DEVONIAN ACRITARCH DISTRIBUTION AND PALAEOLATITUDES

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Devonian palaeogeographic reconstruction on the basis of acritarch (microplankton) distribution pattern of the parts of the North American and European-African continental blocks is attempted for the first time. The qualitative geographic distribution pattern of Devonian microplankton assemblages in parts of these continental blocks was not directly controlled by the depositional environment. The regional differentiation in their assemblages composition might have been determined by climatic factors. Observation made on the regional distribution of the four acritarch assemblages shows such a possibility. Occurrences of the four acritarch "groups": the *Veryhachium octoaster* species group, the *Veryhachium* (*Polyedryxium*) *pharaonis* species group, the *Cymatiosphaera* species group, and the *Multiplicisphaeridium sprucegrovensis* species group suggest distribution pettern, conforming to the climatic belts in broad terms, which parallel to the Devonian palaeolatitudes.

INTRODUCTION

The distribution of organisms (including microplankton) is determined by a complex interplay of physical, chemical, and biological factors. In modern, aqueous environments such factors as temperature, salinity, water depth, currents, oxygen content, substrate, food sources, and biological competition are probably most important influences although it may be difficult to establish which of these are dominant and which subordinate at any given time and place. It is only logical to assume that the same "hierarchy" of influences was operative in Devonian times.

Acritarchs, commonly of world wide distribution in the marine sedimentary rocks, are of great practical interest to Devonian palaeogeography. In several localities these microplanktons occur abundantly. Since these organisms being planktonic in nature, drifting in the surface waters of the oceans, there should have been only a few significant factors which controlled their qualitative distribution.

In general the palaeogeographic reconstructions on the basis of acritarch (microplankton) distribution patterns of parts of the North American, European-African and Asian continental blocks have not been attempted so far due to lack of study and insufficient data available. Cramer (1968, 1970, 1971), Cramer and Diez De Cramer (1972) are the only geologists who have attempted and ably reconstructed a Silurian palaeogeography based on certain acritarch assemblages' distribution patterns of parts of the North American and European-African continental blocks.

Cramer (1968) discussed the matter with the assumption that the qualitative, regional distribution of the acritarchs was most likely influenced by water temperature, salinity, currents, etc., and that climatic conditions were of prime importance. Climates, after all not only influence directly the temperatures, salinities, etc., but

directly also the whole circulation patterns in the atmosphere and hydrosphere. Climatic belts, however, are roughly parallel to latitudes, except where topographic features on land, or currents in the oceans may superimpose their own, local regimes.

A Devonian palaeogeography based on microplankton distribution patterns of parts of the North American and European-African continental blocks has not been reconstructed so far. Therefore an attempt was made by the author (Nautiyal 1972) for the same on the basis of acritarch evidence.

Devonian Climatic Belts

There are several criteria that may be used to delineate palaeolatitudes, especially the warm climate zones of the geologic past. Carbonates in general, and major reef deposits in particular are considered to be reliable indicators of warm climates. Irving (1964, p. 189) thus observed that Devonian carbonate deposits were most widespread in the half of the earth's surface between the 30th parallels, with a high concentration of reefs in the same areas. Schwarzbach (1963, p. 261), presumably thinking along the same lines, postulated a warm climatic belt spanning part of the European and North American continents during Devonian time, in contrast to parts of South America, Central and Southern Africa. The "warm" belts are coincident with the reef tracts and belong to the high diversification of species. As it can be observed, the tropics of the present oceans yield rich varieties of marine fauna (flora), while toward the poles the number of species decreases. Due to this diversity gradient, which is closely related to temperature, it has been suggested that when seas were warm, species diversity was high, and that cooling climates were responsible for large-scale extinctions (Valentine 1968).

Western Canada (incorporating Saskatchewan, Alberta, Great Slave Lake region), part of Eastern Canada and the U.S.A., Belgium and Spain of Central Europe and Tunisia and Northern Algeria of Northern Africa are usually shown on palaeotemperature maps to have had about the same and relatively warm climates (Schwarzbach 1961, 1963; and Nairn & Thorley 1961). There should be, therefore, similarities in assemblage composition with regard to the microplankton (Nautiyal 1972).

Evidence

In Fig. 1 the distribution pattern of 4 acritarch "groups" is outlined, in broad terms, that seem to conform to the climatic belts mentioned (Nautiyal 1972). These groups are reported from North America, Central Europe, and Northern Africa. No detailed account is available from other areas so that the picture outlined is tentative.

Devonian acritarchs (microplanktons) may be conveniently classed in 4 major "groups". The first group comprises the *Veryhachium octoaster* species group, second the *Veryhachium* (*Polyedryxium*) *pharaonis* species group, third the *Cymatiosphaera* species group, and fourth the *Multiplicisphaeridium sprucegrovensis* species group. Other acritarchs associated with these forms cannot be directly compared and seem to be endemic (Nautiyal 1972). They have to be excluded, therefore, from this discussion. The first group contains acritarchs with polygonal tests and 6 to 8

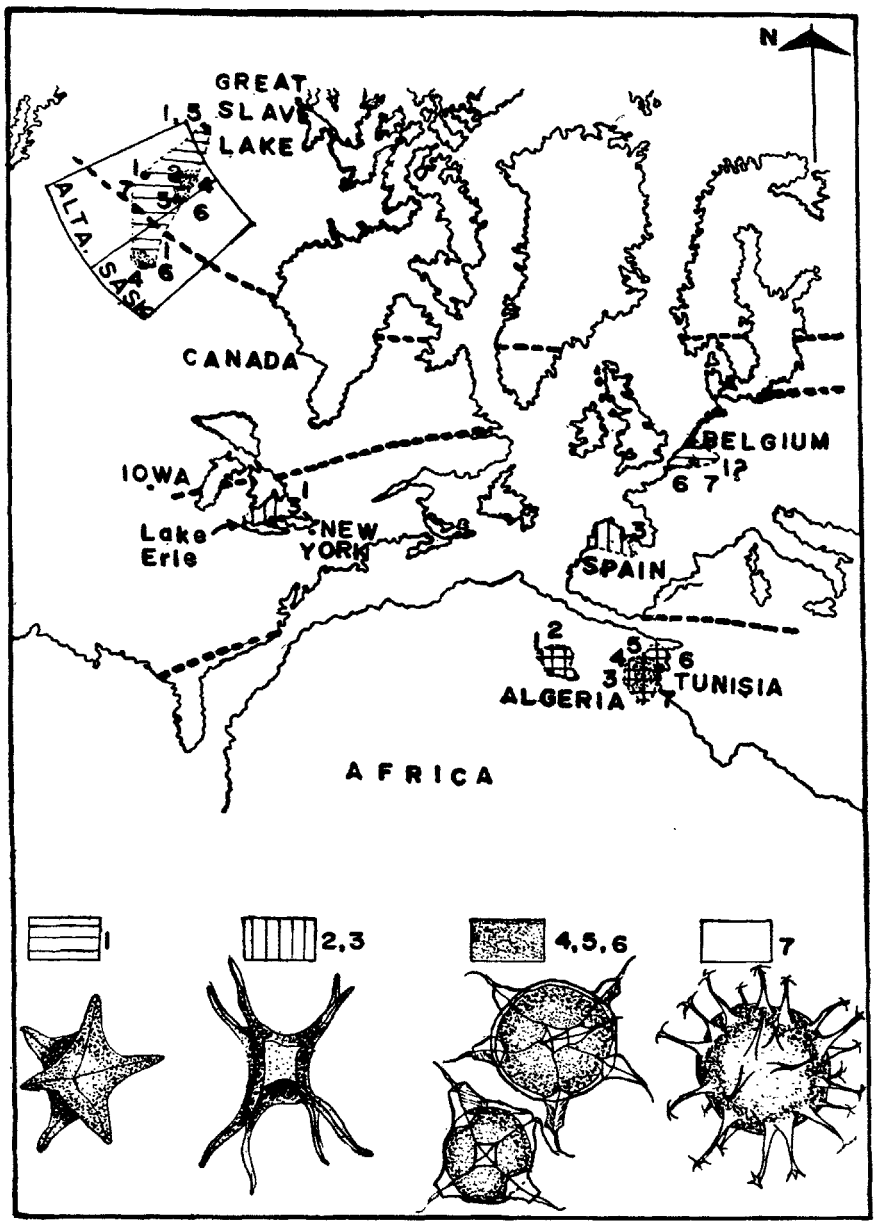

FIG. 1. Palaeogeographic distribution of Devonian acritarch assemblages. Thick, dashed lines indicate approximate limits of Devonian paleolatitudes. Continents' pre-drift position, Bullard *et al.* (1965). Shaded and dotted areas represent distribution of *Veryhachium octoaster*, *V.* (*P.*) *pharaonis* and *Cymatiosphaera* species groups. 1, *Veryhachium octoaster*; 2, *Veryhachium pharaonis cheops* Deunff = *Veryhachium* ? sp. 23 of Nautiyal (1972); 3, *Veryhachium* (*Polyedryxium*) *pharaonis;* 4, *Cymatiosphaera* sp. 3; 5, *Cymatiosphaera* sp. 6; 6, *Cymatiosphaera* sp. 4; 7, *Multiplicisphaeridium sprucegrovensis*.

processes; the second group has forms with cubical tests and 8 processes; the third one contains, in addition to others, acritarchs with spherical, subspherical, and circular tests with pyramid- and pillar-shaped, membraneous structures; and the fourth group consists of forms of circular test with 25 to 30 processes.

Devonian Acritarch Distribution

The *Veryhachium octoaster* group occurs in abundance in the Frasnian sequence of Western Canada (Alberta, Saskatchewan, and the Great Slave Lake region; Nautiyal 1972). Acritarchs that seem to be closely related to *V. octoaster* have been reported from the Devonian-Silurian "Corniferous limestone" of Central and Western New York (Fig. 1) by White (1862), *Veryhachium* aff. *V. octoaster* occurs commonly in the Frasnian shales of Belgium according to Stockmans and Willière (1962*b*). Also, *V. octoaster* is frequently found in the Lower and Middle Devonian sandstones and shales of the Polignac Basin of Northern Algeria (Jardinè & Yapaudjian 1968), and in the Famennian shales and sandstones of the Great Erg Occidental region of Northern Algeria (Lanzoni & Magloire 1969).

The *Veryhachium* (*Polyedryxium*) *pharaonis* group occurs abundantly in the Frasnian sequences of Western Canada (Nautiyal 1972) and the forms were mentioned by Deunff (1954, 1955) from the Middle Devonian rocks of Ontario, Canada. The same species group was reported to be abundant in the sandstones and shales of Lower and Middle Devonian age of the Polignac Basin of Northern Algeria by Jardiné and Yapaudjian (1968), and to be present in the Devonian sedimentary sequences of Tunisia (Deunff 1966), and in the Lower Devonian shales of Northern Spain (Cramer 1964). It may be interesting to note that several forms of the genus *Polyedryxium,* other than *V.* (*P.*) *pharaonis* sp. group, are also confined basically to the same sequences.

The *Cymatiosphaera* group with its pyramid- and pillar-shaped membraneous structures occurs very abundantly in the Frasnian sequences of Western Canada (Nautiyal 1972) and was also reported from the Devonian rocks of Tunisia (Deunff 1966). Some questionable occurrences would be in the Frasnian sequences of Belgium (Stockmans & Willière 1962*a*; and Dricot 1967), and in the Upper Devonian sediments of Ardennes region of Belgium (Bain & Doubinger 1965). Also, Padovani (1970), in a preliminary survey, reported abundant forms of *Cymatiosphaera* and *Polyedryxium,* without giving details concerning the species, from the Devonian Cedar Valley Formation of Iowa.

The fourth and very diagnostic *Multiplicisphaeridium sprucegrovensis* group occurs commonly in the Middle Frasnian carbonate platform areas of central Alberta (Nautiyal 1972). The same species group was also reported sporadically from the Middle Frasnian sedimentary sequences of the Dinant Basin of Belgium (Dricot 1967), and *Baltisphaeridium sprucegrovensis* of Deunff (1966) occurs commonly in the Devonian sequences of Tunisia.

The regional and worldwide distribution pattern of these four remarkable acritarch groups seems to follow a broad belt, coincident with a warmer climatic belt, crossing parts of North America, Europe and Africa, as outlined in Fig. 1. It seems that the qualitative geographic distribution pattern of Devonian microplanktonic

assemblages, as demonstrated by the 4 "groups" of acritarch, was not directly connected to differences in depositional environment. It follows Devonian palaeolatitudes, and appears therefore to be climatically influenced. In the map of Fig. 1, the continents are shown in a pre-drift position, as reconstructed by Bullard *et al.* (1965). However, this should not indicate support of the continental drift theory using this particular acritarch distribution. In general the present data neither support nor contradict the hypothesis of continental drift.

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