).

*Sierra Corisa Limestone.* – The presence of *Fusulinella* of the group *schwagerinoides* (Deprat) (cf. Loc. P 22–2 in van Ginkel, 1965) immediately above the hiatus in the Sierra Corisa Limestone definitely points to at least an upper Myachkovian age for the upper part of this limestone. Although *F. ex gr. schwagerinoides* may occur also in the lower part of the Kasimovian (Zone  $C_3^{11}$  of Schlikova, 1948), the association of fusulinids in the Castillería Limestone and the Estalaya beds suggest that the limit between the Myachkovian and the Kasimovian should be higher in the section. The find of a muddy limestone crowded with specimens belonging to the genus *Hemifusulina* also immediately above the hiatus, is another argument against a Kasimovian age for the upper part of the Sierra Corisa Limestone. *Beedeina corisaensis* van Ginkel of the group *B. elegans*, which species is close to *B. ichinotaniensis* Igo found in the higher part of the *Fusulina* Zone of the Hida Massif (Japan), occurs about 100–150 m lower in the Sierra Corisa Limestone (Loc. P 98). At a yet lower level in this limestone (Loc. P 22–1) a fusulinid species has been found which belongs to the group of *Fusulinella mosquensis* and is close to *F. rara* Schlikova. The evolutionary level of both species suggests a Myachkovian age for at least part of the Sierra Corisa Limestone below the hiatus.

The time interval of non-deposition and erosion represented by the hiatus was apparently quite short as it was also in the Maldrigo Limestone of the Casavegas syncline. In the latter area, however, both final and renewed sedimentation occurred slightly earlier.

#### *Redondo syncline*

*Redondo coals.* – The correlation diagram of post-Leonian successions in Northern Palencia comprising the interval from Upper Westfalian D to Stephanian A (Field meeting on the Carboniferous of northwestern Spain, 19–26 sept., 1970 after Wagner and Varker,

1972, in print) suggests a possible correlation of the Redondo Coals with the Peñacorba Coals in the Barruelo area. If this suggested correlation should prove to be correct, the Redondo Coals would be of upper Cantabrian age.

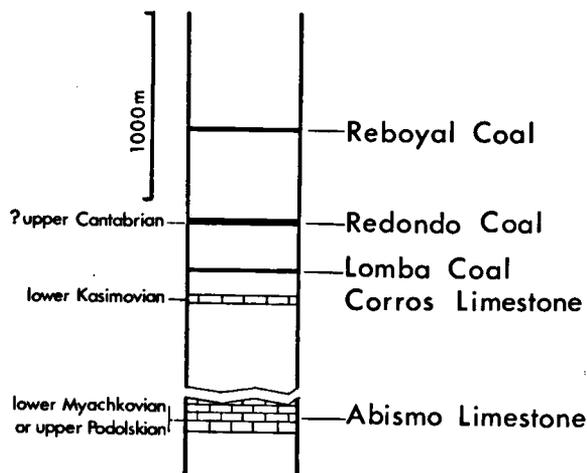


Fig. 3.

**Corros Limestone.** – The fusulinid fauna which consists of *Protriticites* sp. – rather close to *P. plicatus* subsp. *bella* Kireeva and *P. umbonoreticulatus* Kireeva – and *Pseudotrivicites* cf. *lebedevi* (Putrya) indicates that the most probable equivalents in the U.S.S.R. of the Corros Limestone are:

Lower Kasimovian (top of Krevyakino beds) (Moscow platform)

$N_5$  Limestone of the  $C_3^1(N)$  = Isaev suite (Donetz basin)

This fauna belongs to the *Protriticites* Zone (Spain) or the  $C_3^4$  Zone of Rosovskaya (1958) (U.S.S.R.).

**Abismo Limestone.** – *Fusulina cotarazoe* van Ginkel belongs to the group of *F. kamensis* Safonova which means to a group of species occurring in upper Podolskian and lower Myachkovian strata in the U.S.S.R.

*Fusulinella mosquensis* Raus. et Saf. subsp. *abismoe* is related to a number of species known from Podolskian and Myachkovian strata.

The most probable age for the Abismo Limestone is therefore upper Podolskian or lower Myachkovian.

It seems probable that the hiatus above the Abismo Limestone started at about the same time as the hiatus observed near the top of the Maldrigo Limestone (Casavegas syncline) but was of longer duration comprising probably the larger part of the Myachkovian in the Redondo syncline.

#### Barruelo area

**Calero Coals.** – The floras recorded from the Calero Coals indicate a Stephanian A age and should be compared with similar floras of the “Assise de Lentin” of Carmaux in southern France (Wagner and Winkler Prins, 1971, p. 515).

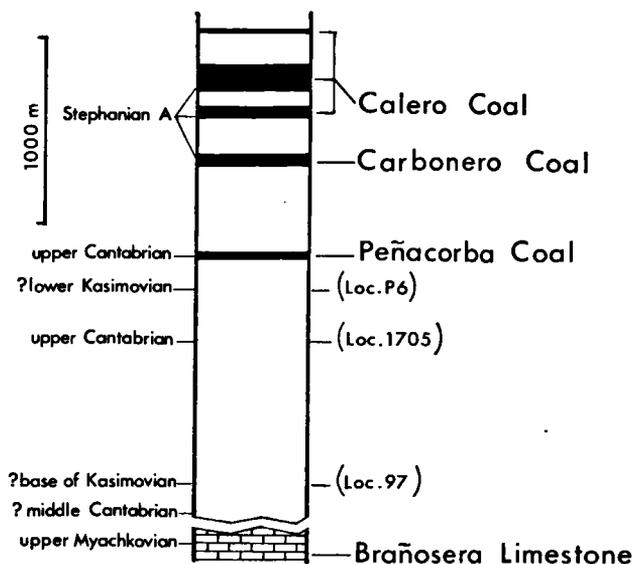


Fig. 4.

**Carboneros Coals.** – The floras recorded from the Carboneros Coals are probably of approximately the same age as those known from the “Faisceau de la Peronnière” of the “Assise de Rive-de-Gier” which is the traditional stratotype of the Stephanian A (Bouroz, Gras and Wagner, 1970, p. 216).

The base of the lowermost coalseam of the Carboneros Coals has been designated as the top of the Cantabrian Stage by the Subcommittee on Carboniferous Stratigraphy at its meeting in Krefeld (1971).

**Peñacorba Coals.** – With regard to the age of the Peñacorba Coals Dr. R. H. Wagner remarks that: “lack of adequate information on the flora of the Assise de Rive-de-Gier in the St. Etienne (Loire) coalfield of east-central France which is the traditional stratotype of Stephanian A (P. Bertrand, 1937), makes it rather difficult to either affirm or deny that the Peñacorba Member is Stephanian A or older in age”. He continues that on the basis of a general correlation in France and Spain, it appears that the Peñacorba should be regarded as slightly older in age i. e. upper Cantabrian (Wagner and Winkler Prins, 1971, p. 506).

**The sequence between the Peñacorba Coals and the Brañosera Limestone.** – a) About 100 m below the Peñacorba

Coals a thin limestone lens which crops out in the river Rubagón yielded fusulinid foraminifera. Among abundant specimens belonging to the genus *Staffella* two sections of spindle-shaped fusulinids were found which might be identified as *Protriticites*. They could represent an early growthstage or they might be close to some of the smaller species of this genus. The wall, without mural pores but also unlike the fusulinellid wall structure, is rather similar to the wall in the inner whorls of advanced *Protriticites*. A lower Kasimovian age is most probable for this horizon in case this interpretation should prove to be correct (van Ginkel, 1971, Loc. P 6, p. 122).

b) Drifted plantfossils in a marine environment have been found by Mr. J. Fernández-Pello approximately 450 m below the Peñacorba Coals which should be regarded as upper Cantabrian in age and certainly not older (Wagner and Winkler Prins, 1971, fig. 3 (Loc. 1705), pp. 502–504).

c) About 250–300 m above the Brañosera Limestone, Wagner and Winkler Prins (1971) mention from their locality 97 a rich fauna of brachiopods which according to the latter author are nearly all known from the "Spiriferenschicht" and from layer 6 of Schellwien in the Carnic Alps. They furthermore state that on its fusulinid content layer 6 of Schellwien is considered to be either uppermost Moscovian or lower Kasimovian in age referring to Passini (1963). With regard to the fusulinid fauna described by Passini, only his samples MLP 996 to MLP 1002 at the very base of his stratigraphic column of the Mount Auernig sequence yielded fusulinids corresponding to this age interval. Wagner and Winkler Prins apparently referred to this basal part of the section and equated it with Schellwiens layer 6. This correlation, though probably correct, is not well established because of faulting and the uncertainty with regard to the exact position of Schellwien's layer 6 (Winkler Prins, oral comm.). The fauna described by Passini (MLP 996–MLP 1002) compares rather well with the fusulinids from the Estalaya beds in the Sierra Corisa syncline. The association with a. o. *Protriticites pramolensis* (Passini) is typical for the *Protriticites* Zone. A lowermost Kasimovian age might be inferred from this association of Mount Auernig. In consequence a similar age might provisionally be assigned to this horizon in the Barruelo area.

*Brañosera Limestone.* – *Fusulinella brañoserae* van Ginkel is closely related to *Fusulinella gracilis* Kanmera. The latter species is characteristic for the upper subzone of the three subzones in the Kurikian stage of the Yayamadake Limestone of South Kyushu (Japan). The Kurikian of Japan is correlated with the Myachkovian of the U.S.S.R. The sequence corresponding to the *Fusulina ohtanii*–*Fusulinella gracilis* Subzone is therefore correlated with the upper part of the Myachkovian of the U.S.S.R. (Kanmera, 1951, 1954; Ishii, 1961; Toriyama, 1967).

It seems probable that the hiatus above the Brañosera

Limestone started at about the same time as the hiatus near the top of the Sierra Corisa Limestone\*.

#### THE LOWER RÍO CARES AREA (CABRALES, OVIEDO)

a) A sequence of mostly shallow marine strata follows unconformably on the Picos de Europa Formation\*\*. Near the base of this sequence in Areños de Cabrales a fossil flora has been discovered by Dr. E. Martínez-García which indicates a Stephanian A or B age. For

\* Time relations of the hiatuses discussed above, clearly demonstrate that tectonic oscillatory movements were active during nearly the entire time-span comprising the Myachkovian. This, of course does not necessarily imply that tectonic conditions were stable or even more stable in Kashirian – Podolskian or uppermost Myachkovian – lower Kasimovian time in the Pisuega basin. The occurrence of megacyclothems (van de Graaff, 1971, p. 206) in this area already before the Myachkovian suggests that there is not a relatively sharply defined tectonic phase (i. e. Leonian phase) in upper Myachkovian times. The hiatus above the Brañosera Limestone and near the top of the Sierra Corisa Limestone may be interpreted as the incidental uplift above sealevel of oscillatory tectonic movements which took place also before and possibly after this event. In my opinion and contrary to that of Wagner and Winkler Prins (1971, p. 519) the relative long duration added to the low intensity of these tectonic movements, which moreover are entirely comparable with similar tectonic activity during most of the Carboniferous history in the Cantabrian mountains, does not warrant the introduction of a Leonian phase in the Pisuega area. The facies analysis of this area by van de Graaff (1971) has shown that the source area from which the basin was supplied was situated to the S, SW or W. This explains also the different nature of the hiatuses in the Pisuega basin. The hiatus in the Maldrigo Limestone and at the Abismo Limestone level in the northern and northeastern part (= more distant from hinterland) of the basin were probably caused by a sudden relative subsidence which resulted in a short interruption of the limestone sedimentation in the Maldrigo Limestone and "wild-flysch"-type deposits locally at the Abismo Limestone level. Sedimentation in the Casavegas syncline above the Maldrigo Limestone kept up with a quick rate of subsidence. This is shown by the short time (Myachkovian) in which the 2000 m sequence was deposited together with the fact that the cycles contain roots and coals. Sedimentation during the same period of time was very low in the Redondo syncline, part of the deepening basin, until it started again with an influx of mature turbidites. In the southern and southeastern parts of the basin (closer to hinterland), however, oscillatory tectonic movements resulted in subaerial erosion as is suggested by the nature of the hiatuses in the Sierra Corisa Limestone (van de Graaff, 1971, pp. 186–192) and above the Brañosera Limestone (Wagner and Winkler Prins, 1971, p. 499, p. 519) or in low-angle unconformities (e. g. Vergaño unconformity in the Sierra Corisa syncline of van de Graaff, 1971, p. 190).

\*\* The Picos de Europa Formation has been introduced by Mr. K. Maas for a sequence of limestones in the Picos de Europa of about 500 m thickness generally underlain by the "Caliza de Montana" (Maas, K., Geology of the Liébana, 1972, in print).

local stratigraphic reasons a Stephanian A age is thought to be somewhat more probable (Martinez-García and Wagner, 1972, p. 302). A calcareous mudstone (Loc. A 4) stratigraphically 10–30 m above this flora, yielded a fusulinid fauna to Mr. M. M. Fischer. The single species present was classified as *Triticites (Montiparus) fischeri* n. sp. and compared with *Tr. (M.) umbonoplicatus* Raus. et Belj. and *Tr. ? peculiaris* Gryzlova. This Spanish species from the *Triticites* Zone was correlated with the  $O_3$  Limestone of the  $C_3^2$  (O) = Avilov suite of the Donetz basin and the Upper Kasimovian (Dorogomilov beds) of the Moscow platform (van Ginkel, 1971, p. 122, 123). b) The Picos de Europa Formation has yielded fusulinids of Myachkovian age near the top of this formation (Maas and van Ginkel, in Maas, 1972, in print).

## CONCLUSIONS

The lower limit of the Myachkovian correlates with some level within the Westfalian D because in the Sierra Corisa syncline the San Cebrian Coals are of lowermost Westfalian D age (Wagner and Wagner-Gentis, 1963, p. 156), whereas the limit between the Podolskian and the Myachkovian is near the Cotarraso

Limestone which occurs higher in the stratigraphical column. The lower limit of the Cantabrian (= base Lores Limestone of the Casavegas syncline) is in the upper part of the Myachkovian as based on fusulinid evidence of the Lores Limestone. The upper limit of the Myachkovian is to be placed in the middle Cantabrian because of the probably uppermost Myachkovian- and middle Cantabrian age of the Castillería Limestone and the San Cristóbal Coals respectively (Sierra Corisa syncline). Floras of probably uppermost Stephanian A age may be found associated with Upper Kasimovian type fusulinids indicating that the top of the Kasimovian correlates probably with some level in the Stephanian B (Areños de Cabañales; Lower Cares area; Oviedo).

Other data dealt with in this paper do not contradict the proposed correlation as given in Figure 5.



Fig. 5.

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