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THE OCCURRENCE OF THE BLUE-GREEN ALGA Girvanella *IN THE LOWER ORDOVICIAN OF PRECORDILLERAN ARGENTINA*

ABSTRACT

The occurrence of the blue-green alga *Girvanella*, reported for the first time in the Ordovician rocks of South America (Precordilleran Argentina), allows the completion of the pattern of horizontal distribution of this organism in relation to the palaeobiogeography of the Lower Ordovician.

RIASSUNTO

La presenza dell'alga calcarea *Girvanella (Schizophyta)*, segnalata per la prima volta nell'Ordoviciano del Sud America (Precordigliera Argentina), permette una migliore conoscenza della distribuzione areale di questo organismo in relazione alla paleobiogeografia dell'Ordoviciano inferiore.

KEY WORDS

Calcareous Algae, Lower Ordovician, South America, Palaeobiogeography.

The purpose of this paper is to illustrate and document the occurrence of the blue-green alga *Girvanella* in the San Juan Limestone which outcrops in the Precordilleran Region (Cordillera frontal of San Juan, Province of San Juan).

This thick formation, already described by Harrington & Leanza (1957), is restricted exclusively to the eastern half of the Precordillera and is considered to be mainly Lower Ordovician in age.

The section studied was sampled on the right side of the valley of the San Juan River halfway between the towns of Calingasta and San Juan and on the basis of conodonts (Serpagli, 1974a) has been dated Arenigian in age.

From an examination of several samples of the sequence, it can immediately be seen that well represented facies of shallow agitated water and tidal channel often occur. These facies, from the sedimentological point of view, fit well in the lithology of San Juan Limestone already described by Serpagli (1973) as being mostly of bahaman type. Among the main constituents of the rock, besides the micritic matrix and sparry cement, occur pellets, oncoids and skeletal grains mostly coated and sometimes bored by tubular filaments of *Girvanella*. This alga is present as free tubular aggregations in sparry calcite (Pl. 1, figs. 1, 2), but usually the abundant *Girvanella* tubes form oncoids and coated grains.

In order to establish the precise palaeontological compositioin of the limestone (Gnoli & Serpagli, in press), a study has been carried out with thin sections using modal analysis by point counting. With this method it was found that *Girvanella* represents about 40% of the whole skeletal amount in the upper part of the sequence. In this case, a so high percentage of these algae, in form of oncoids and boring in a sediment of bahaman type, seems to confirm *Girvanella* as shallow water indicator (Lauritzen & Worsley, 1974) despite the fact that, till now, no confident depth limit can be set for its occurrence (Riding, 1975).

The rule of *Girvanella* as one of the many effective biological agents at work in micrite formation and as a destroyer of skeletal grains in shallow water environments has been discussed and illustrated by Klement & Toomey (1967). Even in the San Juan limestone, these primitive filamentous algae appear to have influenced the alteration and destruction of carbonate grains as well as the formation of micrite. Perhaps, part of the micrite enveloping grains could be considered the result of decay of the penetrative algal filaments. The walls of the *Girvanella* tubes are badly preserved in the bored grains; however, the bore-holes filled by micrite are often recognizable (fig. 1). The process of micrite precipitation in girvanellid bore-holes could be similar to that indicated by Bathurst (1966, p. 20) for recent skeletal grains and could occur in three successive stages:

1) the grains are bored by algal filaments (also by bacteria); 2) the algal filaments die and decay; 3) the vacated algal tubes are filled by micrite.

Fig. 1 - Bored molluscan fragment. The short strongly curved tubules along the edge of the shell resemble the ones ascribed by Johnson, H.M. (1966) to *G. problematica* var. *lumbricalis* Hoeg. The other intraclasts, illustrated in the same photomicrograph, are completely bored by algal filaments and show a micritic rim. X 75.

SYSTEMATIC DESCRIPTION

All the specimens studied are part of the palaeontological collection of Modena University (Italy) and are stored in the Museum of the Institute of Palaeontology.

Investigations and measurements on the algal material were made in thin sections using an eyepiece micrometer (100 parts) in comparison with an object micrometer (2mm/200 parts) at high magnification. Whether cross sections of tubes, as in the method used by Wood (1957, 1963), or longitudinal sections, as suggested by Johnson (1966), were utilized; some difficulties were encountered in the measurement of the internal diameters of the tubes because most of them were completely filled by micrite.

Phylum SCHIZOPHYTA (Folkemberg) Engler, 1892
Class SCHIZOPHYCEAE Cohn, 1880
« Section » POROSTROMATA Pia, 1927
Genus GIRVANELLA Nicholson & Etheridge, 1878
Type-species - Girvanella problematica Nicholson & Etheridge, 1878

Girvanella problematica Nicholson & Etheridge, 1878, emend. Wood, 1957
Pl. 1, figs. 1-4

1878 *Girvanella problematica* NICHOLSON & ETHERIDGE, p. 23, pl. 9, fig. 24.
1957 *Girvanella problematica* Nicholson & Etheridge - WOOD, pp. 26, 27, pl. 5, figs. 1-5, pl. 6, figs. 1-4.
1966 *Girvanella problematica* Nicholson & Etheridge - JOHNSON, H.M., p. 57, pl. 9, fig. 1, text-fig. 3e.
1970 *Girvanella problematica* Nicholson & Etheridge - HORNE & JOHNSON, p. 1059, pl. 141, fig. 6, pl. 142, fig. 1.
1975 *Girvanella problematica* Nicholson & Etheridge - MAMET & ROUX, pp. 141, 142, pl. 2, fig. 6-13, pl. 3, figs. 1-12, pl. 4, figs. 1-9. (*cum syn.*).
1977 *Girvanella problematica* Nicholson & Etheridge - HEROUX, HUBERT, MAMET & ROUX, p. 2870, pl. 1, figs. 2-6. (*cum syn.*).

Description - Tubes flexuous, loosely coiling and twisted together, uniform in diameter, not tapering. Often closely packed to form coatings and small nodular masses. Occasionally tubes are lying, for short distances, sub parallel, partly adhering to each other. Average external diameter of tubes 20-21 μ, ranging from 18 to 24 μ; average internal diameter of tubes 14-15 μ; wall thickness 3-4 μ. Single and repeated branching sometimes occurs at an angle of about 30-40 degrees.

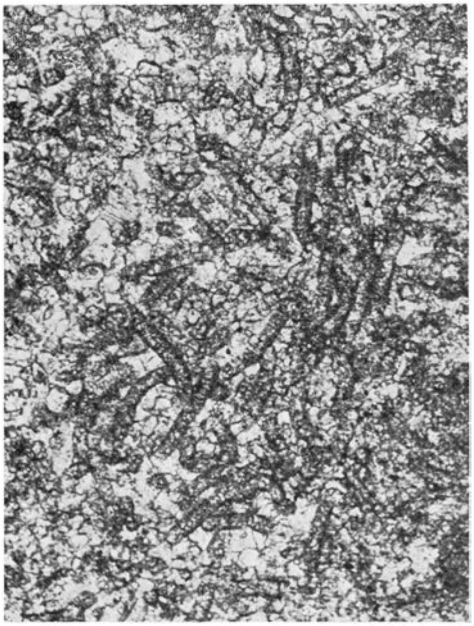
No structures are present inside the tubes or in their walls.

Remarks - All the specimens studied showed small variations in the tube diameters and in the thickness of walls, but not enough to justify a differentiation of forms at the sub-specific level. Also the limited diversity in the growth habit that is reflected in the arrangement of tubes, does not seem, in this case, a useful parameter for the taxonomy of these primitive algal forms. In complete agreement with Maslov (1949), if this primitive alga lived as a boring, encrusting, and free organism (Hessland, 1949;

EXPLANATION OF PLATE 1

Girvanella problematica Nicholson & Etheridge (Figs. 1-4)

Fig. 1 - Small aggregation of tubes in their typical arrangement. Note the single branching at the left center of photomicrograph. X 100.
Fig. 2 - Sub-parallel arrangement of tubes showing possible repeated branching. X 75.
Fig. 3 - Little algal ball composed of closely packed algal filaments. X 75.
Fig. 4 - A loose coiling of filaments to form a sub-spherical soft bioclast. Tubes are mostly filled by micrite. X. 75.



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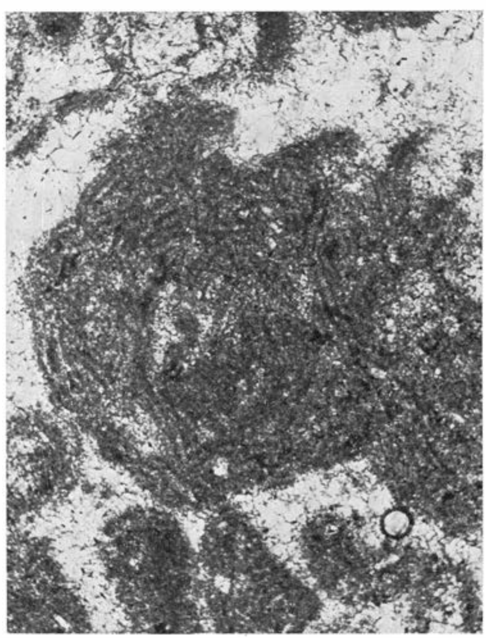

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Johnson, H.M., 1966; Klement & Toomey, 1967; Toomey, 1970; Lauritzen & Worsley, 1974), the diversity in the arrangement of tubes could be related to micro-environmental characteristic and can not always be used as specific and sub-specific distinction. In fact, on the basis of the arrangement of tubes, the specimen illustred here in fig. 1 could probably be close to *G. problematica* var. *lumbricalis* Hoeg that is considered synonim of *G. wetheredii* Chapman (Mamet & Roux, 1975, p. 141). On the other hand, on the basis of tubes diameters, this specimen belongs to *G. problematica* having a wider diameter of tubes. Leaving, however, this problem to the study of experts, because the revision of the several forms recorded up until now is not the purpose of this paper, the classification established by Mamet & Roux (1975), essentially based on the internal diameter of tubes, is here adopted.

One specimen ascribed by Johnson (1966) to *G. problematica* and regarded by Mamet & Roux (1975, p. 141) as synonim of *G. wetheredii* Chapman must be considered as true *G. problematica* because Johnson (1966, p. 57) exactly specifies an internal diameter average close to 15-16 μ.

Finally, it should be pointed out that very probably the systematic position of *Girvanella* should be re-examined (Wood, 1957, p. 27), since in the more recent studies this organism is almost always reported as being boring in habit (Klement & Toomey, 1957; Toomey, 1970; Toomey & Le Mone, 1977).

Geographic distribution - The geographic distribution of *Girvanella* during the Ordovician can be determined from reports of this alga in the literature. Specimens of *Girvanella* have been found in the British Isles, Norway, North America (Ontario, Vermont, New York, Ohio, Indiana, Nevada, Colorado, Texas, Oklahoma) and Tasmania.

The occurrence of the genus *Girvanella* in South America is reported for the first time here. This finding further emphasizes the cosmopolitan distribution of the genus in the carbonate rocks during the Ordovician.

If the occurrences of this alga are reported on the palaeogeographic map elaborated by Smith, Briden & Drewry (1973), *Girvanella* seems to have a geographic range varying from 35 degrees of South latitude to 15 degrees of North latitude (Fig. 2).

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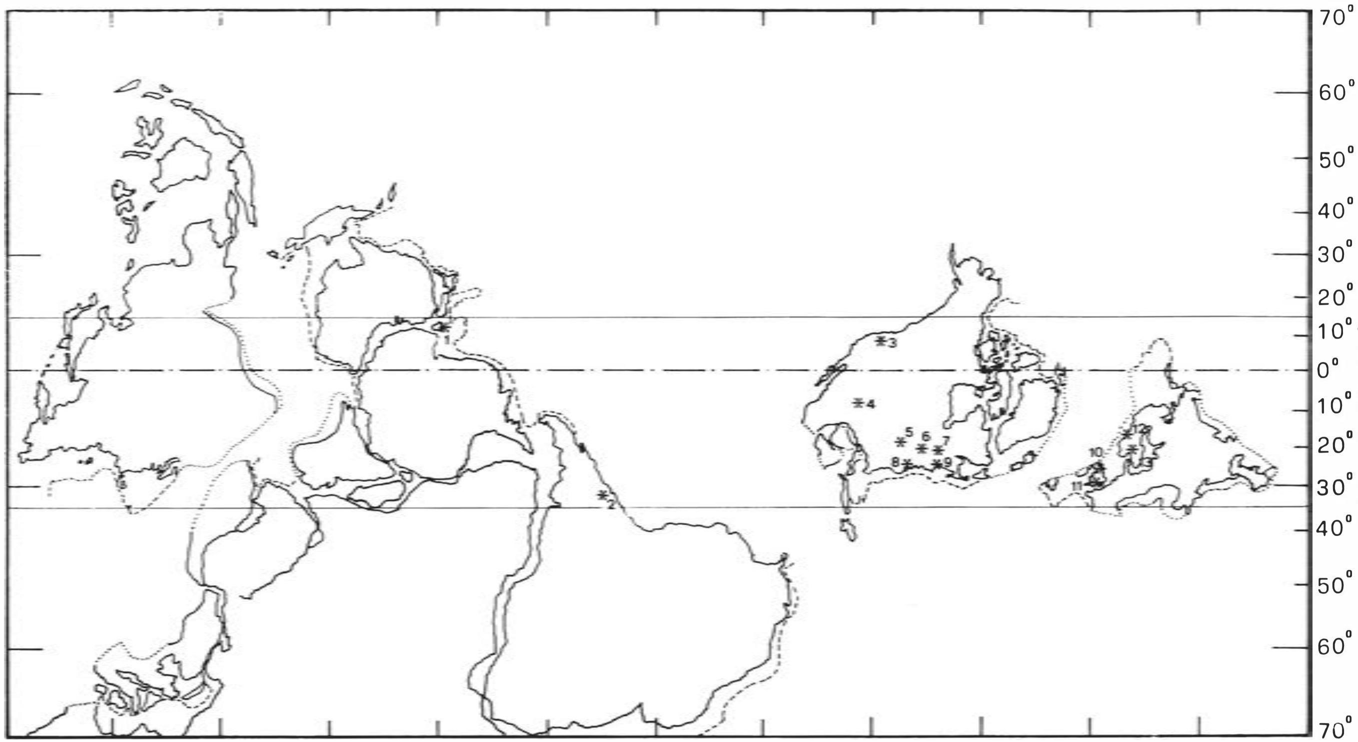

Fig. 2 - Geographic distribution of *Girvanella* during Ordovician time. 1) Tasmania, 2) Argentina, San Juan Region, 3) California- Oregon, 4) West Texas, 5) Cincinnati Region, 6) Toronto Region, 7) Ottawa Region, 8) Maryland-Virginia, 9) Vermont, 10) NE England-Scotland, 11) SW England, 12) Trondheim Region, 13) Oslo Region. Palaeogeographic map, in Mercator projection, is referred to Lower Ordovician (after Smith et al., 1973).

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