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Brachiopods and the Main Classification of the Carboniferous

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ABSTRACT: As a contribution to the discussion on the proposals for an international chronostratigraphic subdivision of the Carboniferous, the brachiopod distribution is reviewed, especially with regard to the major boundaries. Obviously not all groups prove to be equally important: the Inarticulata, Orthida, Orthotetidina, Rhynchonellida, and Terebratulida are of little value, because they are rare, show little evolutionary development, or have not been monographically treated recently. The Chonetidina and Isogrammatidae are of some interest. The most important groups are undoubtedly the Productidina and Spiriferida, both being very abundant and highly varied and showing rapid evolution. Although the evolution of the brachiopods during the Carboniferous was gradual, there were times when important changes took place. By far the most important change within the Carboniferous occurred at the Serpukhovian-Bashkirian boundary, thus supporting the proposal to use this level as the boundary of two subsystems, the Mississippian and Pennsylvanian. Another important boundary, though definitely less so, is the Middle-Upper Carboniferous boundary, which is in accordance with their proposed status as separate series within the Pennsylvanian Subsystem. A problem that arises here is that there are three levels which could be used for this boundary, as far as brachiopods are concerned: a horizon in the upper Myachkovian (within the uppermost Westphalian D), the Myachkovian-Kasimovian boundary (within the middle Cantabrian), and a horizon within the Lower Kasimovian (near the top of the Cantabrian). The Viséan-Namurian boundary, like the Bashkirian-Moscovian boundary, is far less important, though still recognizable, and it merits stage recognition.

INTRODUCTION

Being highly interested in the efforts to arrive at an international chronostratigraphic subdivision for the Carboniferous (at least for the palaeoequatorial belt) by combining the three major subdivisions (the North American, West European, and Russian ones), I was interested to know whether the brachiopod faunas could contribute.

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The preliminary proposals (Bouroz et al., 1977–1979) favoured a subdivision into two subsystems (Mississippian and Pennsylvanian), the upper subsystem being subdivided into two series (Middle and Upper Carboniferous) and the lower subsystem corresponding to the Lower Carboniferous Series. The boundary between the Lower and Middle Carboniferous series (and between the Mississippian and Pennsylvanian subsystems) was proposed to be drawn at some convenient horizon close to the present Mississippian-Pennsylvanian boundary in North America and the Lower–Middle Carboniferous boundary in the USSR (Serpukhovian-Bashkirian boundary). Such a horizon would lie within the Namurian (approximately at the base of the *Reticuloceras* Zone) and well above the Lower-Upper Carboniferous (Dinantian-Silesian) boundary of Western Europe. The boundary between the Middle and Upper Carboniferous series apparently poses less of a problem, since there is a consensus that it should be drawn close to the base of the Stephanian, or near the Desmoinesian-Missourian or Moscovian-Kasimovian boundary, all three levels being considered approximately equivalent.

In order to check the value of this scheme, as far as brachiopods are concerned, I have analysed the changes in the brachiopod faunas at the Dinantian-Silesian (Viséan-Namurian), Mississippian-Pennsylvanian (Serpukhovian-Bashkirian), and Westphalian-Stephanian (Myachkovian-Kasimovian or Desmoinesian-Missourian) boundaries. Data is compiled both from the literature and from personal observations on material collected in Europe, especially Spain (the Cantabrian Mountains with its rich faunas from middle Tournaisian to Stephanian A, or even B) but also from Great Britain, Belgium, Germany and Austria, the USSR (southern Urals and Donets Basin), and Algeria (Béchar-Kenadza region).

LOWER-MIDDLE CARBONIFEROUS BOUNDARY

The lowest possible level for this boundary lies between the Viséan and Namurian (or between the Brigantian and Pendleian of the refined British scheme) which corresponds with the Viséan-Serpukhovian boundary in the USSR, and lies within the Chesterian in North America. Due to rapid facies changes at the beginning of the Namurian in northwestern Europe, there is in that region a

marked faunal change at this horizon, and this boundary proved an excellent one for that area. Elsewhere, however, there has been no marked facies change at this level and the faunal change is much more gradual, so no major boundary was drawn.

The alternative Lower-Middle Carboniferous boundary lies between the Chesterian and Morrowan in North America, within the Namurian (approximately at the Alportian-Kinderscoutian boundary), and between the Serpukhovian and Bashkirian (in the revised sense, including the Kinderscoutian and Marsdenian) in the USSR. In North America, this level is a major break in the sedimentary record and, therefore, the Mississippian and Pennsylvanian were, and still are, considered systems there. In Western Europe, there is no major change in the sedimentation. In the USSR, locally important breaks occur (e.g. in the Moscow Basin the Bashkirian is missing), but in the Urals, for example, there appears to be gradational contact in a shallow-marine limestone sequence.

The inarticulate brachiopods show no appreciable change at either of the boundaries; they apparently had a slow evolutionary development. A good example is the Permian *Crania*? *kirkbyi* Davidson, 1858, which can hardly be distinguished from *Crania*? *quadrata* (M'Coy, 1844) sensu Brunton, 1968 (Brunton, 1968, p.7; Martínez Chacón and Winkler Prins, 1977, p.6) occurring in the Viséan and Namurian. They often show great variability (e.g. *Lingula*, see Graham, 1970) making species differentiation extremely difficult without large faunas, and they are often too poorly preserved for specific identification (see discussion of *Orbiculoidea* by Graham, 1972, p.54).

The Orthida are at the moment not very useful for detailed stratigraphic zoning in the Carboniferous, probably because no recent revision of the Carboniferous orthids exists. *Aulacella* and *Thiemella* apparently vanish before the end of the Viséan, whilst *Aulacophoria* becomes extinct in the Serpukhovian. In the Bashkirian, *Enteletes* and *Orthotichia* appear (Einor et al., 1979). So both boundaries are equally valid, as far as the Orthida are concerned.

The Isogrammatidae are represented only by the genus *Isogramma*, which ranges throughout the Carboniferous into the Permian and thus seems to have little bearing on the problem. Some Lower Carboniferous forms are, however, clearly distinct from typical *Isogramma* and belong to a new genus. This group ranges into the Serpukhovian, thus slightly supporting the upper boundary, above the Serpukhovian.

The strophomenid *Leptagonia* also ranges into the Serpukhovian (Brand, 1972). Of the Orthotetidina, *Drahanorhynchus* has been found in Spain in beds of presumably Marsdenian age, thus indicating that the genus ranges into the Bashkirian (Martínez Chacón and Winkler Prins, 1977) and probably it even occurs as high as the upper Moscovian, and *Orthotetes*, represented by one species in the Serpukhovian (Einor et al., 1979), becomes more abundant in the Bashkirian. These groups do not strongly support either of the boundaries.

Of the Chonetidina, several genera became extinct in the Tournaisian, but otherwise few appear to be confined to the Dinantian (e.g. *Airtonia*). The large Daviesiellidae (*Daviesiella, Delepinea*), considered typical for the upper Dinantian, range throughout the Serpukhovian (Einor et al., 1979) and *Megachonetes* has even been found in the Bashkirian (Martínez Chacón and Winkler Prins, 1984). Also, *Plicochonetes* possibly ranges into the Serpukhovian (see Brand, 1970b); I do not consider the Pennsylvanian *P. dotus* Sturgeon & Hoare, 1968 a true *Plicochonetes* since it is ornamented by normal branching costae instead of the typical coarse, simple costae. *Caenanoplia* has been found in the same beds with *Drahanorhynchus* and thus presumably ranges into the lowermost Bashkirian, and forms that I consider to belong to *Globosochonetes* range into the Kasimovian in Spain (Martínez Chacón and Winkler Prins, 1984). The first occurrences also clearly support the Serpukhovian-Bashkirian boundary: no new genera appear in the Serpukhovian, but several originate in the (lower) Bashkirian (e.g. *Chonetinella, Eolissochonetes, Lissochonetes, Neochonetes*).

The classic monograph on the Productidina by Muir-Wood and Cooper (1960) appears to indicate a strong case in favour of the Viséan-Namurian boundary. New information on the brachiopod faunas from the USSR, Spain, and Algeria (Pareyn, 1961; Conrad and Legrand-Blain, 1971; Legrand-Blain, 1973) has completely changed the picture. Most forms considered typical for the Viséan are known from the Serpukhovian (*Gigantoproductus, Sinuatella, Semiplanus*, or at least the Semiplanidae, see Sarytcheva and Legrand-Blain, 1977), and several even range into the Bashkirian and higher (e.g., *Proboscidella, Productina*). Only a few are rare, specialized forms (practically only known from the Viséan of Belgium), such as *Crossalosia, Cinctifera, Rugicostella, Stipulina*, the Institiferinae, and *Undaria*. The extinction of important groups in the Serpukhovian (apart from the above-named, *Carlinia, Diaphragmus, Inflatia, and Titanaria*) and the appearance of many new genera in the Bashkirian, such as *Regrantia* (a new genus of the Incisiidae, see Winkler Prins, 1984), *Cancrinella, Chaoiella, Kozlowskia, Reticulatia*, and *Rugoclostus* (evolved from *Inflatia*, see Gordon, 1974), strongly support the boundary near the top of the Serpukhovian.

The Rhynchonellida and Terebratulida are generally rather rare in the Middle and Upper Carboniferous and have been insufficiently studied to use them for detailed correlation. They might prove useful in the future but at the moment they give no clue where the Lower-Middle Carboniferous boundary should be drawn.

Some important changes occurred with the Spiriferida. *Fusella*, for example, which became extinct in the Serpukhovian, gave rise to *Brachythyrina*, appearing in the Bashkirian. It is likely that in a similar way *Neospirifer* evolved from *Spirifer* in the Serpukhovian or early Bashkirian. In North America, Sutherland and Harlow (1973) described the evolution of *Spirifer* to *Neospirifer* in the Morrowan-Atokan (early Pennsylvanian) interval in New Mexico. *Choristites* evolved rapidly during the Middle Carboniferous and presumably arose in the Serpukhovian or early Bashkirian from its Lower Carboniferous predecessors, such as *Ecochoristites* or *Eochoristites*. Similarly *Orulgania* evolved in the Bashkirian from some Lower Carboniferous predecessor (*Pseudosyrinx*?). *Davidsonina* became extinct in the Serpukhovian, whilst *Eomartiniopsis*, normally confined to the Devonian and Dinantian, has been found in the Bashkirian of the Donets Basin (Poletaev, 1975) and probably also in the Cantabrian Mountains (Martínez Chacón and Winkler Prins, 1984). *Plicotorynifer* appeared in the early Bashkirian or perhaps in the Serpukhovian. Since the internal structure of many species is poorly known and many different forms are externally similar, it is extremely difficult to judge exactly when some forms became extinct and others appeared. That important changes took place in the Serpukhovian and/or early Bashkirian is without doubt, but it is difficult to choose between the Viséan-Namurian and the Serpukhovian-Bashkirian boundaries, although the latter seems more likely.

Concluding, one can say that the brachiopod information strongly supports the placement of the Lower-Middle Carboniferous boundary approximately at the level of the Serpukhovian-Bashkirian boundary.

MIDDLE-UPPER CARBONIFEROUS BOUNDARY

This boundary is much less controversial since the three different regional boundaries, Middle-Upper Pennsylvanian (Desmoinesian-Missourian), Westphalian-Stephanian (Westphalian D–Cantabrian) and Middle-Upper Carboniferous (Myachkovian-Kasimovian), are generally considered to be approximately at the same level. I do not know of any exact correlation of the Desmoinesian-Missourian boundary with either Western Europe or the USSR. The Westphalian D–Cantabrian boundary has been accurately dated with the help of plants and fusulinids as late Myachkovian, and the Myachkovian-Kasimovian boundary as middle Cantabrian (Wagner et al., 1977).

In studying the changes in the brachiopod faunas at approximately this level, one encounters many problems because few stratigraphically sampled brachiopod faunas have been described. In older publications, notably Sarytcheva and Sokolskaya (1952), species (and genera) were taken too broadly and therefore the stratigraphic range given is also too wide. In many modern Russian publications (e.g., Abramov, 1970; Sarytcheva, 1968; Solomina, 1970) species of this age interval are simply indicated as Middle-Upper Carboniferous. This may either be due to the fact that the Myachkovian-Kasimovian boundary could not be definitely established in these regions, or that many species (and genera) already appear in the upper Myachkovian and continue into the Kasimovian. This is the case in the Cantabrian Mountains of Spain, where the Upper Carboniferous faunas start in the uppermost Westphalian D (upper Myachkovian), and the change in the brachiopod fauna is rather gradual (see Winkler Prins, in Wagner et al., 1977)

As mentioned in the foregoing chapter, the inarticulate brachiopods show no appreciable change at the Middle-Upper Carboniferous boundary either, their evolution being apparently very slow in the upper Palaeozoic.

At the generic level, there is hardly any change in the Orthida and Orthotetidina. This lack of change is considered real and not just caused by the lack of detailed studies on the Carboniferous orthids (see above). In the family Isogrammatidae, a new, as yet undescribed subgenus appears in the upper Myachkovian of the Cantabrian Mountains.

Among the Chonetidina, several survivors from the Lower Carboniferous (*Caenanoplia, Rugosochonetes*) had already disappeared in the Bashkirian; the other genera continued in the Upper Carboniferous. As a new element, *Paramesolobus* (Afanasjeva, 1975b) appears in the Kasimovian of the Russian platform, but it is found already in the upper Myachkovian (and Kasimovian) in Spain, and in North America, it is found in the Desmoinesian, if these latter forms are truly congeneric.

The Productidina evolved rapidly throughout the Carboniferous. In the Moscovian, several new genera appeared, such as *Alexenia, Echinaria,* and *Juresania.* At the end of the Moscovian, in the (upper) Myachkovian, *Calliprotonia, Jakutella, Kochiproductus, Kutorgiella, Muirwoodia, Proteguliferina,* and a new, as yet unnamed genus from the Cantabrian Mountains appeared, and in the lower Kasimovian (upper Cantabrian) *Anidanthus* is encountered for the first time. The incisiid *'Horridonia'* aff. *'H.' incisa (Regrantia cantabrica)* was originally considered typical for the Kasimovian and uppermost Myachkovian in the Cantabrian Mountains (Wagner and Winkler Prins, 1970; Wagner et al., 1977), but recently a few specimens belonging to *Regrantia* were found lower in the Moscovian and even one species most probably belonging to *Regrantia* was found in the Bashkirian (Winkler Prins, 1984). *Urushtenia* appears only higher in the Upper Carboniferous.

The Oldhaminidina make their first appearance in the Upper Carboniferous with *Poikilosakos* and *Eolyttonia,* but they are still very rare (they are, for example, unknown from the Cantabrian Mountains) and they are probably not found at the very base of the Kasimovian.

As was stated above, the Rhynchonellida and Terebratulida from the Middle and Upper Carboniferous are generally rather rare and have been insufficiently studied to use them for detailed correlation at the moment. There appear to be no important changes in these groups at the Middle-Upper Carboniferous boundary.

Like the Productidina, the Spiriferidina showed important developments in the Carboniferous. At the beginning of the Moscovian, the *Choristites* group changed into rather thin-ribbed forms; at the base of the Kasimovian they changed into large, coarse-ribbed forms such as *Choristites fritschi* (Schellwien). Other forms that appeared in the Upper Carboniferous, though probably not at its very base, are *Pterospirifer* and *Spiriferella*. *Attenuatella*, however, originated in the late Myachkovian.

CONCLUSIONS

Not all groups of brachiopods are equally important for the subdivision of the Carboniferous, as might be expected. The Inarticulata, Orthida, Orthotetidina, Rhynchonellida, and Terebratulida are considered to be of little value because they are rather rare in the Middle and Upper Carboniferous, show little evolutionary development, or have not been studied in detail recently; some could prove of considerable interest in the future, however. The most important groups are undoubtedly the Productidina and Spiriferida, both being very abundant and highly varied, and showing a rapid evolution. The Chonetidina and the small, rather rare groups of the Isogrammatidae and Oldhaminidina, which apparently lived under special conditions, are also of some interest.

When considering the different Carboniferous boundaries, it should be remembered that the evolution of the brachiopods during the Carboniferous was gradual, as is to be expected. There are, however, some levels at which important changes took place. By far the most important boundary is a horizon within the European Namurian near the Serpukhovian-Bashkirian boundary, so the proposal to use this level as the boundary of the Mississippian and Pennsylvanian subsystems (Bouroz et al., 1977–1979) is supported by the brachiopod evidence, although the exact level is difficult to establish on the brachiopod evidence. The Viséan-Namurian (Viséan-Serpukhovian) boundary is not very important as far as brachiopods are concerned, and merits only the rank of a stage boundary. A boundary of similar importance is the Bashkirian-Moscovian boundary. The Moscovian-Kasimovian (Middle-Upper Carboniferous) boundary appears to be more important, thus supporting the proposal to make it a series boundary. A special problem of this boundary is that there are several levels at which the boundary could be drawn: in the upper Myachkovian (in the uppermost Westphalian D), at the Myachkovian-Kasimovian boundary, or somewhat higher in the Kasimovian (in the upper Cantabrian), thus indicating that it was a period of important, but gradual, changes. The brachiopod evidence from the Cantabrian Mountains slightly favors the one within the upper Myachkovian.

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