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# CONNECTIONS OF THE CARBONIFEROUS BRACHIOPOD FAUNAS OF THE CANTABRIAN MOUNTAINS (SPAIN)

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## ABSTRACT

During the Lower Viséan the brachiopod fauna in the Cantabrian Mountains was closely related to the N. W. European ones. The absence of Gigantoproductidae and Daviesellidae is explained by unfavourable facies conditions for these groups during the Viséan and Lower Namurian. When the environment changed in their favour (*i. e.* in Upper Namurian times) these groups were already extinct, but many other species known from the Lower Carboniferous are found together with some younger (Moscovian) elements indicating a Bashkirian age. These Lower Carboniferous species are presumed to have migrated from the main Tethyan area where they are also found to persist in slightly younger strata. Some brachiopods from the Pennsylvanian of the U. S. A. were found in Upper Bashkirian deposits and this connection with North America appears to have persisted throughout the Moscovian into the Kasimovian. However, this affinity was never very close, and was only important in the Moscovian brachiopod fauna of the Central Asturian Basin. The Lower Moscovian and Podolskian brachiopod faunas contain many species known from the Westphalian C marine bands of western Europe, thus indicating good sea connections. The brachiopod faunas from Upper Moscovian and, especially, Kasimovian deposits have many species in common with Russian faunas, and this is one of the reasons why Russian chronostratigraphic units are used in preference to the West European ones. Close affinities are also found with the Alps, Hungary and even China.

## RESUMEN

Durante el Viséense la fauna de braquiópodos en la Cordillera Cantábrica guardaba una relación estrecha con las del noroeste de Europa, explicándose la ausencia de Gigantoproductidae y Daviesellidae por las condiciones desfavorables para estos grupos durante el Viséense y el Namuriense bajo. Cuando las condiciones cambiaron a su favor, durante el Namuriense superior, estos braquiópodos ya se habían extinguido. Otras especies ya conocidas del Carbonífero inferior se encuentran asociadas a elementos más modernos (del Moscoviense) en estos estratos, indicando así una edad Bashkiriense. Estas especies del Carbonífero inferior probablemente venían del ámbito principal del «Paleotethys» donde continuan igualmente en estratos algo más modernos. Algunos braquiópodos del Pennsylvaniense de los EE. UU. se han encontrado en sedimentos del alto Bashkiriense y esta conexión con América del Norte parece haber persistido durante todo el Moscoviense e incluso el Kasimoviense. Sin embargo, las afinidades no parecen haber sido muy grandes y se muestran solamente importantes en el caso de los braquiópodos del Moscoviense de la Cuenca Central de Asturias. Las faunas de braquiópodos del Moscoviense inferior y del Podolskiense contienen muchas especies conocidas de los niveles marinos del Westfaliense C de Europa noroccidental, indicando comunicaciones directas. Los braquiópodos del Moscoviense superior y

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del Kasimoviense muestran afinidades con faunas rusas, justificando así el empleo de las unidades crono-estratigráficas rusas con preferencia sobre las de Europa noroccidental. También muestran afinidades con las faunas de los Alpes, Hungría y hasta China.

## INTRODUCTION

Brachiopod faunas from the Cantabrian Mountains, NW Spain, ranging in age from Tournaisian (or lowermost Viséan) to Stephanian A, have been investigated by the author during the last few years, first as part of a doctoral thesis (WINKLER PRINS 1968) and presently as a research project of the Rijksmuseum van Geologie en Mineralogie (National Museum of Geology and Mineralogy) in Leiden. Previous investigations on Spanish Carboniferous (brachiopod) faunas are mainly those of BARROIS (1882) and DELÉPINE (1943; DELÉPINE & LLOPIS LLADÓ 1956).

More material has recently become available, partly as the result of new collections made by the present author and partly from the investigations of Dr. R. H. WAGNER (University of Sheffield) and his associates, from E. MARTÍNEZ GARCÍA (Universidad de Oviedo), and from students of Leiden University. Although this material is too voluminous to have been studied completely, it has already yielded additional information which can be usefully summarised in terms of affinity with brachiopod faunas in other parts of the world. A comparison of the Upper Carboniferous brachiopod faunas of the Cantabrian Mountains with those of the Carnic Alps and Karavanke Mountains has been given by Professor A. RAMOVŠ (1971).

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## LOWER CARBONIFEROUS AND NAMURIAN/BASHKIRIAN FAUNAS

The brachiopod fauna of the Vegamián Formation (WINKLER PRINS 1968, Table 1) is closely comparable to the one described by NICOLAUS (1963) from the *crenistria* Zone in Germany. Species in common are, e. g., *Irboskites? culmica* (NICOLAUS), *Chonetipustula plicata* (SARRES, emend. KAYSER), *C. concentrica* (SARRES, emend. KAYSER), *Tornquistia polita* (McCOY), *T. schmiereri* PAECKELMANN, and *Globosochonetes waldschmidti* (PAECKELMANN). It also compares with faunas from Viséan shales in Poland (ZAKOWA 1962). These faunas (*Chonetipustula* sub-assemblage of WINKLER PRINS 1968) are clearly facies controlled since they occur only in dark shales, and they distinctly belong to the Culm facies realm (compare PAUL 1939). These faunas vary in age from Tournaisian (GANDL 1968, Table 4) to Lower Namurian (SCHMIDT 1951) and they are practically restricted to the European Culm Measures. However, a similar type of fauna with *Chonetipustula*, also in dark shales, has been reported from isolated localities in Thailand (REED 1920, see also KOBAYASHI 1964) and Australia (DEAR 1969). The Lower Viséan brachiopod fauna of the Genicera Formation is poor and gives no good evidence, but it seems to point to a good connection with northwestern Europe (the Cantabrian area lies well within the

Culm sea as drawn by PAUL in 1939), as was demonstrated for the cephalopods by KULLMANN (1963, p.316). In the Upper Viséan and Lower Namurian, the brachiopod faunas are even sparser and give no clue, but the cephalopods indicate that the connections with western Europe diminish and the Mediterranean influence becomes increasingly prominent (KULLMANN 1963, p.317). It is presumed that the NW European basin became separated from the main Tethyan ocean to which the Cantabrian area belonged. The absence of Gigantoproductidae and Daviesellidae in these Lower Carboniferous deposits is remarkable, since they are characteristic for this period in N. W. Europe (VAUGHAN 1915, SIMPSON 1953, MUIR-WOOD & COOPER 1960, MUIR-WOOD 1962), Poland (ZAKOWA, e. g. 1966), the U. S. S. R. (SARYCHEVA & SOKOLSKÀYA 1952, EINOR *et al.* 1965), North Africa (PAREYN 1961), and even in China (CHAO 1927, 1928), Japan (YANAGIDA 1968) and Australia (CAMPBELL & ROBERTS 1964). The explanation is found in unfavourable ecological conditions during the Lower Carboniferous in the Cantabrian area (black shales and cephalopod-bearing nodular limestones indicating quiet bottom conditions far from the coast —Culm facies of PAUL (1929) —yielding faunal assemblages described by the author in 1968 as the *Chonetipustula* sub-assemblage and the *Goniatites-Ufimia* assemblage, respectively). When the conditions became favourable for the gigantoproductids and daviesellids— during the deposition of the Valdeteja Formation in «Mountain Limestone» (or «Kohlenkalk», see also PAUL 1939) facies (see below)— these groups were apparently extinct. They are not known from deposits younger than early Namurian, and the Valdeteja Formation is of Bashkirian (Namurian C) age (cf. MOORE *et al.* 1971).

A large part of the Namurian in the Cantabrian Mountains is represented by practically unfossiliferous, black limestones (the Barcaliente Formation, see the author's description of the Valdeteja section in this volume) and contains only a few unidentified brachiopods near its top (referred to as the «*Martiniopsis*» Band). These dark limestones are followed by generally light coloured limestones of the Valdeteja Formation which contain a fairly rich fauna, especially of productid brachiopods. The brachiopod fauna has many species in common with the Viséan and Lower Namurian faunas of NW Europa (see Table VI of WINKLER PRINS 1968), e.g. *Productina pectinoides* (PHILLIPS), *Avonia (Quasiavonia) aculeata* (SOWERBY), several species of *Krotovia, Alitaria, Eomarginifera, Productus, Echinoconchus* and *Antiquatonia, Balakhonia continentalis* (TORNQUIST) and *Fluctuaria undata* (DEFRANCE). These species, however, occur for a large part also in North Africa (PAREYN 1961) and the U. S. S. R. (STEPANOV *et al.* 1937, SARYCHEVA & SOKOLSKAYA 1952), and partly in younger strata than in western Europe. SEMIKHATOVA (1969) has listed Bashkirian brachiopod faunas from the type area, several of which are also found in the Valdeteja and San Emiliano formations (*Echinoconchus punctatus* (SOWERBY), *Productus concinnus* SOWERBY, *Antiquatonia* ex gr. *hindi* (MUIR-WOOD) and *Fluctuaria undata* (DEFRANCE). Other brachiopods are closely related to or perhaps even identical with Spanish forms: e.g. compare *Linoproductus postovatus* SEMIKHATOVA with *Ovatia ovata* (HALL), and *Eomarginifera laqueata* (MUIR-WOOD) with *E. lobata* (SOWERBY) (see the discussion of this species by the author in 1968, p. 83). A compar-

ison with Russian species was unfortunately not possible since the descriptions by SEMIKHATOVA were not yet available to the author. More similarities may be found when the spiriferids of the Cantabrian Mountains are sufficiently studied, since several species of *Choristites*, *Martinia* and *Phricodothyris* are present. The productid brachiopods mentioned above are mainly confined to well-aerated, shallow seas and are principally found in deposits of Carboniferous Limestone facies, like the Valdeteja Formation. A migration from the Mediterranean area (Russia included) seems more probable than a direct link with NW Europe; considering also the fact that faunal connections shifted during the Viséan from NW Europe to the Mediterranean area. The affinities with the Bashkirian fauna of Bashkiria and the presence of Moscovian elements, e.g. *Dictyoclostus? inflatiformis* IVANOV, *Chaoiella gruenewaldti* (KROTOW) and *Reticulatia moelleri* (STUCKENBERG), support this conclusion. The coral fauna of the Valdeteja Formation shows some connection with North America in the presence of *Leonardophyllum* (see the note on *Leonardophyllum leonense* by DE GROOT, *in* WINKLER PRINS 1971). For the brachiopods, however, the American influence becomes only perceptible in the Upper Bashkirian and lowermost Moscovian deposits (e. g. the San Emiliano Formation), an exception being made for the earlier occurrence of *Ovatia ovata* (HALL), which is also known from Russia. Examples are *Neochonetes acanthophorus* (GIRTY), *Chonetinella flemingi crassiradiata* (DUNBAR & CONDRA) and, somewhat higher in the Lower Moscovian, *Echinaria* cf. *semipunctata knighti* (compare DUNBAR & CONDRA 1932). The San Emiliano Formation and related deposits further contain similar Viséan and Lower Namurian species known also from NW Europe, together with some younger faunal elements, as in the Valdeteja Formation.

## MOSCOVIAN AND KASIMOVIAN FAUNAS

The Lower Moscovian fauna of La Camocha (the *Cancrinella-Tornquistia* Zone of WINKLER PRINS 1968, p.66) contains many forms known from the lowermost Westphalian C marine bands of N. W. Europe, for example *Productus carbonarius* DE KONINCK, *Cancrinella craigmarkensis* (MUIR-WOOD) and *Tornquistia diminuta* (DEMANET) (compare CURRIE, DUNCAN & MUIR-WOOD 1937, DEMANET 1943). They are considered to occur earlier in Spain (no rich brachiopod faunas are known from the Lower Westphalian of NW Europe), especially since they belong to genera known from the Lower Carboniferous onwards. The occurrence in Spain of these and other species (see below) supports the idea of a southern origin for at least part of these faunas (RAMSBOTTOM 1952, p.19) and even suggests that the transgression in northwestern Europe may have come from the western Mediterranean area.

In the Upper Moscovian and perhaps uppermost Lower Moscovian (upper Kashirian), several rich brachiopod faunas occur. These have been described as the *Kozlowskia-Karavankina* Zone by the author in 1968. Originally, this zone was considered to be confined to the lower Westphalian C (upper Kashirian and lower Podolskian), but recent investigations (e. g. WINKLER PRINS, *in* VAN LOON 1971)

have shown that this zone is much broader and possibly ranges throughout the Podolskian and including perhaps also the upper Kashirian and the lower Myachkovian. These Podolskian faunas have several species in common with Westphalian C marine bands, but in contrast to the fauna of La Camocha (see above) they belong especially to more modern genera occurring for the first time in western Europe. Examples are *Kozlowskia aberbaidenensis* (RAMSBOTTOM), *Dictyoclostus? aegiranus* BÖGER & FIEBIG and possibly *Karavankina rakuszi* WINKLER PRINS (compare RAMSBOTTOM 1952, BÖGER & FIEBIG 1963). The Podolskian deposits, such as the Pando Formation (see VAN LOON 1971), contain many species which are closely related or identical to those from the Carnic Alps (RAMOVŠ, this volume), Hungary (RAKUSZ 1932), the U. S. S. R. (e. g. SARYCHEVA 1968) and even from China (CHAO 1927), as, for example, *Avonia (Quasiavonia) echidniformis* (CHAO), *Karavankina* cf. *dobsinensis* (RAKUSZ), *Juresania* cf. *kalitvaensis* (LICHAREW), *Orthotetes radiata* (FISCHER DE WALDHEIM), *Brachythyrina strangwaysi* (DE VERNEUIL) and *Zaissania* sp. On the other hand, *Linoproductus magnispinus* (DUNBAR & CONDRA) points to a connection with North America. The occurrence of *Isogramma davidsoni* (BARROIS), which is closely related to *I. paotechowensis* (GRABAU & CHAO), in Kashirian deposits from the railway section south-east of Villanueva de la Tercia (MOORE, NEVES, WAGNER & WAGNER-GENTIS 1971) is of interest since species of this peculiar genus are found on both the Eurasian and North American continents.

The Myachkovian and Kasimovian faunas (especially from the Corisa and Brañosera formations in N Palencia) are as yet insufficiently known to give a detailed zonal subdivision, but the preliminary results (WINKLER PRINS *in* WAGNER & WINKLER PRINS 1970, *in* WAGNER & VARKER 1971, and *in* VAN LOON 1971) indicate that this will be possible, since differences of stratigraphic importance are found. These faunas have no longer elements in common with the NW European faunas of Westphalian C age and they show close affinities to the faunas from the Alps and the U. S. S. R. (IVANOVA 1958, VOLGIN 1960, SARYCHEVA 1968, a. o.). Some species already occurred in the Podolskian deposits mentioned above, e. g. *Avonia (Quasiavonia) echidniformis* (CHAO), *Hustedia* aff. *remota* (VON EICHWALD) and species of *Zaissania*. Besides, *Mesolobus? sinuosus* (SCHELLWIEN), *Enteletes pentamera* (VON EICHWALD), *E. carnica* (SCHELLWIEN), *Krotovia pustulata* (VON KEYSERLING), *Karavankina paraelegans* SARYCHEVA, *Juresania subpunctata* (NIKITIN), *Alexenia* sp. ex gr. *A. reticulata* IVANOVA, *Choristites fritschi* (SCHELLWIEN), *Martinia karawanica* VOLGIN, *Cleiothyridina pectinifera* (SOWERBY), *Kitakamithyris minuta* PAVLOVA, and *Reticulariina acutiplicata* SOKOLSKAYA are found. Of special interest is the occurrence of *«Horridonia» incisa* (SCHELLWIEN) known from the Permian of the Alps and the U. S. S. R. and of *Attenuatella* aff. *frechi* (SCHELLWIEN), a species which is closely allied to SCHELLWIEN's species from Kasimovian or slightly younger deposits in the Alps, and which may eventually prove to be identical (WAGNER & WINKLER PRINS 1970). These are the only Carboniferous representatives of the otherwise Permian genus *Attenuatella* (compare ARMSTRONG 1968). The affinities to the Upper Pennsylvanian faunas of the U. S. A. are slight, but present.

The Upper Moscovian brachiopod faunas of the Sama Formation (Central Asturian Coalfield) (DELÉPINE 1943, WINKLER PRINS *in* VAN AMEROM, BLESS & WINKLER PRINS 1970) show on the contrary closer affinities to the American faunas than to the Russian ones, e. g. the occurrence of *Kozlowskia splendens* (NORWOOD & PRATTEN). This may be due to a different environment, or to a difference in palaeogeographic position, since they occur on the other side of the Cantabrian Block. A Moscovian fauna found somewhat more to the east (near Campo de Caso, in the Escalada Formation) is comparable to that of the Pando Formation (compare WINKLER PRINS 1968, Table VII) and shows clear Russian and Hungarian affinities.

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