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MARINE CALCAREOUS ALGAE FROM THE DEVONIAN-CARBONIFEROUS TRANSITION BEDS

by

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ABSTRACT. - The algal microflora of the Late Famennian-Early Carboniferous is cosmopolitan, undiversified, and quite uncharacteristic. It is composed of long-ranging Paleozoic taxa and witnesses no major extinction or first occurrence.

Spongiostromids (*Malacostroma, Spongiostroma*) are scarce. Among porostromids, *Girvanella* is ubiquitous, while *Sphaerocodium* slowly disappears at the base of the Carboniferous. Long-ranging nodular codiaceans *(Bevocastria, Ortonella, Garwoodia, Pseudohedstroemia, Mitcheldeania)* form complex oncolithes. Among massive codiaceans, *Poncetellina* extends up to the base of the Tournaisian. Udoteaceans and phylloids are both unknown. The extinction of the characteristic Devonian *Litanaia* flora is Late Frasnian and there is an apparent blank in the evolution of the udoteaceans until the Late Tournaisian renewal of the *Orthriosiphon* flora. Dasyclads are quite simple and represented by vermiporellids, dasyporellids, issinellids and coelosporellids. Some of the most prolific floras are composed of palaeoberesellids *(Palaeoberesella, Pseudokamaena, Kamaena, Kamaenella* and *Exvotarisella).* Solenoporids *(Solenopora, Parachaetetes, Pseudosolenopora)* are generally scarce. Among the debatable *incertae sedis* one notes occasional *Renalcis, Proninella, Wetheredella, Palaeomicrocodium, Kulikaella* and *Evlania ? Sycidium* and *Trochiliscus* are mixed with abundant umbellinids such as *Umbellina, Protoumbella, Ellenia, Biumbella* and *Quasiumbella.*

RESUME. - La microflore alguaire de la fin du Famennien et du début du Carbonifère est cosmopolite, non diversifiée et entièrement non-caractéristique. Elle est composée de taxa paléozoïques de longue durée et ne montre aucune extinction ou première apparition de quelque importance.

Les Spongiostromides (*Malacostroma, Spongiostroma*) sont rares. Parmi les Porostromides, *Girvanella* est ubiquiste tandis que *Sphaerocodium* disparaît progressivement à la base du Carbonifère. Des codiacées nodulaires, à longue durée, *(Bevocastria, Ortonella, Garwoodia, Pseudohedstroemia, Mitcheldeania)* forment des oncolites complexes. Parmi les Codiacées massives, *Poncetellina* s'étend jusqu'à la base du Tournaisien. Les Udoteacées et les phylloides sont inconnus. L'extinction de la flore caractéristique dévonienne se produit au Frasnien supérieur et il y a un vide apparent dans l'évolution des Udoteacées jusqu'au renouveau tardi-tournaisien de la flore à Orthriosiphon. Les Dasycladacées sont toutes simples et représentées par des vermiporellides, dasyporellides, issinellides et coelosporellides. Quelques-unes des flores les plus prolifiques sont composées de palaeoberesellides *(Palaeoberesella, Pseudokamaena, Kamaena, Kamaenella* et *Exvotarisella).* Les Solenoporides *(Solenopora, Parachaetetes, Pseudosolenopora)* sont généralement rares. Parmi les *incertae sedis* on remarque d'occasionnel *Renalcis, Proninella, Wetheredella, Paleomicrocodium, Kulikaella* et *Evlania ? Sycidium* et *Trochiliscus* sont mélangés à d'abondants umbellinides tels que *Umbellina, Protoumbella, Ellenia, Biumbella* et *Quasiumbella.*

INTRODUCTION

This short note describes and interprets the algal microflora of the Late Famennian-Early Tournaisian "transition beds". To avoid controversy, we have used this intentionally vague term for the sequence bridging the Late Famennian *sensu lato* to what has been considered by many to be Early Tournaisian (*pro parte*).

When compared to the underlying Givetian-Frasnian or to the overlying Tournaisian-Viséan-Namurian algal assemblages, this microflora is quite uncharacteristic. The poverty on a world-wide scale is partially due to three factors : a) the small extension of

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carbonate platforms, b) the absence of important bioconstructions, c) the widespread occurrence, mostly in North America, of sediments unfavourable to the preservation of the thalli.

a) Algae proliferate in shallow water carbonate platforms and in particular in and around reefs and lagoons (Wray, 1977; Flügel, 1982). On a world-wide scale, latest Devonian carbonate platforms are quite small compared to those of the Devonian and the Carboniferous. One will find in Lipina (1973) the geographic distribution of the "transition beds" mostly valid for Eurasia : the Franco-Belgian basin and its extension towards Germany and Poland, the Donets basin, the Petschora region, the middle and southern Urals, Kazakhstan and the Omolon Massif. In Australia, algal *Quasiendothyra* carbonate facies are known from the Canning and the Bonaparte Gulf Basins. The Crana Beds in Queensland have good cyanophytes microflora (Mamet & Roux, 1983). In North America, oxygenated algal platforms are scarce. Notable exceptions are the top of the Kugururok Formation, the upper part of the Baird Group in Alaska (Mamet & Tailleur, 1983) and the Fitchville and Pinyon Peak formations in Utah.

b) No important reef is recognized in the world at that time. Here and there, some small carbonate mounds have been reported. A notable occurrence is the bioconstruction below the original Etroeungt Limestone at Etroeungt. However these mounds do not form continuous barrier, hence the poor development of associated lagoons.

c) Lithofacies is always a very important factor in the preservation of algal thalli. The most favourable environments are protected aragonitic mats where even the most fragile cyanophytes can be preserved. In slightly more agitated facies, early cementation can fossilize the flexible phylloid algae. On the other hand, detrital environments, sandstones, siltstones, shales are unfavourable to fossilization. It is unfortunately that type of sedimentation which is widespread in the North American platform (Gutschick & Moreman, 1967). Umbellinids are the only notable exception to that distribution as they are remarkably robust and are preserved even in highly turbulent detrital facies.

It is therefore not surprising that the "Strunian" flora is quite poor and uncharacteristic. Similarly, it is not surprising that there is only one exhaustive treatment dealing with this flora, the work of Berchenko on the $C_1^t{}_a$ of the Donets (1981). For the Devonian and Carboniferous flora, refer to Mamet & Roux (1974, 1975a, 1975b, 1977 and 1983). Most of the data reported here come from personal observations, in particular for Australia and North America.

ALGAL MICROFLORA

In order to discuss the stratigraphic distribution, we will group the microflora in fifteen associations ranging from the spongiostromids-porostromids to the udoteaceans-dasycladaceans, the rhodophytes, the *incertae sedis* and the controversial taxa.

A. SPONGIOSTROMIDS

They are scarce and represented by *Malacostroma* and *Spongiostroma.* They are similar to their Devonian and Carboniferous counterparts and indicate supratidal environments.

B. POROSTROMIDS

Girvanella is ubiquitous in shallow algal mats. It is often reworked in form of pellets and lumps. It is a major constituent of encrustations, oncolites and mud-coated grains. Four species are widespread : *Girvanella problematica* Nicholson and Etheridge, *G. staminea* Garwood, *G. wetheredii* Chapman and *G. ? kasakiensis* Maslov.

The scarcity of bioconstructions readily explains the paucity of *Sphaerocodium,* and important alga forming bindstones and bafflestones. On the other hand, the *Sphaerocodium* flora, so important in Ordovician-Devonian time, peters out at the base of the Carboniferous. The genus is still abundant (*Sphaerocodium magnum* Wray) at the top of the Buttoms Beds of Australia.

C. NODULAR CODIACEANS

These highly calcified codiaceans form complex nodules and oncolites. *Bevocastria* (*Bevocastria conglobata* Garwood), *Ortonella* (mostly *Ortonella gracilis* Johnson), *Garwoodia* (*Garwoodia gregaria* Nicholson), *Pseudohedstroemia* and *Mitcheldeania* are well known in the Devonian and the Carboniferous. *Bevocastria* is particularly abundant in the Late Famennian Button Beds and in the *Quasiendothyra* layers of the Ningbing Limestone of Australia.

D. MASSIVE CODIACEANS

They are mostly Devonian, although *Poncetellina* is still known in the Tournaisian of Alaska.

E. CODIACEANS-UDOTEACEANS

Poorly calcified litanaids are characteristics of the Devonian *(Abacella, Lancicula, Litanaia, Paralitanaia, Pseudopalaeoporella)* (Poncet, 1982). They are not known in the Famennian and *a fortiori* in the "transition beds". There is therefore a wide gap in the stratigraphic distribution of the last Frasnian udoteacean

litanaids (*Litanaia perissea* Wray) and the first Carboniferous *Orthriosiphon* and *Orthriosiphonoides* (see Bassoullet *et al.*, 1983, table 16).

F. CODIACEANS?-PHYLLOIDS

As for *Sphaerocodium,* the scarcity of bioconstructions explains the absence of phylloids which are known since the Givetian (Mamet & Préat, 1983). The phylloid flora is mainly developed in the Middle Carboniferous and ranges into the Permian (Wray, 1977).

G. DASYCLADACEANS

The only ubiquitous form is *Issinella,* with *Issinella devonica* Reitlinger and *Issinella sainsii* Mamet & Roux. One has to add a few scarce vermiporellids and dasyporellids. *Eouraloporella* is known in Alaska and in the Donets.

The presence of *Dasyporella* and *Nanopora* reported by Berchenko (1981) and that of *Rhabdoporella* by Aizenberg & Braznikhova (1966) in the $C_1^t{}_a$ of the Donets deserves further confirmation. A taxonomic revision is necessary for *Dokutchavskella* which should be placed among the proninellids and for *Koninckopora antiqua* Berchenko which is to be transferred to the coelosporellids. *Coelosporella* is known from the Kugururok Limestone of Alaska (Zone 6). Finally the report of *Yukonella bamberi* Mamet & Rudloff and of *Pseudonanopora* in the Elergetkhyn Suite (Omolon Massif) by Radionova (1979) has to be revised.

After elimination of a number of doubtful descriptions, the number of *bona fide* dasyclads is quite small. Truly, they are quite undiversified.

H. PALAEOBERESELLIDS

These tubular siphonales are by far the most abundant green algae from the Middle Devonian to the Lower Carboniferous. They are ubiquitous and can form bafflestones. The transition beds contain *Palaeoberesella* (mostly *Palaeoberesella lahuseni* von Moller) (see Shilo *et al.*, 1984), *Pseudokamaena* (*Pseudokamaena armstrongi* Mamet), *Kamaena* (*Kamaena awirsi,* Mamet & Roux) and *Kamaenella.* Berchenko (1981) has added *Stylaella, Subkamaena* and *Braznikhovia. Exvotarisella* is mostly known from the Carboniferous, but also from the Devonian-Carboniferous transition of Siberia (Radionova, 1979). It is also reported from the latest Famennian of Australia (Mamet & Roux, 1983).

J. SOLENOPORIDS

Red algae are mainly represented by *Solenopora, Parachaetetes* (*Parachaetetes johnsoni* Maslov and *P. regularis* Konishi) and *Pseudosolenopora.* The three genera are not widespread. The only known exception concerns the prolific Button Beds in Australia.

K. EPIPHYTES

The cavity-dwelling *Tharama-Frutexites* have not been observed up to now. Quite common in the Frasnian (Tsien, 1979) they peter out at the base of the Famennian.

L. COCCOIDS

They are unknown, unless *Renalcis* is to be attributed to the group.

M. INCERTAE SEDIS

We have artificially grouped here a number of thalli of debatable origin.

Renalcis is present in the Kugururok Limestone, Endicott Mountains, Alaska. The genus which plays an important sedimentological role (Pratt, 1984), is mostly Cambrian-Devonian, but it is still known as high as the Viséan (Mamet & Martinez, 1981).

Proninella is illustrated from the $C_1^t{}_a$ of the Donets as "*Nodosinella*" by Aizenberg & Brazhnikova (1966). Proninellids and palaeoberesellids have the same ecology and are both quite common.

Wetheredella is mostly Ordovician-Late Devonian, but extends in the "passage beds" of Australia.

Palaeomicrocodium is a common, very shallow-water, perforating organism, cosmopolitan from Emsian to Carboniferous time.

Kulikaella has some affinities with *Fasciella* and could be the first representative of these encrusting rhodophytes.

Evlania ? is present in the "Strunian" of the Kagvik Creek section, Alaska.

N. CHAROPHYTES AND UMBELLINIDS

Charophytes such as *Sycidium* and *Trochiliscus* are quite scarce, while umbellinids are widespread : *Umbellina, Protoumbella, Eoumbella, Ellenia, Biumbella* and *Quasiumbella.* While *Umbellina bella* Maslov ? disappears in the Late Famennian, well before the "transition beds", the umbellinids become extinct in the Tournaisian.

O. CALCISPHERES

Algal kysts abound in Devonian-Middle Carboniferous lagoons. The most common are *Calcisphaera* mixed with radiospheres and parathuramminids.

In brief, of the forty mentioned genera, all of them have wide stratigraphic distribution and most of them are cosmopolitan.

As early as 1972, Mamet and Rudloff noted that the Early Tournaisian microflora of the North American Cordillera was quite poor and hard to distinguish from that of the Late Famennian. One may unfortunately extend that conclusion on a global scale.

CONCLUSIONS

Chuvashov & Riding (1984) have recently schematized the stratigraphy of 18 groups of Paleozoic algae. Their figure 1 shows a progressive evolution of the flora, with a notable exception, the Devonian-Carboniferous boundary where the epiphytes, the Moniliporellaceae and the "rothpletzellids" disappear and where the beresellids and ungdarellids-stacheeins appear for the first time.

This dramatic change cannot be conciliated with precise stratigraphic data. The epiphytes disappear at the end of the Frasnian, the Moniliporellaceae, if this group is really well-founded, are not known above the Middle Devonian, and *Sphaerocodium ("Rothpletzella")* is certainly present in the *Quasiendothyra* layers of Australia.

On the other hand, beresellids occur for the first time in Middle Carboniferous. The most primitive stacheeins appear at the very top of the Tournaisian and the flora is characteristic of the Visean-Namurian, as is the case for the ungdarellids.

In conclusion, the "transition beds" microflora is cosmopolitan and composed of genera with very long stratigraphic ranges. It is not characterized by massive extinctions or important renewals. It does not possess one single characteristic genus. Its relative poverty in codiaceans and dasyclads is readily explained by the scarcity of bioconstructions. The dissapearance of the characteristic Devonian *Lancicula-Litanaia* flora is Frasnian. The proliferation of stacheeins and of complex dasyclads such as *Eovelebitella, Pseudovelebitella, Cabrieopora,* mixed with the first aciculellids is Viséan. In between these two assemblages, the latest Famennian-earliest Tourniasian flora is grey, monotonous, and uncharacteristic.

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